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FEBRUARY 1978/$1

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SN7405	.19	.20
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SN7408	.21	.22
SN7410	.19	.20
SN7413	.39	.40
SN7414	.65	.66
SN7416	.29	.30
SN7417	.35	.36
SN7420	.19	.20
SN7423	.29	.30
SN7426	.25	.26
SN7427	.25	.26
SN7430	.29	.30
SN7432	.25	.26
SN7437	.25	.26
SN7436	.29	.30
SN7440	.19	.20
SN7442	.69	.70
SN7443	.69	.70
SN7444	.65	.66
SN7445	.99	1.00
SN7446	1.35	1.36
SN7447	1.25	1.26
SN7448	1.35	1.36
SN7450	.19	.20
SN7451	.19	.20
SN7453	.19	.20
SN7454	.19	.20
SN7455	.19	.20
SN7460	.19	.20
SN7462	.19	.20
SN7464	.19	.20
SN7465	.19	.20
SN7470	.25	.26
SN7471	.25	.26
SN7472	.25	.26
SN7473	.55	.56
SN7474	.29	.30
SN7475	.79	.80
SN7476	.59	.60
SN7478	.59	.60
SN7480	.29	.30
SN7482	.39	.40
SN7483	.99	1.00
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SN7486	.39	.40
SN7488	1.95	1.96
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SN7492	.45	.46
SN7493	.49	.50
SN7494	.69	.70
SN7495	.69	.70
SN7496	.69	.70
SN7498	.69	.70
SN74100	1.49	1.50
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SN74123	.69	.70
SN74125	.59	.60
SN74126	.39	.40
SN74132	1.25	1.26
SN74140	.99	1.00
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SN74145	1.25	1.26
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SN74150	.99	1.00
SN74151	.99	1.00
SN74153	.99	1.00
SN74154	1.75	1.76
SN74155	.79	.80
SN74156	.69	.70
SN74157	.99	1.00
SN74158	.99	1.00
SN74160	1.25	1.26
SN74161	1.25	1.26
SN74163	1.19	1.20
SN74164	.99	1.00
SN74165	1.25	1.26
SN74166	1.25	1.26
SN74173	1.25	1.26
SN74174	1.49	1.50
SN74175	.99	1.00
SN74177	.79	.80
SN74179	1.49	1.50
SN74180	.49	.50
SN74182	.69	.70
SN74190	1.49	1.50
SN74191	1.75	1.76
SN74192	.85	.86
SN74193	.85	.86
SN74194	1.25	1.26
SN74195	.49	.50
SN74197	.75	.76
SN74199	1.75	1.76
SN74200	5.50	5.51
SN74251	1.75	1.76
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LM324N	1.75	1.76
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LM704H	.29	.30
LM709N-H	.25	.26
LM710N	.39	.40
LM733N	.79	.80
LM739N	.89	.90
LM741V-N-H	.29	.30
LM1304	.79	.80
LM1310	.99	1.00
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LM1458V	.69	.70
LM1800N	.99	1.00
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LM4250	1.19	1.20
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LM75453	.39	.40
LM75491	.79	.80
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30—WIRE NUTS, ties, 2 bare ended wires together (2E3724)	1.19
3—BLANK PC BOARDS, 4x6's, double sided, G-10 (2E3833)	1.19
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50—POWER RESISTORS, wirewound, vit, sq, up 25 w. asst (2E228)	1.19
60—COILS AND CHOKES, r-f, ant, parasitic, i-f, etc. (2E297)	1.19
75—HALF WATTERS, resistors, color-coded, carbo-film, most pop (2E454)	1.19
10—SOLAR CHIPS, silicon, "broken energy", each chip 0.5v. asst mils (2E5083)	1.19

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Type	Sale
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74LS02	.32
74LS04	.35
74LS08	.32
74LS10	.32
74LS11	.32
74LS13	.64
74LS20	.32
74LS21	.32
74LS22	.32
74LS27	.39
74LS30	.32
74LS32	.39
74LS37	.45
74LS38	.45
74LS42	1.19
74LS47	.99
74LS74	.49
74LS90	.89
74LS92	.89
74LS93	.89
74LS109	.58
74LS112	.58
74LS113	.58
74LS114	.49
74LS132	1.19
74LS138	1.24
74LS139	1.24
74LS151	1.25
74LS153	1.25
74LS155	1.25
74LS160	1.47
74LS161	1.47
74LS162	1.47
74LS163	1.47
74LS168	1.68
74LS169	1.68
74LS173	1.68
74LS174	1.05
74LS190	1.77
74LS191	1.75
74LS192	1.75
74LS193	1.75
74LS195	1.25
74LS197	1.25
74LS257	1.35
74LS266	.54
74LS366	.66
74LS368	.69
74LS390	2.95

C-MOS

Order By Cat. No. 2E2320 & Type No.

Type	Sale
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CD4001	.29
CD4002	.29
CD4006	1.19
CD4007	.29
CD4008	.79
CD4009	.59
CD4010	.59
CD4011	.29
CD4012	.29
CD4013	.69
CD4015	1.19
CD4016	.49
CD4017	1.19
CD4018	1.19
CD4019	.49
CD4020	.99
CD4021	1.29
CD4022	1.19
CD4023	.29
CD4024	.79
CD4025	.34
CD4027	.69
CD4028	.89
CD4029	1.19
CD4030	.49
CD4033	1.60
CD4035	.99
CD4040	1.19
CD4041	1.25
CD4042	.88
CD4046	1.79
CD4049	.49
CD4066	.79
CD4071	.29

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7400N TTL

SN7400N	.16	SN7472N	.39	SN74160N	1.25
SN7401N	.18	SN7473N	.39	SN74161N	.99
SN7402N	.20	SN7474N	.35	SN74162N	1.95
SN7403N	.20	SN7475N	.50	SN74163N	.99
SN7404N	20	SN7476N	.35	SN74164N	99
SN7405N	20	SN7479N	5.00	SN74165N	.99
SN7406N	.35	SN7480N	.50	SN74166N	1.25
SN7407N	.35	SN7482N	.99	SN74167N	3 25
SN7408N	.20	SN7483N	.70	SN74170N	2 10
SN7409N	.25	SN7485N	.89	SN74172N	6 00
SN7410N	.20	SN7486N	.39	SN74173N	1 50
SN7411N	30	SN7488N	3.50	SN74174N	1 25
SN7412N	.35	SN7489N	2.49	SN74175N	.99
SN7413N	.69	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.75	SN74177N	.79
SN7416N	.35	SN7492N	.49	SN74179N	2.49
SN7417N	.35	SN7493N	.49	SN74180N	.99
SN7420N	.20	SN7494N	.79	SN74181N	2.49
SN7421N	.39	SN7495N	.79	SN74182N	.95
SN7422N	.49	SN7496N	79	SN74184N	1 95
SN7423N	.37	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	1.25	SN74186N	15 00
SN7426N	.29	SN74107N	.39	SN74187N	6.00
SN7427N	.37	SN74109N	.95	SN74188N	3.95
SN7429N	.42	SN74116N	1.95	SN74190N	1.79
SN7430N	.25	SN74121N	.39	SN74191N	1.25
SN7432N	.25	SN74122N	.39	SN74192N	89
SN7437N	.35	SN74123N	.50	SN74193N	89
SN7438N	.35	SN74125N	.60	SN74194N	1.25
SN7439N	.25	SN74126N	.60	SN74195N	.75
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SN7441N	89	SN74136N	.95	SN74197N	1.00
SN7442N	.69	SN74141N	1.15	SN74198N	1 75
SN7443N	.75	SN74142N	2.95	SN74199N	1.75
SN7444N	.75	SN74143N	3.25	SN74200N	5.59
SN7445N	.75	SN74144N	3.00	SN74251N	1.79
SN7446N	.89	SN74145N	1.15	SN74279N	.90
SN7447N	.69	SN74147N	2.35	SN74283N	2.25
SN7448N	.89	SN74148N	2.00	SN74284N	6.00
SN7450N	.25	SN74150N	1.25	SN74285N	6.00
SN7451N	.25	SN74151N	.79	SN74365N	.75
SN7453N	.25	SN74153N	.89	SN74366N	.75
SN7454N	.25	SN74154N	1.25	SN74367N	.75
SN7459A	.25	SN74155N	.89	SN74368N	.75
SN7460N	.25	SN74156N	.89	SN74390N	2.25
SN7470N	.45	SN74157N	.89	SN74393N	2.25

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CD4001	.23	CD4046	1.79	MC14562	14.50
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CD4006	1.19	CD4048	1.35	MC14583	3.50
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CD4010	.49	CD4051	1.19	74C02	.55
CD4011	.23	CD4053	1.19	74C04	.75
CD4012	.25	CD4056	1.49	74C10	.65
CD4013	.39	CD4059	9.95	74C14	3.00
CD4014	1.39	CD4060	1.49	74C20	.65
CD4015	1.19	CD4066	.79	74C30	.65
CD4016	.49	CD4068	.39	74C42	2.15
CD4017	1.19	CD4069	.45	74C73	1.50
CD4018	.99	CD4070	.55	74C74	1.15
CD4019	.49	CD4071	.23	74C89	4.00
CD4020	1.19	CD4072	.49	74C90	3.00
CD4021	1.39	CD4076	1.39	74C93	2.00
CD4022	1.19	CD4081	.23	74C95	2.00
CD4023	.23	CD4082	.23	74C107	1.25
CD4024	.79	CD4098	2.49	74C151	2.90
CD4025	.23	MC14409	14.95	74C154	3.00
CD4026	2.25	MC14410	14.95	74C157	2.15
CD4027	.69	MC14411	14.95	74C160	3.25
CD4028	.89	MC14419	4.95	74C161	3.25
CD4029	1.19	MC14506	.75	74C163	3 00
CD4030	.49	MC14507	.99	74C164	3 25
CD4035	.99	CD4508	3.95	74C173	2 60
CD4040	1.19	CD4510	1 39	74C193	2.75
CD4041	1.25	CD4511	1 29	74C195	2.75
CD4042	99	CD4515	2.95	80C95	1.50
		CD4518	1.29	80C97	1.50

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LM301CN	.35	LM340T-12	1 25	LM741CN	.35
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LM304H	1.00	LM340T-18	1.25	LM747H	.79
LM305H	.60	LM340T-24	1.25	LM747N	.79
LM307CN	.35	LM350N	1.00	LM748H	.39
LM308H	1.00	LM351CN	.65	LM748N	.39
LM308CN	1.00	78MG	1.75	LM1303N	.90
LM309H	1.10	LM370N	1.15	LM1304N	1.19
LM309K	1.25	LM373N	3.25	LM1305N	1.40
LM310CN	1.15	LM377N	4.00	LM1307N	.85
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LM340K-8	1.35	LM709H	29	75453CN	.39
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74LS05	.35	74LS83	1.75	74LS162	1.95
74LS08	.29	74LS85	2.49	74LS163	1.95
74LS10	.29	74LS86	.49	74LS164	1.95
74LS13	.69	74LS90	.89	74LS175	1.95
74LS14	1.75	74LS92	89	74LS181	3.69
74LS20	.29	74LS93	.89	74LS190	2.49
74LS26	.39	74LS95	1.50	74LS191	2.49
74LS27	.39	74LS96	1.89	74LS192	2.49
74LS28	.39	74LS107	.59	74LS193	2.49
74LS30	.29	74LS109	.59	74LS194	1.89
74LS32	.39	74LS112	59	74LS195	1.89
74LS40	.39	74LS123	1.25	74LS253	1.75
74LS42	1.25	74LS132	1.25	74LS257	1.75
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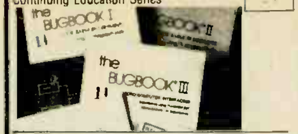

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MAN 2	5 x 7 Dot Matrix-red	300	4 95
MAN 3	Common Cathode-red	.125	.39
MAN 4	Common Cathode-red	.187	1.95
MAN 7	Common Anode-red	.270	1 25
MAN 7G	Common Anode-green	.270	1 95
MAN 7Y	Common Anode-yellow	.270	1 95
MAN 52	Common Anode-green	.300	1.00
MAN 71	Common Anode-red	.300	1.25
MAN 72	Common Anode-red	.300	1 25
MAN 74	Common Cathode-red	.300	1.50
MAN 81	Common Anode-yellow	.300	1.00
MAN 82	Common Anode-yellow	.300	1 00
MAN 84	Common Cathode-yellow	.300	1 00
MAN 3620	Common Anode-orange	300	1 00
MAN 3630	Common Anode-orange ±1	300	1 35
MAN 3640	Common Cathode-orange	.300	1 75
MAN 4610	Common Anode-orange	300	1 00
MAN 4640	Common Cathode-orange	400	1.00
MAN 4710	Common Anode-red ±1	.400	1 00
MAN 4730	Common Anode-red	.400	1 00
MAN 4740	Common Cathode-red	400	1.00
MAN 4810	Common Anode-yellow	400	1 00
MAN 6610	Common Anode-orange-D.D.	560	1 25
MAN 6630	Common Anode-orange	560	1.25
MAN 6640	Common Cathode-orange-D D	.560	1.25
MAN 6650	Common Cathode-orange ±1	560	1.25
MAN 6660	Common Anode-orange	560	1.25
MAN 6680	Common Cathode-orange	560	1.25
MAN 6710	Common Anode-red-D D	560	1 25
MAN 6730	Common Anode-red ±1	560	1.25
MAN 6740	Common Cathode-red-D D	560	1.25
MAN 6750	Common Cathode-red ±1	.560	1.25
MAN 6760	Common Anode-red	.560	1.25
MAN 6780	Common Cathode-red	.560	1.25
DL701	Common Anode-red ±1	300	1 00
DL702	Common Cathode-red	300	1.25
DL704	Common Cathode-red	.300	1.50
DL707	Common Anode-red	300	1.50
DL741	Common Anode-red	.600	1 95
DL746	Common Anode-red ±1	.630	1.95
DL747	Common Anode-red	600	2.25
DL749	Common Cathode-red ±1	.630	1.95
DL750	Common Cathode-red	600	2.49
DL338	Common Cathode-red	110	.69
FND70	Common Cathode (FND359)	250	75
FND503	Common Cathode (FND500)	500	1 29
FND507	Common Anode (FND510)	500	1.29
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CA3023	2.56	CA3083	1 60
CA3035	2 48	CA3086	85
CA3039	1 35	CA3089	3.75
CA3046	1 30	CA3091	3.50
CA3053	1.50	CA3102	2 95
CA3059	3.25	CA3123	2 15
CA3060	3.25	CA3130	1 39
CA3080	.85	CA3140	1 25
CA3081	2.00	CA3401	.49
		CA3600	1.75

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XR-205	$8.40	XR-2211CP	$6.70	XR-555CP	$ .49
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XR-2207CP	3 85	XR-1468	3 85	XR-556CP	1 85
STEREO DECODERS		XR-1488	5 80	XR-2556CP	3 20
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XR-1310EP	3 20	XR 2208	5 20	**PHASE LOCKED LOOPS**	
XR-1800P	3 20			XR-210	5 20
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				XR-567CP	1.95
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IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	16	15	24 pin	$.38	37	36
14 pin	20	19	18	28 pin	45	44	43
16 pin	22	21	20	36 pin	60	59	58
18 pin	29	28	27	40 pin	63	62	61
22 pin	37	36	35				

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin	$.27	25	24	28 pin	$.99	90	81
16 pin	30	27	25	36 pin	1 39	1 26	1 15
18 pin	35	32	30	40 pin	1 59	1 45	1 30
24 pin	49	45	42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.30	27	24	24 pin	$.70	63	57
14 pin	35	32	29	28 pin	1 10	1 00	90
16 pin	38	35	32	36 pin	1 75	1 40	1 26
18 pin	52	47	43	40 pin	1 75	1 59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.40	.38	.35	22 pin	.95	.85	.75
10 pin	45	41	37	24 pin	$1 05	95	85
14 pin	39	38	37	28 pin	1 40	1 25	1 10
16 pin	43	42	41	36 pin	1 59	1 45	1 30
18 pin	75	68	62	40 pin	1 75	1 55	1 40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	1/4 WATT 5%	50 PCS.
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	1/4 WATT 5%	50 PCS.
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	1/4 WATT 5%	50 PCS.
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	1/4 WATT 5%	50 PCS.
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	1/4 WATT 5%	50 PCS.
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	1/4 WATT 5%	50 PCS.
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	1/4 WATT 5%	50 PCS.

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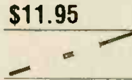

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WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation — Specify — Blue-Yellow-White-Red

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1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
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2N2484	4/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2906A	4/$1.00	2N3772	$2.25	2N5089	4/$1.00
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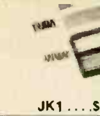
2N2925	5/$1.00	2N3904	4/$1.00	2N5138	5/$1.00
2N3035	2/$1.00	2N3905	4/$1.00	2N5139	5/$1.00
2N3055	$ .89	2N3906	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4013	3/$1.00	2N5210	5/$1.00
MJE3055	$1.00	2N4014	3/$1.00	2N5432	$2.00
2N3392	5/$1.00	2N4123	6/$1.00	2N5449	3/$1.00
2N3398	5/$1.00	PN4249	4/$1.00	2N5951	5/$1.00
PN3567	3/$1.00			C106B1SCR	2/$1.00
PN3568	4/$1.00			40409	$1.75
PN3569	4/$1.00			40410	$1.75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	04	03	001µF	.05	.04	.035
22 pf	.05	04	03	0047µF	.05	.04	.035
47 pf	.05	.04	03	01µF	.05	.04	.035
100 pf	.05	.04	03	022µF	.06	.05	.04
220 pf	.05	04	03	047µF	.06	.05	.04
470 pf	05	04	035	1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
001mf	.12	.10	.07	.022mf	.13	.11	.08
0022	.12	.10	.07	.047mf	.21	.17	.13
0047mf	.12	.10	.07	1mf	.27	.23	17
.01mf	.12	.10	.07	.22mf	.33	.27	22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	17	1.5/35V	30	.26	.21
.15/35V	.28	23	.17	2 2/25V	.31	.27	.22
.22/35V	28	.23	17	3.3/25V	.31	.27	.22
.33/35V	.28	23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	25
.68/35V	.28	.23	.17	10/25V	.40	.35	29
1 0/35V	.28	.23	.17	15/25V	63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				**Radial Lead**			
.47/50V	15	13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	11	47/50V	.16	.14	.11
3.3/50V	.15	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1 0/25V	.16	.14	.11
10/25V	.15	.13	.10	1 0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	20	.18	4.7/50V	.16	.14	.11
47 25V	.19	17	15	10/16V	.14	.12	09
47/50V	.25	.21	19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	27	100/50V	.35	30	28
1000/16V	.55	.50	45	220/16V	23	.17	16
2200/16V	.70	.62	55	470/25V	.31	.28	26

BREAD BOARD JUMPER WIRE KIT



Each kit contains 350 wires cut to 14 different lengths from 0.1" to 5.0". Each wire is stripped and the leads are bent 90° for easy insertion. Wire length is classified by color coding. All wire is solid tinned 22 gauge with PVC insulation. The wires come packed in a convenient plastic box.

JK1 . . . . $10.00 / kit

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

Provides both straight and right angle functions. Mates with standard .10" x .10" dual row connectors (i.e. 3m, Ainsley, etc.) Permits quick testing of inaccessible lines.

Part No.: 922576-26 No. of contacts: 26 Price $6.90 ea.

INTRA-SWITCH

Permits instant line-by-line switching for diagnostic or QA testing. Switches actuated with pencil or probe tip. Mates with standard .10" x .10" dual-row connectors. Low profile design. Switch buttons recessed to eliminate accidental switching.

Part No.: IS-26 No. of contacts: 26 Price $13.80 ea.

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY2.01	2.010 MHz	HC33/U	$1.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out
Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100	PINS (Wire Wrap)	$6.95
50/100A (.100 Spacing)	PINS (Wire Wrap)	$6.95

25 PIN-D SUBMINATURE (RS232)

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

HEAT SINKS

680-.75A 205-CB

205-CB	Beryllium Copper w-black finish for T0-5	$ .25
291-.36H	Aluminum for T0-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum for T0-3	$1.60
Dude 4	Black Anodized Aluminum — predrilled mounting holes for T0-3 — 4¾ x 1¼ x 2"	$1.75

Etching Kits (cannot be shipped via air)

32 X A-1	P.C. Etch Materials Kit enough for 5 circuit boards	$29.95 ea.
27 X A-1	Etched Circuit Kit	$ 9.95 ea.

Plugboards

3662	Complete kit — only add water. 6.5 x 4.5 X 1/16 Epoxy glass P-Pattern-44 P.C. Tabs-spaced .156	$ 6.95 ea.
22/44	Mating connector for plugboard — 22 pin double readout	$ 2.95 ea.
8800V	Universal Microcomputer Processor plugboard — Epoxy Glass — complete with heatsink and mounting hardware 5.313 X 10 X 1/16 copper clad	$19.95 ea.

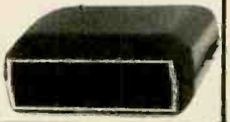
Vector

1/16 VECTOR BOARD

0.1 Hole Spacing P-Pattern

	Part No	L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

INSTRUMENT/ CLOCK CASE



Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".

$3.95 ea.

MICROPROCESSOR COMPONENTS

8080A	CPU	$16.00	CDP1802	CPU	$19.95
8212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	24.95
8214	Priority Interrupt Control	15.95	MC6820	Periph. Interface Adapter	15.00
8216	Bi-Directional Bus Driver	6.95	MC6810AP1	128 x 8 Static RAM	6.00
8224	Clock Generator/Driver	9.95	MC6830L8	1024 x 8 Bit ROM	15.00
8228	System Controller Bus Driver	10.95	Z80	CPU	29.95

CPU'S

8080A	Super 8008	16.00
2650	8 BIT MPU	26.50
P8085	CPU	29.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
2522	Dual 132 Bit SSR	2.95
2524	512 Dynamic	1.95
2525	1024 Dynamic	3.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	5.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$5.95

ROM'S

2513(2140)	Char. Gen.-upper case	$ 9.95
2513(3021)	Char. Gen.-lower case	9.95
2516	Char. Gen.	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107 5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02/91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	2 for 1.00
UPD414(2104)4K		Dynamic 16 Pin	5.95

PROMS

1702A	2048	Famos	$ 9.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	19.95
2716	16K	Eprom	34.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$5.00	11C90	19.95	7205	19.95	9368	3.95
AY-3-8500-1	8.95	4N33	3.95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	17.50	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	2.00	ICM7208	22.00	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	13.50	MK50240	17.50	MC1408L7	8.95
9374	1.95	MCM6574	13.50	DS0026CH	3.75	MC1408L8	9.95
82S115	25.00	MCM6575	13.50	TIL308	10.50		

CLOCK CHIPS

MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
CT7001	5.95

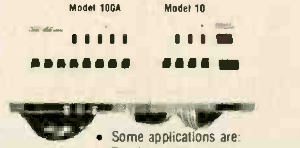
PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit

Model 100A assembled $295.00



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

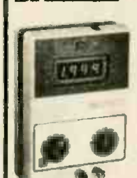
- Some applications are:
  - — Troubleshooting microprocessor address, instruction, and data flow
  - — Examine contents of ROMS
  - — Tracing operation of control logic
  - — Checking counter and shift register operation
  - — Monitoring I/O sequences
  - — Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit.

Model 10 Kit — $229.00
Model 10 Assembled — $295.00
Baseplate — $9.95
Model 10 Manual — $4.95

B&K PRECISION 3½-Digit Portable DMM



- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage = 0-1000V/ AC Voltage 0-1000V
Freq. Response: 50-400 HZ
DC/AC Current: 0-100mA
Resistance: 0-10 meg ohm
Size: 6.4" x 4.4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

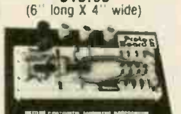
ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator — use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator — use 110 V AC — Model 100 — CAI $9.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6

$15.95
(6" long X 4" wide)



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	129.95

PROTO CLIPS

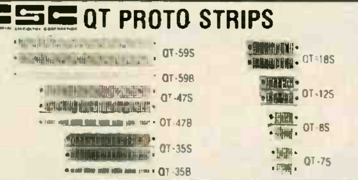
14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

DESIGN MATES

DM1 - Circuit Designer $69.95
DM2 - Function Generator $74.95
DM3 - RC Bridge $74.95

LOGIC MONITOR for DTL, HTL, TTL or CMOS Devices **$84.95**

CSC QT PROTO STRIPS



QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.30

Experimentor 300	$ 9.95
Experimentor 600	$10.95

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

NOW OPEN SATURDAYS

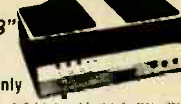
James ELECTRONICS

1978 CATALOG NOW AVAILABLE

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097

Advertised Prices Good Thru February

The Incredible "Pennywhistle 103"



$129.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space. 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) – 1070 space, 1270 mark. High – 025 space, 2225 mark.
Receive Sensitivity	-46 dbm acoustically coupled.
Transmit Level	-15 dbm nominal. Adjustable from -6 dbm to -20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

NEW! BULB-ENERGY SAVER

Bulb lasts 3 or more times longer. Fits Standard Socket 6 watts to 200 watts

BES-1 1-9 $1.50 ea. 10+ 1.25 ea.

BULB-ENERGY SAVERS used for years by major Industrial users — now available for home or office use. Bulb Savers can cut electrical bills by as much as 3%.

BULB-SAVERS lengthens light life by:

1. Acting as an electrical "shock absorber", turns the bulb on slowly, eliminating the "thermal shock". Bulb life increases 300 percent.
2. Banishes Current "Surges". Cushions line voltage surges when other loads cut power line.
3. Reduces Energy Consumption

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit	$49.00
Model 311D-5C-5V Power Kit	$17.50

JE700 CLOCK

12 or 24 Hour
115 VAC

The JE700 is a low cost digital clock but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

KIT ONLY **$16.95**

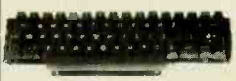
HEXADECIMAL ENCODER 19-KEY PAD

- 1 - 0
- ABCDEF
- Shift Key
- 2 Optional Keys

$10.95 each

63 KEY KEYBOARD

$29.95



This keyboard features 63 unencoded SPST keys unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications.

HD0165	Encoder Chip (encodes 16 Keys)	$7.95 ea.
AY-5-2376	Encoder Chip (encodes 88 Keys)	$14.95 ea.

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

CIRCLE NO. 27 ON FREE INFORMATION CARD

Radio Hut P

Money back guarantee. NO COD'S. Texas residents add 5% sales tax. Add 5% of order for postage and handling. Orders under $15.00 add 75 cents. Foreign orders add 20% for postage.
For your convenience, call your Bank Americard or Master Charge orders in on our Toll Free Watts Line: 1-800-527-2304. Texas residents call collect: 1-214-271-8423.

(All prices subject to change without prior notice.)
P.O. Box 38323P
Dallas, Texas 75238

VARIABLE POWER SUPPLY KIT NO. 1 ONLY $10.95

- Continuously variable from 5V to 20V
- Excellent regulation up to ½ Amp
- Kit includes all components
- Drilled fiberglass P.C. Board
- Case Included
- 4400 Mfd of filtering
- One hour assembly

VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with a 1 Amp output, also with case
ONLY $13.95

This model will power a 5 watt transistorized CB Radio

LOOK AT THIS SPECIAL FROM RADIO HUT

- Power Supply Kit: 5V1 amp reg.
- Line regulation .005%
- Load regulation 50mV

Kit includes components, PC board, transformer, fuse and pilot light. Line cord not included.

Only $6.50

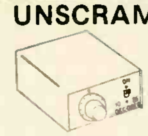
60 Hz. Crystal Time Base for Digital Clocks

$4.50
Buy 2 for $8.

A. 60 Hz. output with accuracy comparable to a digital watch.
B. Directly interfaces with all MOS clock chips.
C. Super low power consumption (1.5 ma type.)
D. Uses latest MOS 17 stage divider IC.
E. Eliminates forever the problem of AC line glitches.
F. Perfect for cars, boats, campers, or even for portable clocks at ham field days.
G. Small size, can be used in existing enclosures.

KIT INCLUDES CRYSTAL, DIVIDER IC, P.C. BOARD PLUS ALL NECESSARY PARTS & SPECS.

UNSCRAMBLER



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Plugs into earphone or external speaker of any Scanner or Monitor. Guaranteed to unscramble any 1085 call.

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- Drilled fiberglass P.C. Board
- One Hour Assembly
- Punched Case

MA 1003 CAR CLOCK FROM NATIONAL INCLUDES SPECS. AND 3 SWITCHES. $ 17.95 ALSO, THIS MONTH ONLY, FREE EDGE CONNECTOR.

7400 TTL DIGITAL CIRCUITS

7400	.11	7430	.13	7480	.31	74153	.61
7401	.13	7432	.23	7481	.55	74154	.98
7402	.13	7433	.26	7482	.57	74155	.89
7403	.13	7437	.23	7483	.67	74156	.89
7404	.15	7438	.23	7485	.89	74157	.55
74L04	.29	7440	.13	7489	1.25	74160	.55
74S04	.44	7441	.76	7490	.65	74161	.65
7405	.13	7442	.47	7491	.61	74163	.65
7406	.16	7443	.59	7492	.43	74164	.85
7407	.16	7444	.59	7493	.43	74165	.89
7408	.19	7446	.68	7494	.67	74174	.85
7409	.19	7447	.68	7495	.67	74175	.85
7410	.13	7448	.71	7496	.67	74180	.67
7411	.18	7450	.13	74100	.30	74181	1.93
7412	.26	7451	.13	74104	.49	74182	.68
7413	.37	7453	.13	74107	.26	74191	.98
7416	.15	7454	.13	74109	.31	74192	.79
7420	.13	7460	.19	74121	.29	74193	.81
7421	.13	7470	.27	74123	.48	74194	.81
7423	.25	7472	.25	74132	.99	74195	.69
7425	.29	7473	.29	74136	.99	9316	.85
7426	.24	7474	.29	745138	1.95	9601	3/$1
7427	.19	7475	.47	74141	.75	9L04	.35
7428	.26	7476	.31	74151	.61		

74LS00 LOW POWER SCHOTTKY

74LS00	.21	74LS47	.73	74LS136	.37	74LS258	.71
74LS02	.21	74LS51	.26	74LS138	.71	74LS260	.26
74LS03	.21	74LS54	.26	74LS139	.71	74LS266	.26
74LS04	.28	74LS55	.26	74LS145	1.00	74LS279	.55
74LS05	.28	74LS73	.35	74LS151	.70	74LS290	.75
74LS08	.21	74LS74	.35	74LS153	.70	74LS293	.61
74LS09	.28	74LS76	.49	74LS155	.69	74LS295	.95
74LS10	.21	74LS83	.73	74LS156	.70	74LS298	.95
74LS11	.21	74LS85	1.35	74LS157	.75	74LS365	.55
74LS13	.45	74LS86	.36	74LS158	.71	74LS366	.55
74LS14	.99	74LS90	.55	74LS160	.85	74LS367	.55
74LS15	.26	74LS92	.55	74LS161	.85	74LS368	.55
74LS20	.24	74LS93	.55	74LS162	.85	74LS390	1.75
74LS21	.28	74LS109	.38	74LS163	.85	74LS393	1.45
74LS22	.28	74LS112	.38	74LS164	1.49	74LS670	2.30
74LS26	.32	74LS113	.38	74LS168	.85	74LS192	.95
74LS27	.32	74LS114	.38	74LS169	.85	74LS193	.95
74LS30	.26	74LS122	.49	74LS170	1.69	74LS194	.95
74LS32	.32	74LS124	.99	74LS173	1.10	74LS195	.85
74LS37	.32	74LS125	.47	74LS174	1.00	74LS196	.85
74LS38	.32	74LS126	.47	74LS175	.81	74LS197	.85
74LS40	.26	74LS132	.79	74LS190	.95	74LS251	.85
74LS42	.65	74LS133	.35	74LS191	.95	74LS253	.81
						74LS257	.71

74H SERIES TTL

74H00	.18	74H21	.29	74H53	.29	74H73	.39
74H05	.29	74H40	.29	74H61	.25	74H74	.39
74H20	.29	74H50	.20	74H72	.45		

CMOS

CD400	.19	CD4017	.95	CD4040	1.00	CD4071	.19
CD4001	.19	CD4018	.95	CD4041	.69	CD4081	.19
CD4002	.19	CD4019	.19	CD4042	.69	CD4507	.35
CD4006	1.20	CD4020	.97	CD4043	.60	CD4508	2.80
CD4007	.19	CD4021	.97	CD4044	.60	CD4510	1.00
CD4009	.47	CD4022	.97	CD4046	1.39	CD4512	1.10
CD4010	.39	CD4023	.19	CD4047	1.50	CD4516	.79
CD4011	.19	CD4024	.75	CD4049	.35	CD4518	1.10
CD4012	.29	CD4025	.19	CD4050	.39	CD4520	.69
CD4013	.32	CD4027	.39	CD4051	1.19	CD4528	.85
CD4014	.78	CD4028	.85	CD4053	1.19	74C02	.45
CD4015	.78	CD4029	.99	CD4056	1.15	74C04	.32
CD4016	.32	CD4030	.35	CD4066	.78	74C107	.79

ITT HIGH LEVEL LOGIC

301	Dual 5 Input NAND Gate	.15
302	Quad 2 Input Buffer open collector	.18
303	Quad 2 Input NAND Buffer	.15
311	Master Slave F/F	.18
312	Dual JK Flip Flop	.18
321	Quad 2 Input NAND Gate	.18
322	Dual 5 Input NAND Gate	.15
323	Quad 2 Input NAND Gate	.18
324	Quad 2 input NAND Gate	.18
325	Dual 2 Dual 3 Input NAND Gate	.13
326	Dual 2 Dual 3 Input NAND Gate	.13
331	Dual 5 Input Expander	.13
332	Hex Inverter	.18
333	Hex Inverter	.18
334	Hex Inverter	.18
335	Hex Inverter	.18
342	Dual One Shot Multivibrator	.25
343	Dual 4 Bit Comparator	.22
370	Quad D Flip Flop	.22
371	Decode Counter	.30
372	Quad Ripple Counter	.39
380	BCE to Decimal Decoder	.39
381	BCD to Decimal Decoder	.39

ITT MOS TO LED DRIVERS

ITT 501 Quad Seg. Dr.	.35
ITT 502 Hex Digit Dr.	.49
ITT 503 Quad Seg. Dr.	.49
ITT 506 Hex Digit Dr.	.49
ITT 508 8 Digit Dr.	.49
ITT 509 8 Seg. Dr.	.49
ITT 511 Quad Seg. Dr.	.55
ITT 514 8 Digit Dr.	.59

We have 100's of thousands of listed parts. These parts are 100% prime.

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9003/7410	10/1.00
9004/7420	10/1.00
9006/7460	6/1.00
9007/7430	10/1.00
9009/7440	10/1.00
9016/7404	8/1.00
9024/74109	3/1.00
9300/74195	3/1.00

9000 series parts prime from ITT. Pin for Pin compatible with 7400 series.

DTL

932	Dual 4 Input Buffer	8/$1
934	Dual 5 Input NAND Gate	10/$1
941	One Shot Multivibrator	5/$1
945	JK F/F	8/$1
946	Quad 11 Input Gate NAND/NOR	8/$1
948	JK F/F	8/$1
950	F/F	10/$1
951	One Shot Multivibrator	5/$1
1800	(see 934 above)	10/$1
1806	Quad 2 Input NAND Gate	10/$1
9093	Dual JK F/F	8/$1
9094	Dual JK F/F	8/$1
9097	Dual JK F/F	8/$1
9099	Dual JK F/F	8/$1
9109	Hex Inverter	7/$1
9110	Hex Inverter	7/$1
9112	Hex Inverter	7/$1
9601	One Shot	3/$1
9930	Dual 4 Input Ext. NAND	8/$1
9932	Quad 2 Input NAND Buffer	8/$1
9945	RS F/F	8/$1
9946	Quad 2 Input NAND	8/$1
9949	Quad 2 Input NAND	8/$1
9951	Monostable Multivibrator	8/$1
9962	Triple 3 Input NAND	8/$1

HOUSE # TTL IC's

7400	10/1.00	7437	6/1.00
7404	10/1.00	7438	6/1.00
7408	10/1.00	74141	3/1.00
7420	10/1.00	74153	3/1.00

Please specify that you are ordering House Number TTL.

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300 KHz	$1.50
3.57945	1.25

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MK50252	Clock Chip	$4.99
MM5316	Clock Chip	3.75
MK50250	Alarm Clock	3.75
MK50380	Alarm Chip	2.95
FCM7010	Direct Drive Clock Chip	4.95
MK5005	4 Digit Counter w/Latch	8.50
MK5002	4 Digit Counter	8.95
MK50395	6 Digit UP/Down Counter	12.95
MK50397	6 Digit Elapsed Timer	8.95
CT5005	Calculator Chip w/Specs	1.25
MK5021	Cal. Chip w/sq. rt.	2.50

SOCKET SPECIAL! 28 PIN 1C SOCKET 3 FOR $1 WHEN PURCHASED W/CLOCK 1C

SOCKETS

- 8 Pin Low Profile .20
- 14 Pin Low Profile .22
- 16 Pin Low Profile .25
- 18 Pin Low Profile .30
- 28 Pin Low Profile .69
- 40 Pin Low profile .89

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INTERSIL DUAL TRANSISTORS
Originally Cost $3. each
Similar to 2N913
2 Per Pack 2/$1

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2N 4402 PNP	10/$1	2N 3055	.75
EN 2222 NPN	8/$1	TN 2021 By RCA	.95
EN 2907 PNP	8/$1	FET TIS 75 HOUSE #	5/$1

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20 MFD 250V	5/$1	47 MFD 35V PC Leads	10/$1
35 MFD 25V	15/$1	68 MFD 25V PC Leads	8/$1
200 MFD 25V	5/$1	330 MFD 50V PC Leads	5/$1
470 MFD 35V	4/$1	470 MFD 16V	4/$1
470 MFD 16V	4/$1	1000 MFD 35V PC Leads	4/$1
500 MFD 35V	5/$1		
2000 MFD 16V	3/$1	150 PFD MICA 5%	10/$1

COMPUTER GRADE

1,900 MFD 35WVDC (Mini)	3/$2
8,000 MFD 15WVDC	95 cents each
33,000 MFD 40WVDC	$4.00 Each

68 PFd	50V	680 PFd	50V
100 PFd	100V	.001 Fd	
150 PFd	50V	.002 MFd	50V
220 PFd	50V	.01 MFd	200V
330 PFd	50V	.02 MFd	200V
.001 UFd	500V	3.3 PF	500V
.0015 UFd	500V	4.7 PF	500V
.005 UFd	500V	8.2 PF	500V
		100PF	500V

PC Leads 25/89 cents No Mix
Long Leads 25/89 cents No Mix

TANTALUM

1 MFD20 WVDCPC Leads	15/$1
3.3 MFD35 WVDC PC Leads	8/$1
4.7 MFD10 WVDC PC Leads	5/$1
10 MFD20 WVDC PC Leads	8/$1
33 MFD10 WVDC	6/$1
22 UF10	10/$1

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The most popular digital IC's ever produced. Very hard to find!

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723 VOLTAGE REGULATORS
Output voltages variable from 2 volts to 37 volts. A very versatile and popular device.—14 PIN DIP.
69c

MOTOROLA VOLTAGE REGULATOR
MC1469R. TO-66. 9 lead package for 3 to 30V outputs. Provides 600 MA direct output or more by using an external power transistor. Regular catalog price — $4.00 each! With specs. $1.95 each

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6 Amp	50V	1.10
10 Amp	50V	1.25
25 Amp	50V	1.39

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IN 4004	1 Amp	400 V	15/$1
IN 4007	1 Amp	1000 V	10/$1

GERMANIUM DIODES

IN 54A	6/$1
IN 270	10/$1

ZENER DIODES

IN 746	3.3 V	400M	4/$1
IN 752	5.6 V	400M	4/$1
IN 1958	8.2 V	400M	4/$1
IN 5259	39 V	500M	10/$1
IN 5271	100 V	500M	10/$1
IN 5280	180 V	500M	10/$1

HOUSE # ZENER

4.7 V	500 MW	10/$1
9. V	500 MW	10/$1
10 V	1 Watt	8/$1
15 V	500 MW	10/$1
22 V	5 Watt	6/$1

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IN 4148/IN914 Long Leads	20/$1
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709	Operational Amplifier	.25
710	Differential Comparators	.40
711	Dual Differential Comp.	.35
712	Half Adder	.25
749	Stereo Pre-Amp by Fairchild	2/$1
LM 301	Operational Amplifier	.30
LM 307	Operational Amplifier	.30
LM 308	Operational Amplifier	.95
LM 309K	5V Lamp Regulator	1.49
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LM 311	Voltage Comparator	.85
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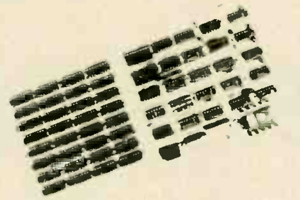
8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.



8K FOR $151.00

INTERFACE CAPABILITY
Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS
+ 8VDC 400MA DC
+ 18VDC 400MA DC
—18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

MEMORY ACCESS TIME IS 375ns.
Memory Cycle Time is 500ns.

Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

PRICES START AT $151. FOR 8K RAM KIT
Add $108.00 for each additional 8K Ram

S.D. SALES NEW EXPANDABLE EPROM BOARD

16K or 32K EPROM $49.95 w/out EPROM
Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of Eprom.

KIT FEATURES:

1. All address lines & data lines buffered.
2. Quality plated through P.C. Board, including solder mask and silk screen.
3. Selectable wait states.
4. On board regulation provided.
5. All sockets provided w/board.

WE CAN SUPPLY 450ns 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

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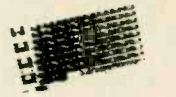
CHECK THE ADVANCED FEATURES OF OUR Z—80 CPU BOARD: Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus sockets priced for all IC's. *Add $10 extra for Z—80A chip which allows 4MHZ operation. Z—80 chip with Manual — $39.95

8K LOW POWER RAM — $159.95

Fully assembled and tested. Not a kit. Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select.



4K LOW POWER RAM KIT

Fully Buffered — on board regulated — reduced power consumption utilizing low power 21L02 — 1 500ns RAMS — Sockets provided for all IC's. Quality plated through PC board. *Add $10. for 250ns RAM operation.

The Whole Works - $79.95

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One tune supplied with each kit. Additional tunes — $6.95 each. Special tunes available. Standard tunes now available: — Dixie — Eyes of Texas — On Wisconsin — Yankee Doodle Dandy — Notre Dame — Pink Panther — Aggie War Song — Anchors Away — Never on Sunday — Yellow Rose of Texas — Deep in the Heart of Texas — Boomer Sooner — Bridge over River Kwai.

CAR & BOAT KIT $34.95 · HOME KIT $26.90 · Special Design Case $3.50

Jumbo LED Car Clock Kit

FEATURES:

A. Bowmar Jumbo .5 inch LED array.
B. MOSTEK — 50250 — Super clock chip.
C. On board precision crystal time base.
D. 12 or 24 hour Real Time format.
E. Perfect for cars, boats, vans, etc.
F. PC board and all parts (less case) inc.

Alarm option — $1.50
AC XFMR — $1.50

$16.95

DIGITAL LED READOUT THERMOMETER — $29.95

Features: Litronix dual 1/2'' displays. Uses Silicoalx LD131 single chip CMOS A/D converter. Kit includes all necessary parts (except case); AC line cord and power supply included. 0-149° F.

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2'' displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle.

AC XFMR — $1.50 Case $3.50

5 Digit Countdown Utility Darkroom Timer Kit

Features: Large LED 1/2'' displays oper. from 0.1 sec. to 59 min. 59.99 sec. 5A-115V. Relay included to control appliances. Operates on 115V AC. Displays can be turned off for total darkness while counting. All necessary parts included.
Special design case $3.75.

$44.95

6 Digit General Purpose or Computer Timer Kit — $29.95

Features: Large LED 1/2'' displays, Mostek 50397 counter display/driver, counts up to 59 minutes, 59.99 seconds with crystal controlled 1/100 second accuracy, operates on 115V AC or 12V DC supply. All necessary parts included. Special design case $3.75.

Bowmar 4 Digit LED Readout Array

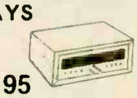
Full ½'' Litronix Jumbo Dual Digit LED Displays

4 JUMBO .50'' DIGITS ON ONE STICK!
WITH COLONS & AM/PM INDICATOR
$3.95

DL 722 - C.C.	DL 728 - C.C.
DL 721 8 C.A.	DL 727 - C.A.
99c	$1.29

NEW COMPETITION CHESS TIME KIT WITH TWO INDEPENDENT FIVE DIGIT 1/2'' LED DISPLAYS

The timers can be used independently or coupled. The timer can be set to 59 minutes 59.9 seconds at 0.1 intervals. Kit includes all necessary parts and an attractive woodgrain case.



$79.95 Complete Kit

Low Cost Cassette Interface Kit

$14.95

Features: K.C. standard 2400/1200 Hz, 300 Baud, TTL, I/O compatible, phase lock loop, 22 pin connector. Feeds serial data via microprocessors I/O ports and from cassette tape recorder. $14.95

RAM'S

21L02 - 500NS	8/11.50
21L02 - 250NS	8/15.95
2114 — 4K	14.95
1101A — 256	8/$4.00
1103 — 1K	.35
MK 4115 - 8K	15.45
74S 200 - 256	3.95

CPU'S

Z—80 includes manual	29.95
Z—80A includes manual	34.95
8080A CPU 8 BIT	11.95
8008 CPU 8 BIT	6.95

PROMS

1702A - 1K - 1.5us	3.95 or 10/35.
2708 - 8K Intel - 450ns	14.95
5204 - 4K	7.95
82S129 — 1K	2.50
2708S 8 8K signetics 650ns	9.95

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MK50397 6 Digit elapsed timer	8.95
MK50250 Alarm clock	4.99
MK50380 Alarm chip	2.95
MK50396 6 digit up/down counter	12.95
MK5002 4 digit counter	8.95
MK5021 - Cal. chip sq. root	2.50

THERMISTORS MEPCO — NEW! 1.5K OHM 5/$1.00 *

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FLAT PACK IC ASSORT. FLAT PACK 5400 SERIES. SPECIAL BUY FROM ITT. 20 Assorted Devices for $1.00 *

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STANDARD COILS Use in TV Sets. 1.2 uh 5% and 1.5 uh 10%. Your choice. 12/$1 *

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Photocell Asst. We bought almost 200K from a big US mfg. Three product families: small, medium and dual photocells. Perfect for all light sensitive applications. * 12/$1.00

PLASTIC READ-OUT FILTERS Originally used in desk top calculators. Perfect for use with LED and other type readouts. AMBER — 6 for $1. *

TTL ASSORTMENT Contains a high yield of usable parts. 50/$1.50 *

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DISC CAP ASST. PC leads. At least 10 different values; includes .001, .01, .05 plus other standard values. 60/$1.00 *

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The World's Smallest
Coded BCD Dual-In-Line
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TTL

7400	.21	7450	.21	74147	1.63	74198	1.49
7401	.21	7451	.21	74148	1.30	74199	1.49
7402	.21	7453	.21	74150	1.16	74221	.86
7403	.21	7454	.21	74151	.70	74251	1.09
7404	.21	7460	.21	74153	.65	74279	.55
7405	.21	7470	.30	74154	1.03	74298	.94
7406	.25	7472	.30	74155	.70	74365	.67
7407	.25	7473	.30	74156	.70	74366	.67
7408	.21	7474	.30	74157	.70	74367	.67
7409	.21	7475	.49	74160	.88	74368	.67
7410	.21	7476	.32	74161	.88		
7411	.21	7480	.70	74162	.88		
7412	.21	7483	.70	74163	.88		
7413	.25	7485	.89	74164	.96		
7414	.89	7486	.28	74165	1.15		
7416	.25	7489	2.19	74166	1.15		
7417	.25	7490	.44	74170	2.64		
7420	.21	7491	.70	74174	.98		
7421	.25	7492	.44	74175	.93		
7423	.35	7493	.44	74176	.79		
7425	.35	7494	.70	74177	.79		
7426	.25	7495	.70	74180	.70		
7427	.33	7496	.70	74181	2.15		
7428	.28	74100	1.28	74182	.79		
7430	.21	74107	.30	74184	2.15		
7432	.25	74109	.33	74185	2.19		
7433	.30	74116	1.26	74189	3.50		
7437	.25	74121	.35	74190	1.23		
7438	.25	74122	.44	74191	1.23		
7439	.50	74123	.61	74192	.88		
7440	.21	74125	.40	74193	.88		
7442	.53	74126	.40	74194	.88		
7445	.70	74128	.48	74195	.88		
7446	.70	74132	.70	74196	.88		
7447	.70	74141	.88	74197	.88		
7448	.70	74145	.70				

74LS00

74LS00	.28	74LS54	.28	74LS153	.75	74LS241	1.90
74LS01	.28	74LS55	.28	74LS154	1.10	74LS242	1.70
74LS02	.28	74LS73	.39	74LS155	.75	74LS243	1.70
74LS03	.28	74LS74	.39	74LS156	.75	74LS244	1.70
74LS04	.29	74LS75	.53	74LS157	.75	74LS247	.79
74LS05	.29	74LS76	.39	74LS158	.75	74LS248	.79
74LS08	.29	74LS78	.39	74LS160	1.02	74LS249	.79
74LS09	.29	74LS83	.79	74LS161	1.02	74LS251	.84
74LS10	.28	74LS85	.49	74LS163	1.02	74LS253	.84
74LS11	.28	74LS86	.39	74LS164	1.02	74LS257	.75
74LS12	.28	74LS90	.57	74LS168	1.14	74LS258	.75
74LS13	.47	74LS92	.57	74LS169	1.14	74LS260	.34
74LS14	1.02	74LS93	.57	74LS170	1.73	74LS261	2.00
74LS15	.28	74LS95	.88	74LS173	1.34	74LS266	.39
74LS20	.28	74LS96	.88	74LS174	1.06	74LS273	1.28
74LS21	.28	74LS107	.39	74LS175	.84	74LS279	.62
74LS22	.28	74LS109	.39	74LS181	2.50	74LS283	.79
74LS26	.33	74LS112	.39	74LS190	1.18	74LS290	.65
74LS27	.33	74LS113	.39	74LS191	1.18	74LS293	.65
74LS28	.33	74LS114	.39	74LS192	.98	74LS295	1.12
74LS30	.28	74LS125	.49	74LS193	1.06	74LS298	1.30
74LS32	.33	74LS126	.49	74LS194	.88	74LS365	.67
74LS33	.33	74LS132	.81	74LS195	.86	74LS366	.67
74LS37	.33	74LS136	.39	74LS196	.86	74LS367	.67
74LS38	.33	74LS138	.73	74LS197	.86	74LS368	.67
74LS40	.28	74LS139	.73	74LS221	1.06	74LS377	1.50
74LS42	.67	74LS151	.75	74LS240	1.90	74LS386	.39
74LS47	.79					74LS395	1.74
74LS48	.77					74LS670	2.34
74LS51	.28					81LS95	.77
						81LS96	.77
						81LS97	.77
						81LS98	.77

INTERFACE

8093	.40	75452	.61
8094	.40	75453	.61
8095	.67	75454	.61
8096	.67	75491	.81
8097	.67	75492	.84
8098	.67	75493	1.09
75450	.88	75494	1.19
75451	.61	MC1488N	.90
		MC1489N	.90

4000 CMOS

4000	.23	4025	.23	4072	.23
4001	.23	4026	1.68	4073	.23
4002	.23	4027	.40	4075	.23
4006	1.23	4028	.89	4078	.23
4007	.23	4029	1.14	4081	.23
4008	.79	4030	.23	4082	.23
4009	.44	4033	1.51	4502	.79
4010	.44	4034	3.50	4510	1.14
4011	.23	4035	1.14	4511	1.05
4012	.23	4040	1.14	4514	2.80
4013	.40	4041	.79	4515	2.80
4014	.96	4042	.79	4516	1.23
4015	.96	4043	.70	4518	1.14
4016	.40	4044	.70	4520	1.14
4017	1.05	4046	1.86	4527	1.68
4018	1.05	4049	.40	4528	.88
4019	.23	4050	.40	4585	1.23
4020	1.14	4051	1.26	74C00	.23
4021	1.14	4052	1.26		
4022	.96	4053	1.26		
4023	.23	4060	1.58		
4024	.84	4066	.79		
		4071	.23		

LINEAR

CA3046	.75	LM341P-6	.98	NE567V	1.36
CA3086	.50	LM341P-8	.98	UA709CV	.44
LF351N	.76	LM341P-10	.98	UA710CA	.44
LF356N	1.20	LM341P-12	.98	UA711CA	.53
LF357N	1.20	LM341P-15	.98	UA723CA	.60
LF13741	.76	LM341P-18	.98	UA733CA	.65
LM301AN	.44	LM341P-24	.98	UA741CV	.44
LM307N	.64	LM348N	1.60	UA747CA	.70
LM308N	1.00	LM349N	1.60	UA748CV	.49
LM309K	1.80	LM358N	.72	UA7805CU	1.25
LM311N	.90	LM1310N	.84	UA7806CU	1.25
LM317T	3.00	LM1800N	.94	UA7808CU	1.25
LM317MP	1.90	LM1801N	1.70	UA7812CU	1.25
LM318N	2.70	LM1812N	4.80	UA7815CU	1.25
LM320MP-5	1.30	LM1830N	1.30	UA7818CU	1.25
LM320MP-6	1.30	LM1889N	2.00	UA7824CU	1.25
LM320MP-8	1.30	LM2111N	1.25	UA78L05ACZ	.40
LM320MP-9	1.30	LM2907N	1.50	UA78L06ACZ	.40
LM320MP-12	1.30	LM2917N	1.50	UA78L08ACZ	.40
LM320MP-15	1.30	LM3089N	1.30	UA78L10ACZ	.40
LM320MP-18	1.30	LM3900N	.88	UA78L12ACZ	.40
LM320MP-24	1.30	LM3900N	.88	UA78L15ACZ	.40
LM323K	7.50	LM3905N	1.40	UA78L18ACZ	.40
LM324N	.72	LM3909N	.69	UA78L24ACZ	.40
LM325N	2.70	LM3911N	1.50	UA7905CU	1.70
LM326N	2.70	MC1456V	1.00	UA7906CU	1.70
LM327N	2.70	MC1458V	.53	UA7908CU	1.70
LM339N	1.15	MC1496N	.70	UA7909CU	1.70
LM340T-5	1.25	MC3302P	1.15	UA7912CU	1.70
LM340T-6	1.25	NE536T	2.50	UA7915CU	1.70
LM340T-8	1.25	NE540L	2.04	UA7918CU	1.70
LM340T-10	1.25	NE555V	.48	UA7924CU	1.70
LM340T-12	1.25	NE556A	.88		
LM240T-15	1.25	NE558N	2.40		
LM340T-18	1.25	NE559N	2.40		
LM340T-24	1.25	NE560B	2.50		
LM341P-5	.98	NE561B	2.50		
		NE562B	2.50		
		NE565A	1.25		
		NE566V	1.28		

MISC IC

MM5314N 3.75

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$12.95
8212	8-BIT I/O PORT	$ 3.95
8216	BI-DIRECTIONAL BUS DRIVER	$ 4.25
8224	CLOCK GENERATOR	$ 3.95
8228	SYSTEM CONTROLLER	$ 6.95
8251	COMMUNICATIONS INTERFACE	$12.95
8255	PERIPHERAL INTERFACE	$11.95
1702A	2K EPROM (256x8)	$ 6.95
2708	8K EPROM (1Kx8)	$29.50
2102-1	1K RAM 500 NS	$ 1.79
SC/MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MH-2 CLOCK 40 DIL	$24.95

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.00/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

8080A CHIP SET
ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102-1's ALL FOR — **$49.95**

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

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300 CAPS 18 VALUES $26.00

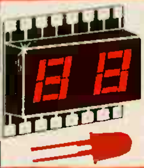
MINIBOX METALIZED POLYESTER CAPACITORS

.001	.14	1.15/10	9.00/C	.033	.15	1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15	1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36	3.00/10	24.00/C

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.12	1.00/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.51/10	12.89/C
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.11	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.29	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.29	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/100	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

LED DIGITS AND LAMPS



FND357	.375" Single Digit, CC, Red	$1.35
FND500	.5" Single Digit, CC, Red	1.35
FND507	.5" Single Digit, CC, Red	1.35
FND800	.8" Single Digit, CC, Red	2.50
FND807	.8" Single Digit, CA, Red	2.50
NSN373	.3" Dual Digits, CC, Red	2.20
NSN374	.3" Dual Digits, CA, Red	2.20
NSN583	.5" Dual Digits, CC, Red	2.60
NSN584	.5" Dual Digits, CA, Red	2.60
NSN783	.7" Dual Digits, CC, Red	3.00
NSN784	.7" Dual Digits, CA, Red	3.00

NSL5053 Dif. Red T-1¾ Lamp w Mtg. Hdwe $1.80/10 $16.00/100
NSL5056 Dif. Narrow Angle Red T-1¾ Lamp w Mtg. Hdwe $1.80/10 $16.00/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

½ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS250	Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

Bishop Graphics 5"x6" 1X Scale PC Design Template

The Digi-Key Catalog features many more quality Bishop Graphics products.

3365-ND 12.50

CLOCK MODULES

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

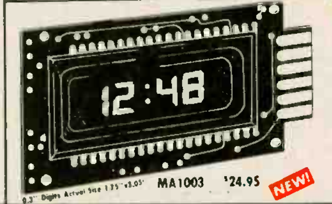
MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module w/Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$24.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module w/Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module w/Transformer & Switches	$16.45

MA1002 0.5" High Digits

Actual Size: 1.375" x3.05"

MA1010 0.84" High Digits

Actual size: 1.75" x3.75"



0.3" Digits Actual Size 1.35" x3.05" MA1003 $24.95 NEW!

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1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
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MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
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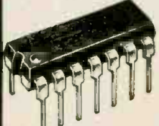

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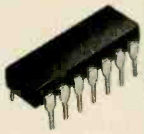

Type	Cat. No.	ONLY
7400	276-1801	35¢
7402	276-1811	39¢
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7473	276-1803	49¢
7474	276-1818	49¢
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7476	276-1813	59¢
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74145	276-1828	1.19
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29

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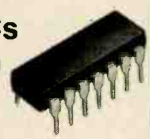

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74C74	276-2310	89¢
74C76	276-2312	89¢
74C90	276-2315	1.49
74C192	276-2321	1.69
74C193	276-2322	1.69
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4011	276-2411	49¢
4013	276-2413	89¢
4017	276-2417	1.49
4020	276-2420	1.49
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566CN	276-1724	1.69
567CN	276-1721	1.99
723CN	276-1740	69¢
741CN	276-007	49¢
741H	276-010	49¢
3900N	276-1713	99¢
3909N	276-1705	99¢
3911N	276-1706	1.99
4558CN	276-038	79¢
75491	276-1701	99¢
75492	276-1702	99¢
7805	276-1770	1.29
7812	276-1771	1.29
7815	276-1772	1.29

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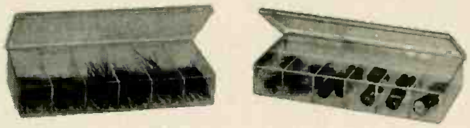

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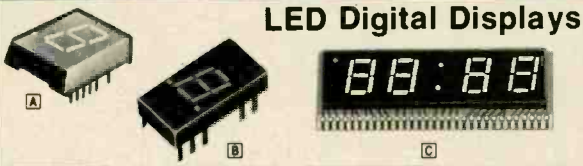
LED Digital Displays



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B 1	0.3"	Anod.	276-053	1.99
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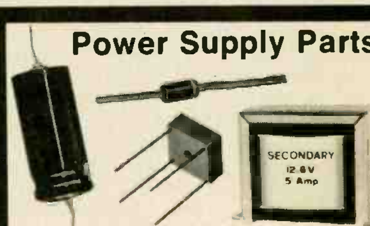
C 4	0.5"	Anod.	276-1201	6.95
C 4	0.5"	Cath.	276-1202	6.95

Power Supply Parts



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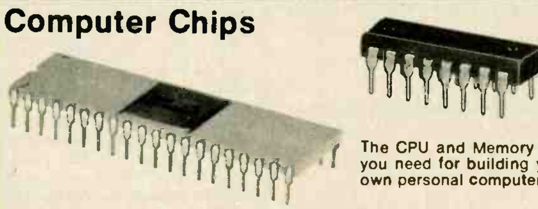

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Lafayette Model HE-15 AC, CB. Schematic and operator's manual. Ron Brunson, 16191. Azales Way, Los Gatos, CA 95030.

Lafayette Micro-P450 uhf mobile monitor receiver. Schematic and operation manual. L.A. Freel, 4725 Lane Ave. S., Jacksonville, FL 32210.

Grundig Model 5490. Schematics. John F. Pane, R.D. #1, Mason Rd., Baden, PA 15005.

National HRO-50, 60. Need coils, calibrator, original speaker. George Saunders, 28821 Portsmouth Dr., Sun City, CA 92381.

Vivitar Model RC-730 stereo cassette recorder/AM/FM radio. Schematic. R.V. Powell, 2202 Villa Dr., Greensboro, NC 27403.

Revere open-reel tape recorder Model T-1100. Schematics, instruction manual, parts information. Paul Goldwhite, 1704 Oak St., So. Pasadena, CA 91030.

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Hallicrafters Model SX105. Need schematic and service manual. Bill Bond, 521½ Elko Street, Reno, NV 89512.

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Patterson Model PR-15 communication receiver. Schematics and service manual. E.W. Clede, 6811 Spring Forest, San Antonio, TX.

Nova-Tech Pilot Pal three-band direction finder radio. Schematic and available parts source. Martin DerOvanseian, 725 Opa-Locka Blvd., Opa-Locka, FL 33054.

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Transformers, Inc., Model 214 ratiometer. Ratiometer and plug in's for 60, 400, 1000 Hz. Donald Krankkaia, 7335 Greensboro St., Goleta, CA 93017.

Regal-Eye TV camera and video monitor. Schematic and parts supply. Donald H. Palmer, 3620 Woodchase #24, Houston, TX 77042.

Dumont Labs, Inc. oscilloscope Type 224-A. Operating manual and schematics. Leonard G. Falba, 38 Bryson Rd., New Castle, PA 16101.

RCA Radiola 82. Schematic and source of tubes. **Heathkit** FM-3A. Owner's and assembly manual. Mike Miller, 202½ N. Ballston Ave., Scotia, NY 12302.

Ampex PR-10 tape deck. Source for drive belts needed. **Realistic** Patrolman-4 portable radio schematic. Bill Stottlemyer, Box A, Trezevant, TN 38258.

Military oscilloscope, Model OS62B/USM50. Schematic diagram and parts. G.M. Durrence, 1587 Coralwood Ct., Decatur, GA 30033.

Trion Instruments, LS-5 ruby laser system. Any technical information. Hajdrowski, 965 Cambridge Lane, Crystal Lake, IL 60014.

Collins surplus RT-380 (18 S-4) Autotune transceiver. Manual, schematic, conversion information. Chris Bobbitt, WDNA Radio, CPO 381, Berea, KY 40404.

Harvey-Wells Bandmaster Z-Match radio gear unit. Instruction manual. Robert Hoffmeister, 514 Esther St., N. Tonawanda, NY 14120.

Cenco #71556 oscilloscope. Operating manual and servicing information. D. Samek, 31-06 38 St., Astoria, NY 11103.

Roberts 770X tape recorder. Service manual. M. Toman, 7143 Georgia Ave., N.W., Washington, D.C. 20012.

Tektronix dual-trace oscilloscope, Model 535. **Tektronix** plug-in unit 53/54C, Model 535. **Beckman/Berkeley** Universal EPUT and Timer, model 7360W. Robert T. Kintz, 104 Council Rock Ave., Rochester, NY 14610.

Farnsworth CRT-F10-WC, BT 57 battery radio, serial No. F22520. Service information and plans for suitable ac power supply. G.W. Brown, Box 3543, Burlington NC 27215.

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Dumont Model 208-B, (ref. #DD-1789-C-2). Schematic, operation manual or supplier. D. Thorson, WB9YSE, 3365 Cardinal Dr., Brookfield, WI 53005.

Radio City Products tube and set tester. Model 802NA. Current tube chart and address of company Charles McNeely, 1999 Redstone Dr., Fairborn, OH 45324.

Marcon Electronics Corp., Western Union facsimile preamplifier Model 6575. Technical manual and schematic. Jeffrey K. White, Box 767, Athens, OH 45701.

Nihon Handotai Co. Ltd., Nippan frequency counter model FC-3A with prescaler. Schematic and specifications. J.E. James, AM- Radio Op., VE7BCJ, 1187 West 23 St., North Vancouver, B.C. V7P 2H2.

Hallicrafters Model SX-62-A shortwave receiver. Schematic. Paul S. La Follette, 229 Amesbury Circle, Sun City Center, FL 33570.

Ballantine Model 305 A-peak volt meter. **Tektronix** 180-S1 time mark generator. Manuals or any information. Clyde N. Smith, 11 Brown St., Reynoldsville, PA 15851.

Midwest Radio Corp. Model 816, series 16, serial No. 8163781. Any information and schematic. Eric L. Dreher, 838 Lois Ave., Sunnyvale, CA 94087.

Precision Instruments Model 640 tube tester. Operating instructions and data for modern tube types, socket and adapter data. Kevin Lovingood, 9 Peachtree Circle, Columbia, SC 29206.

Hallicrafters Model S-40B. Schematic, parts list, and other information. Tim Mooney, 11 Cornell Dr., Delran, NJ 08075.

Motorola 80D factory converter-12DC-146 MHz FM. Schematic and alignment data. J.H. McCune, 5617 Moravin Rd., Baltimore, MD 21206.

Tektronix Model 513D oscilloscope. Schematic, operating and maintenance manual. Frank Tattersall, 118 West St., Milford, MA 01757.

RCA Manufacturing Co., Rider Channelist. Operating manual. **Nova Tech** Pilot II four-band receiver. Maintenance and tuning alignment manual. W.L. Fenska Lot 27, 4729 Palm Beach Blvd., Fort Myers, FL 33905.

Accurate Instrument Co. Model 257 tube tester. Operating instructions, tube chart and wiring diagram. Howar J. Kaczmarek, 565 McHenry Ave., Crystal Lake, IL 60014.

Knight signal generator Model KG-696. Schematic and operation manual. John Roark, 3216 Coruus Loop, Millington, TN 38053.

Radio Shack 277-110 5 range DMM project board. Schematics, parts list, instructions. Kevin Deitrich, 8118 8th Street West, Rock Island, IL 61201.

Lafayette Model HE-10 series (A.B.C.) tube-type CB transceiver. Schematic and repairable unit. C. Pryson, 4909 Gettysburg Rd., Knoxville, TN 37921.

Carnegie AM-FM 8-track stereo console, Model #V6S039-R. Schematic. Marvin Kosmal, 1931 Palmgrove, Pomona, CA 91767.

Hammarlund HQ 145A. Schematic and alignment data. E. Lee Tolson, 135 Manistee Ave., Panama City Beach, FL 32407.

Precision VTVM series EV-10. Schematics, manuals, any information. Filbert Katz, 3311 Susan Dr., San Bruno, CA 94066.

Hallicrafters Model S-40B receiver. Schematic or any available service information. Richard Nehrbass, USS SC (CGN-37), FPO New York, NY 09501.

Hallicrafters Model S-38C. Manual and schematic. John M. Ray, 306 Simone, Carson City, NV 89701.

Brother Model 862 5-function calculator. Need schematic and green gaseous 9-digit display tube, or plans to convert to red LED display. B.S. Bridges, Box 41, Boiling Springs, NC 28017.

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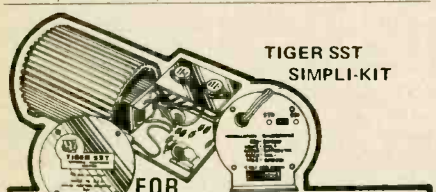

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At the top end of our line is the new Model **1850**, very conservatively rated at 520MHz. Features include: TCXO time base...Period measurements from 5Hz to 1MHz...Leading zero suppression...Bright .43" LED display... Gate times from 10 ms to 10 seconds...**$450**.

The **1820** Universal Counter is one of the most versatile counters available at any price. Frequency measurement typically extends beyond 100MHz...Period measurements from 5Hz to 1MHz . . . Period average, auto and manual positions . . . Elapsed time measurements to 9999.99 seconds (plus overflow)... Totalizes event counts to 999999 (plus overflow)... **$260**.

At only **$120**, the **1827** portable frequency counter is slightly larger than a pocket calculator. 30MHz guaranteed; 50MHz typical . . . Battery saver for all-day field use . . . Full range of optional accessories available.

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CIRCLE NO. 57 ON FREE INFORMATION CARD

Dolby makes the Realistic difference in 8-track recording

Make perfectionist recordings for car or home!

The Realistic® TR-802 record/play deck is a double value for people who like to listen to 8-track stereo at home and on the road. Use it to make standard tapes for your car's player, then switch on the Dolby* noise reduction system for audiophile-quality recordings you can enjoy at home. Either way, you'll build up a custom tape library at a fraction of the cost of pre-recorded material!

Connect the TR-802 to your stereo system and tape directly off the air, copy records, or make live recordings using the mike inputs. Dolby gives you reduced hiss, superior treble and extended loud-to-soft range. Stereo 8-track never sounded so good!

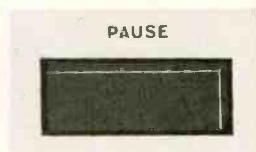
The TR-802 is strong on convenience, too. Two record/play modes: Auto-Stop after each program and at end of program-4. Three playback-only modes: program repeat, continuous-play, and Auto-Stop. Five push-button function controls.

So get the 8-track deck with a difference — by Realistic! Just 179.95.

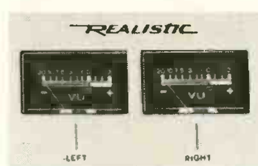
*"Dolby" is a trademark of Dolby Laboratories, Inc.

A unique combination of features . . .

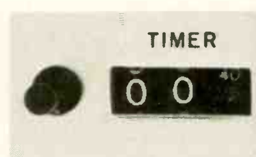
Simple pushbutton Dolby system for making and playing noise-free tapes



Pause button for pre-setting record levels and editing tapes as you make them



Large dual VU meters glow red during record, orange during play



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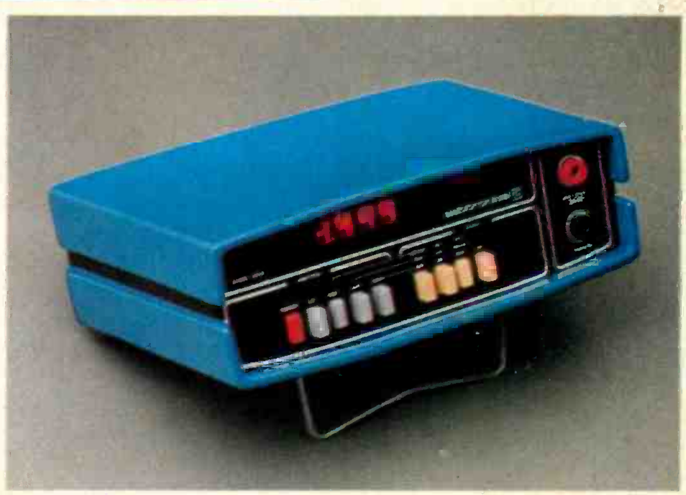

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Our guarantee to you; examine the 2000 DMM kit for 10 days. If you're not satisfied, return it unassembled for a full refund of purchase price.

SPECIFICATIONS:

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AC volts in 5 ranges: 100μV to 1000V
DC current in 6 ranges: 100nA to 2A
AC current in 6 ranges: 100nA to 2A
Resistance: 0.1Ω to 20MΩ in 6 ranges
AC frequency response: 40Hz to 50KHz
9mm (.36") LED display
Input impedance: 10MΩ
Size: 8"W x 6.5"D x 3"H
(203W x 165D x 76H mm)

Power requireme is: 4 "C" cells (not included)

CIRCLE NO. 44 ON FREE INFORMATION CARD

Pocket CB

New integrated circuit technology and a major electronic breakthrough brings you the world's smallest citizens band transceiver.

Scientists have produced a personal communications system so small that it can easily fit in your pocket. It's called the PocketCom and it replaces larger units that cost considerably more.

MANY PERSONAL USES

An executive can now talk with anybody in his office, his factory or job site. The housewife can find her children at a busy shopping center. The motorist can signal for help in an emergency. The salesman, the construction foreman, the traveler, the sportsman, the hobbyist—everybody can use the PocketCom.

LONG RANGE COMMUNICATIONS

The PocketCom's range is limited only by its 100 milliwatt power and the number of metal objects between units or from a few blocks in the city to several miles on a lake. Its receiver is so sensitive, that signals several miles away can be picked up from stronger citizens band base or mobile stations.

VERY SIMPLE OPERATION

To use the PocketCom simply turn it on, extend the antenna, press a button to transmit, and release it to listen. And no FCC license is required to operate it. The PocketCom has two Channels—channel 14 and an optional second channel. To use the second channel, plug in one of the 22 other citizens band crystals and slide the channel selector to the second position. Crystals for the second channel cost $7.95 and can only be ordered after receipt of your unit.

The PocketCom components are equivalent to 112 transistors whereas most comparable units contain only twelve.

A MAJOR BREAKTHROUGH

The PocketCom's small size results from a breakthrough in the solid state device that made the pocket calculator a reality. Scientists took 112 transistors, integrated them on a micro silicon wafer and produced the world's first transceiver linear integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance.

BEEP-TONE PAGING SYSTEM

You can page another PocketCom user, within close range, by simply pressing the PocketCom's call button which produces a beep tone on the other unit if it has been left in the standby mode. In the standby mode the unit is silent and can be kept on for weeks without draining the batteries.

SUPERIOR FEATURES

Just check the advanced PocketCom features now possible through this new circuit breakthrough: 1) Incoming signals are amplified several million times compared to only 100,000 times on comparable conventional systems. 2) Even with a 60 decibel difference in signal strength, the unit's automatic gain control will bring up each incoming signal to a maximum uniform level. 3) A high squelch sensitivity (0.7 microvolts) permits noiseless operation without squelching weak signals.

EXTRA LONG BATTERY LIFE

The PocketCom has a light-emitting diode low-battery indicator that tells you when your 'N' cell batteries require replacement. The integrated circuit requires such low power that the two batteries, with average use, will last weeks without running down.

The PocketCom can be used as a pager, an intercom, a telephone or even a security device.

MULTIPLEX INTERCOM

Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A citizens band base station with 23 channels is used to page each PocketCom. The results: an inexpensive and flexible multiplex intercom system for large construction sites, factories, offices, or farms.

NATIONAL SERVICE

The PocketCom is manufactured exclusively for JS&A and is the unit currently used on the hit TV show, Charlie's Angels. JS&A is America's largest supplier of space-age products—further assurance that your modest investment is well protected. The PocketCom should give you years of trouble-free service, however, should service ever be required, simply slip your 5 ounce PocketCom into its handy mailer and send it to our prompt national service-by-mail center.

The PocketCom measures approximately ¾" x 1½" x 5½" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

GIVE IT A REAL WORKOUT

Remember the first time you saw a pocket calculator? It probably seemed unbelieveable. The PocketCom may also seem unbelieveable so we give you the opportunity to personally examine one without obligation. Order only two units on a trial basis. Then really test them. Test the range, the sensitivity, the convenience. Test them under your everyday conditions and compare the PocketCom with larger units.

After you are absolutely convinced that the PocketCom is indeed that advanced product breakthrough, order your additional units, crystals or accessories on a priority basis as one of our established customers. If, however, the PocketCom does not suit your particular requirements perfectly, then return your units within ten days after receipt for a prompt and courteous refund. You cannot lose. Here is your opportunity to test an advanced space-age product at absolutely no risk.

A COMPLETE PACKAGE

Each PocketCom comes complete with mercury batteries, high performance Channel 14 crystals for one channel, complete instructions, and a 90 day parts and labor warranty. To order by mail, simply mail your check for $19.95 per unit (or $39.95 for two) plus $2.50 per order for postage, insurance and handling to the address shown below. (Illinois residents add 5% sales tax). But don't delay.

Personal communications is the future of communications. Join the revolution. Order your PocketComs at no obligation today.

NEW LOW PRICE!

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CIRCLE NO. 56 ON FREE INFORMATION CARD

SAVE UP TO 50% ON PARTS.

Hobbyist or professional, there are probably a lot of circuits you build just for the fun of it. And a lot you'd *like* to build, but never get around to.

One reason is the cost of parts. Parts you buy for one project, but can't re-use . . . because you haven't time to take them carefully apart. Or because of heat and mechanical damage that occur when you do.

Now, there's an easier way that can save you big money on parts *and hours on every project*, as well: *Proto-Board® Solderless Breadboards.*

Now, assembling, testing and modifying circuits is as easy as pushing in—or pulling out—a lead. IC's, LED's, transistors, resistors, capacitors . . . virtually every kind of component . . . connect and interconnect instantly via long-life, nickel-silver contacts. No special patch cords or jumpers needed—just lengths of ordinary #22-30 AWG solid hookup wire.

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PB-6	630	6	$15.95	Kit—10-minute assembly
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PB-203	2250	24	80.00	Built-in 1%-regulated 5V, 1A low-ripple power supply
PB-203A	2250	24	129.95	As above plus separate ½-amp +15V and −15V internally adjustable regulated outputs

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Prices and specifications subject to change without notice.

Circuits go together as quickly as you can think them up. And parts are re-usable, so as your "junk box" builds, you build more and more projects for less and less money.

Before you invest in your next project, invest in a CSC breadboard. See your dealer or order by phone: 203-624-3103 (East Coast) or 415-421-8872 (West Coast)—major charge cards accepted. You've got nothing to lose . . . and a lot to gain.

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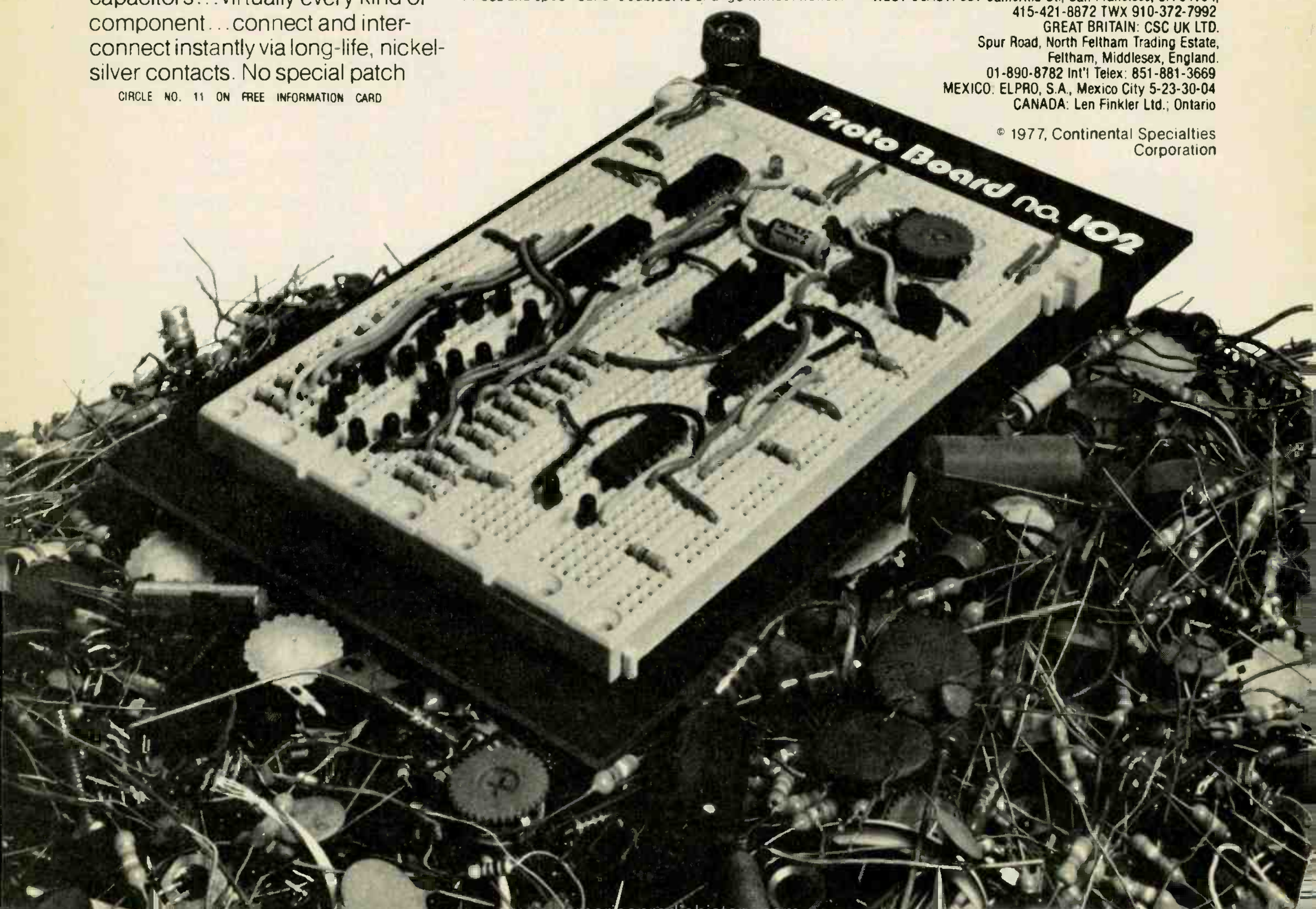

Popular Electronics®

FEBRUARY 1978

VOLUME 13, NUMBER 2

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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Editorial

THE SOUND RECORDING CENTENNIAL

It's 100 years since Edison was granted a U.S. patent on his "phonograph." Although it wasn't really the first talking machine (Edison's patent application was for an "Improvement in Phonograph or Speaking Machines"), it marked the beginning of the audio recording industry.

A variety of refinements followed to improve sound quality of repeatable-playing recordings. But milestones—embarking in a new direction that displaces other methods—are of most importance. One such benchmark was Emile Berliner's development of the lateral record disc and its reproducing machine, the Gramaphone, in 1888.

The next milestone was electrical recording, made in 1925 by the Victor Talking Machine Company. Gradual improvements in the record-playing medium, playback machines, et al., continued until the introduction of the variable reluctance magnetic pickup and 33⅓- and 45-rpm fine-groove discs in the late 1940's. Here we had another revolution in the making—the beginning of "high fidelity." I witnessed this significant development point, as many of you did. Interestingly, when CBS (developer of the LP record as we know it today) bought Columbia Records in 1938, it commenced to make all recordings at both 78-rpm and 33⅓-rpm speeds, using the latter as "safeties" in the event a 78-rpm master was damaged. So there was a large LP record library just waiting for the day when the new-speed records would be introduced to the public.

The last true milestone for disc sound recording occurred in the late 1950's, I feel, with the introduction of the stereophonic disc. It used Alan Dower Blumlein's 45-45 system, developed about 25 years earlier. (Perhaps at some future time I'll look back and say that the 1969 and 1970 demonstrations of quadraphonic records were next, but since quadraphony hasn't displaced stereo at this time, I won't consider it yet.)

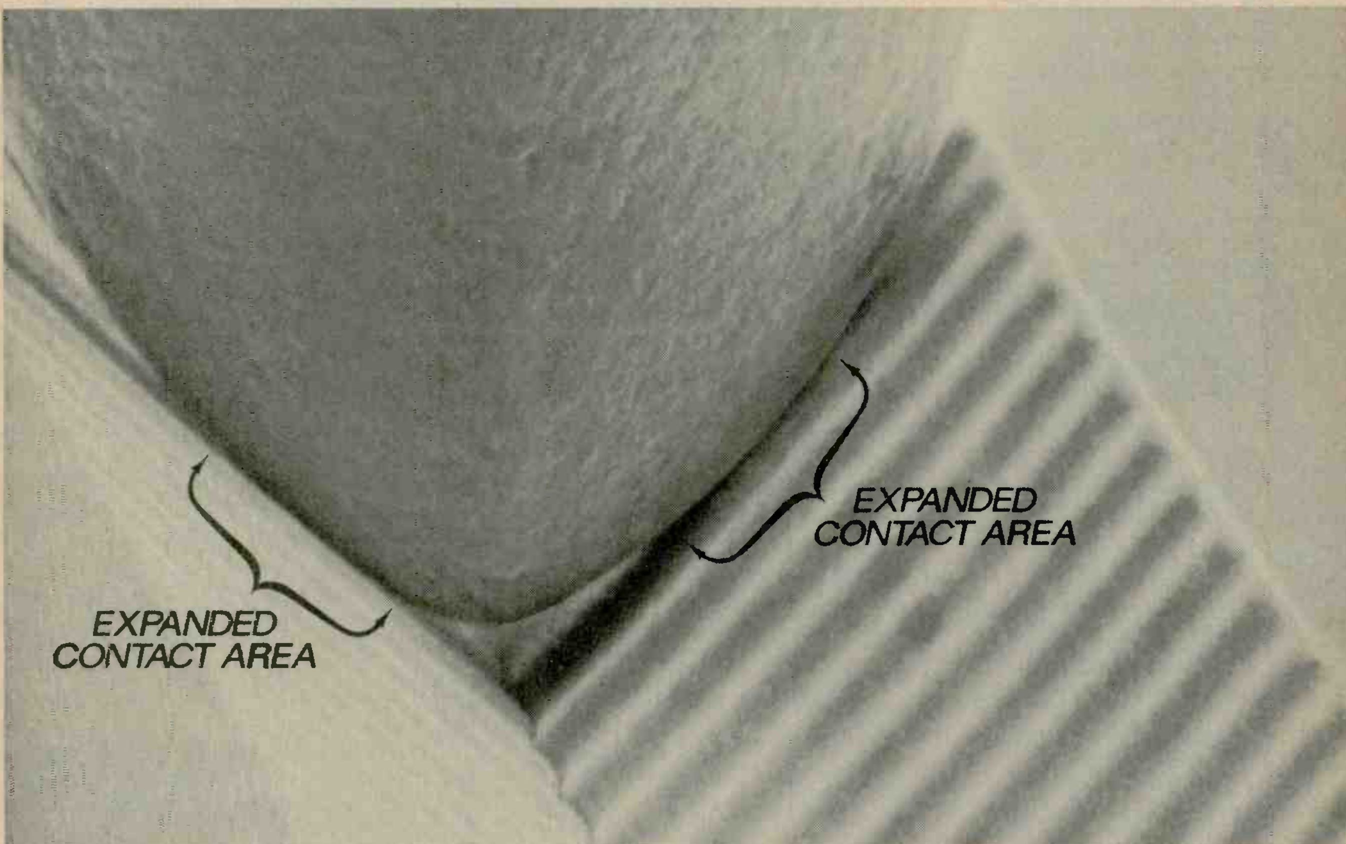
Of course, it wasn't the singular advent of stereo that accounted for public recognition of its more realistic sound reproduction, nor was stereo alone responsible for the burgeoning growth of the hi-fi component industry. Actually, it was part of a series of happenings, much of which occured in what I consider to be hi-fi's "big accomplishment decade"—the 1960's. During this period, for example, solid-state hi-fi equipment challenged vacuum-tube designs; stereo FM was launched; the Dolby professional noise reduction system was adopted by many recording studios; 8-track cartridge and cassette systems were entered into the marketplace; electronic music infiltrated pop music, spurred by the enormous sales success of the "Switched-on Bach" LP; new recording engineer techniques were employed; and so on.

Now we are enjoying the benefits of all those little continual pushes and shoves in technology that enable reproduced sound to inch forward toward even better audio while we await another burst of advancement. Will it be digitized recording? Four-channel FM? Stereo AM broadcasts? An automatic room acoustics delay line? Phono pickups using new video disc technology such as a laser device? A new record material chemical mix that improves record discs as much as new tape formulations enhanced cassettes?

Or will technology turn inward and refine a discarded principle? After all, a direct-drive record playing system in the 1920's was abandoned for many years in favor of the idler-wheel rim drive. Now the former is growing in popularity. Today, a few recording outfits even ignore computer-controlled equipment and tape machines, now pursuing direct-disc recording; and some very few amplifier manufacturers still use vacuum tubes. Judging from what sound recording history revealed in the past, one never knows what strange twists the future will bring.

Art Salsberg

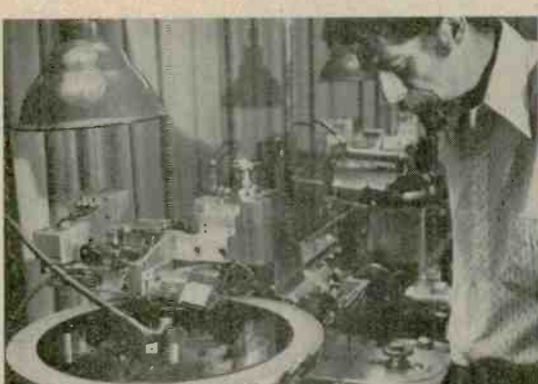
Better stereo records are the result of better playback pick-ups



© Stanton Magnetics, Inc., 1977

Scanning Electron Beam Microscope photo of Stereohedron Stylus; 2000 times magnification. Brackets point out wider contact area.

Enter the New Professional Calibration Standard, Stanton's 881S



Mike Reese of the famous Mastering Lab in Los Angeles says: "Wh le maintaining the Calibration Standard, the 881S sets new levels for tracking and high frequency response. It's an aud ble improvement. We use the 881S exclusively for calibration and evaluation n our operation"

The recording engineer can only produce a product as good as his ability to analyze it. Such analysis is best accomplished through the use of a playback pick-up. Hence, better records are the result of better playback pick-up. Naturally, a calibrated pick-up is essential.

There is an additional dimension to Stanton's new Professional Calibration Standard cartridges. They are designed for maximum record protection. This requires a brand new tip shape, the Stereohedron®, which was developed for not only better sound characteristics but also the gentlest possible treatment of the record groove. This cartridge possesses a revolutionary new magnet made of an exotic rare earth compound which, because of its enormous power, is far smaller than ordinary magnets.

Stanton guarantees each 881S to meet the specifications within exacting limits. The most meaningful warranty possible, individual calibration test results, come packed with each unit.

Whether your usage involves recording, broadcasting or home entertainment, your choice should be the choice of the professionals... the STANTON 881S.

STANTON

For further information write to Stanton Magnetics, Terminal Drive, Plainview, New York 11803

CIRCLE NO. 51 ON FREE INFORMATION CARD

Letters

TIMER HAS MORE RESOLUTION

I wish to commend POPULAR ELECTRONICS for publishing articles about programmable calculators ("The HP-25 as a Clock and Timer," August 1977). Just before I received my copy of PE, I had written a two-step timing program which had more resolution than Mr. Peters'. In my program, the elapsed time is not displayed until the timer is stopped.

To use it you must first go through an initialization process that takes about a minute. This need be done only the first time the program is run. Load the following:

STEP	KEY	CODE
00		
01	+	51
02	GTO 01	13, 01

Return to the RUN mode. Depress f, prgm, and 1. Enter three times to fill the stack with 1's. Press clx and run the program for one minute using an accurate timing source. At the end of a minute, a number of about 500 should be displayed. Multiply its reciprocal by 60 to obtain the constant for your calculator, which will be used each time the program is run in place of the 1 in the first initialization.

Since the display with this program is in seconds and tenths of seconds, use f fix 1 notation. If you wish to start at some time other than zero, key in this time before pressing R/S. Always press f prgm before running the program. Greater accuracy in starting is obtained if you depress R/S before the starting time and then releasing the key at the starting time.—*Leigh Klotz, Jr., McComb, MS.*

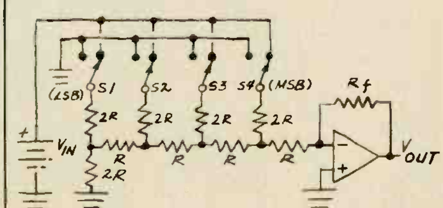
MORE ON HANDLING MOS

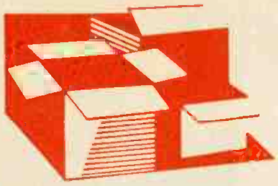
"How to Handle MOS Devices Without Destroying Them" (August 1977) presented some valuable information but contained two misleading and inaccurate statements. First, although the zener-diode protection circuit in Fig. 3 is sometimes used in discrete MOSFET's, I have never seen it incorporated into a MOS IC. The other error is the warning for readers not to use multimeters to test MOS devices. IC manufacturers, such as RCA and Solid State Scientific, recommend the use of common VOM's for simple testing of their CMOS devices and publish specific instructions for such testing.

I agree with the author that conductive plastics are invaluable for safely handling MOS devices. I have used all of the products mentioned and found them to be quite helpful. It is unfortunate that manufacturers' and dealers' minimum-order requirements make them too expensive for most hobbyists. The Velostat kit mentioned in the article is a good value. As an additional service to POPULAR ELECTRONICS readers, we are offering ¼" (6.4-mm) thick Velostat foam for 3¢/sq in. plus 25¢ postage/order, with no minimum purchase requirement. This material can be adapted for 99% of antistatic uses. —*J. L. Mitchell, WFCO, Box 148, Runnemede, NJ 08078.*

D/A AND A/D CONVERTERS

In "How's and Why's of D/A and A/D Converters" (April 1977), the circuit in Fig. 3 is incorrect. There is a resistor across virtual ground of the op amp, which makes no sense at all. Plus, for the binary ladder effect to work properly, the logic-0 input must be grounded when the switches are not connected to logic-1 (V_{IN}). The circuit should look like the one shown here. —*Craig Keefer, Nashua, NH.*





New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.

DAVID HAFLER PREAMPLIFIER

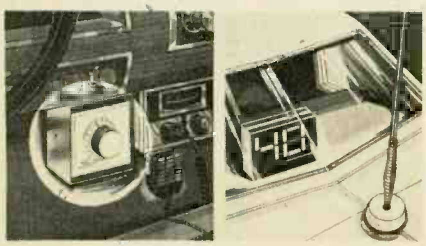
The David Hafler Company has announced its first product, a stereo preamplifier and control unit. Available in both kit and assembled form, the new DH-101 preamplifier is an all-push-pull design with distortion said to be

below 0.001%, and correspondingly low supersonic intermodulation distortion. Control features include volume, balance, bass, treble and selection by indicator-type pushbuttons of two phono inputs, one tuner and one aux input, and two tape monitor circuits with dubbing facilities. A stereo-mono and tone-flat switch are also provided. The unit is supplied with an international power transformer, and can operate at all voltages from 100 to 260 V. Assembled price, $299.95; kit form, $199.95

CIRCLE NO. 93 ON FREE INFORMATION CARD

CB CHANNEL "BILLBOARD"

Controls, Inc. has updated its CB "Billboard" 23-channel display to cover 40 channels. Powered by 12 volts dc, the digital display box is mounted in an auto window and displays which CB channel the driver is monitoring via two 2-inch (5.1-cm) seven-segment numerals. The display box is connected to a rotary selector switch which can be mounted near the transceiver by means of a flat cable with snap connectors. The 40-channel "Billboard" package includes the digital display box, selector switch, mounting brackets,



hardware, and installation instructions. Address: Controls, Inc., Consumer Sales, Box 522, Logansport IN 46947.

ZENITH TV REMOTE CONTROL TESTER

A device for testing television remote control transmitters, Model 852-240, has been announced by Zenith Radio Corp. A LED is illuminated when it receives an ultrasonic, continuous sine wave of up to 50 kHz that is strong enough to operate a TV remote control. The tester can be used on all Zenith remote-control transmitters, mechanical as well as electronic handhelds, and other brands producing a 50-kHz output signal. It includes an output jack for use with a frequency counter. Address: Zenith Parts & Accessories Div., 11,000 Seymour Ave., Franklin Park, IL 60131.

KENWOOD RECEIVER

The Model KR-4070 AM/stereo FM receiver has an amplifier section rated at 40 watts rms/channel continuous into 8 ohms from 20 to 20,000 Hz., with 0.1% maximum THD. The preamplifier section has a 73-dB S/N and varies from standard RIAA equalization by no more than ±0.3 dB. Tone controls have center-off positions. The tuner section, with a 1.9 μV IHF usable sensitivity, has a 3-gang, variable capacitor in its FET front end. Linear-phase, 4-element ceramic i-f filters are said to

yield 60 dB selectivity. The multiplex section employs a PLL. Other features include speaker switching, switchable loudness contour, and both signal-strength and center-channel meters. Simulated walnut-grain side panels are optional. Dimensions are 17 1/4" W x 11 13/16"D x 5 5/16"H (43.8 x 30 x 13.5 cm). $300.

CIRCLE NO. 94 ON FREE INFORMATION CARD

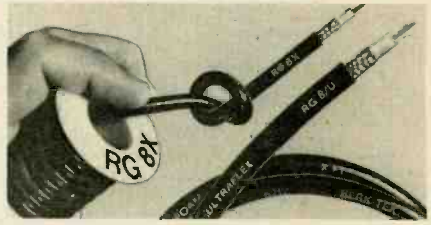
CB BASE STATION ANTENNA

Antenna, Inc.'s new "Herman" omnidirectional CB base station antenna is designed for easy installation. It weighs 3 1/2 lb (1.6kg) and has a telescoping vertical radiator and four radials that fold down against the mast and secure with wing nuts. The half-wavelength, 16' (5-M) high dipole antenna has a claimed SWR of 1.35:1 or less across all 40 CB channels. $39.95.

CIRCLE NO. 95 ON FREE INFORMATION CARD

BERK-TEK MINIATURE RG 8/U CABLE

A miniature replacement for RG 8/U coaxial cable is now available from from Berk-Tek, Inc. The new, low-loss cable, trade-marked "RG 8X," is 40% smaller than RG 8/U, and



many times more flexible. It has 95% braid shielding and a 19-strand center conductor. Power handling capacity is more than 1 kW at 27 MHz. Nominal attenuation is said to be 1.35 dB at CB frequencies, a gain of as much as 2 dB over typical RG 58/U cables. Address: Berk-Tek, Inc, Box 60, Reading, PA 19607.

REMOTE SWITCHING BY CB

The "CB Auto Light" is a solid-state remote-control switch which can be activated by a CB signal from up to 300 ft away. The unit can be used to turn on garage and outdoor lights by keying the CB microphone. $26.95. Address: Kronotek Corp., Bonnie Dell Industrial Park, 231 Rt. 17, Rutherford, NJ 07070.

NEW REVOX TAPE RECORDER

A new, 10½"-reel recorder, Model B77, has been added to the Revox line. The B77 is currently available with ¼-track or ½-track heads and speeds of 3¾ and 7½ ips, but a 7½-15-ips version will be available this year. Features include several switch-selected inputs for each channel, a direct drive capstan servomotor, logic control of tape motion, large VU meters, LED overload indicators, and a built-in splicer with self-sharpening tape cutter. Specifications include a record/play frequency response of 30-20,000 Hz +2/−3 dB at 7½ ips, and 30-16,000 at 3¾ ips. Signal-to-signal noise is rated at 66 dB (7½ ips, half-track, "A" weighted), and headroom at 24 dB. Dimensions are 18" W x 16¼" H x 8" D (45 x 42 x 20 cm).

CIRCLE NO. 96 ON FREE INFORMATION CARD

PC BOARD AIDS

Three unusual aids for circuit-board construction are available from A.F. Stahler Co. One is a rubber-stamp drilling template to mark hole positions for DIP devices. The stamp is supplied with ink pad and a bottle of special fast-drying ink that adheres to copper, tin, and nickel. Also available are special drills for use on copper-clad boards, which inscribe an isolated pad around the hole being drilled. The drills are available in #60 and #69 sizes, in high-speed steel or carbide, and for 0.10", 0.15" or 0.20" pads. Also available is a Spot-Drill Mill, which clears an insulated spot around the hole as it drills; all other specifica-

tions are the same as for the drills. The RSDT-DIP16 template stamp set is $12.50. The drills and mills are $10.50 each in high-speed steel, $12.50 each in carbide. Address: A.F. Stahler Co., P.O. Box 354, Cupertino, Ca 95014.

AR BOOKSHELF SPEAKER

The Acoustic Research Model AR-17 has a speaker system with 8" acoustic-suspension woofer and a 1 1/4" ring-radiator tweeter, with the crossover at 2000 Hz. The 8-ohm system has a two-position high-range level control and is said to produce 86 dB SPL for 1 watt output on axis at 1 meter. Claimed low-frequency response is down 3-dB at 50 Hz. Effective system Q is 1. Maximum power handling capacity is 100 watts continuously driven to clipping 10% of the time on normal music source material. Dimensions are 18 1/2" x 10" x 8 3/4" (46.4 x 25.4 x 22.2 cm); weight is 17 lb (7.7 kg). $95.

CIRCLE NO. 97 ON FREE INFORMATION CARD

TRIPLET 3 1/2-DIGIT DMM

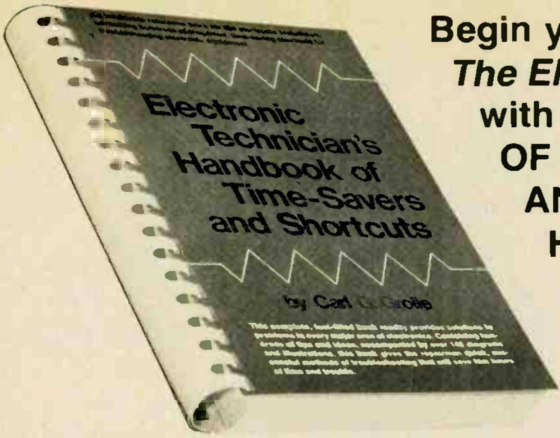
Triplett Corp's Model 3300 pocket-size digital multimeter measures 5 3/8"L x 3"W x 1 3/8"D (13.7 x 7.6 x 3.5 cm) and has a 3 1/2-digit LED display with 0.3" (7.6-mm) digits. The instrument has a single selector switch for ac and dc voltage ranges of from 200 mV to 600V, resistance ranges of 200 to 20M ohms,

and ac and dc current ranges from 2 to 200 mA, all full-scale. Typical dc accuracy is said to be 0.5%. The new DMM features automatic polarity indication on dc measurements. The probes have insulating safety boots. Additional safety features include fuse protection for both probe and meter and a design with no exposed metal parts. The snap-in "Battery-Pac" supplied can be recharged within the tester or separately, using the ac adapter/charger supplied. $175.

CIRCLE NO. 98 ON FREE INFORMATION CARD

40-CHANNEL CB "ONE HANDER"

The new, 40-channel version of the Realistic "One-Hander" mobile CB transceiver, like its 23-channel predecessor, has all operating



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This treasury of troubleshooting tips provides ready solutions to problems in every major area of electronics. It contains hundreds of time-saving shortcuts and techniques for troubleshooting all types of electronic equipment—and over 140 diagrams and illustrations that make them easy to use.

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- Shortcuts for making your work with **resistors** easy.
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- Key steps to **soldering** and **desoldering**.
- Successful **wiring methods**.
- Guidelines for designing and making **printed circuits**.
- Time saving shortcuts for **chassis construction**.
- Faster ways to select and use **test instruments**.
- Practical shortcuts in **breadboarding**.
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Showing you successful ways to solve problems quickly, this handbook cuts the toughest troubleshooting jobs from days to hours. And your other jobs from hours to minutes. It gives you fast, proven techniques—in a concise, straight-to-the-point way.

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CIRCLE NO. 17 ON FREE INFORMATION CARD

Pioneer's new RT-707 has a lot more in common with today's most sophisticated 10-inch tape decks than it does with most 7-inch tape decks.

Because unlike other 7-inch tape decks, the RT-707 isn't filled with 15 year old ideas.

THE MOST ACCURATE DRIVE SYSTEM: DIRECT-DRIVE.


The extraordinary direct-drive system.

Instead of the old fashioned belt-drive system, the RT-707 is driven by a far more accurate and efficient AC Servo direct-drive capstan motor. This motor generates its own frequency to monitor and help correct even the slightest variation in tape speed. Which all but eliminates wow and flutter.

In addition, the drive system of the RT-707 is unaffected by fluctuations in line voltage and won't deteriorate with age like belt-drive. And because it doesn't generate heat like the belt-driven "dinosaurs" it doesn't need a fan. So all you'll hear is music with a clarity and crispness not possible on any 7-inch, or many 10-inch tape decks.

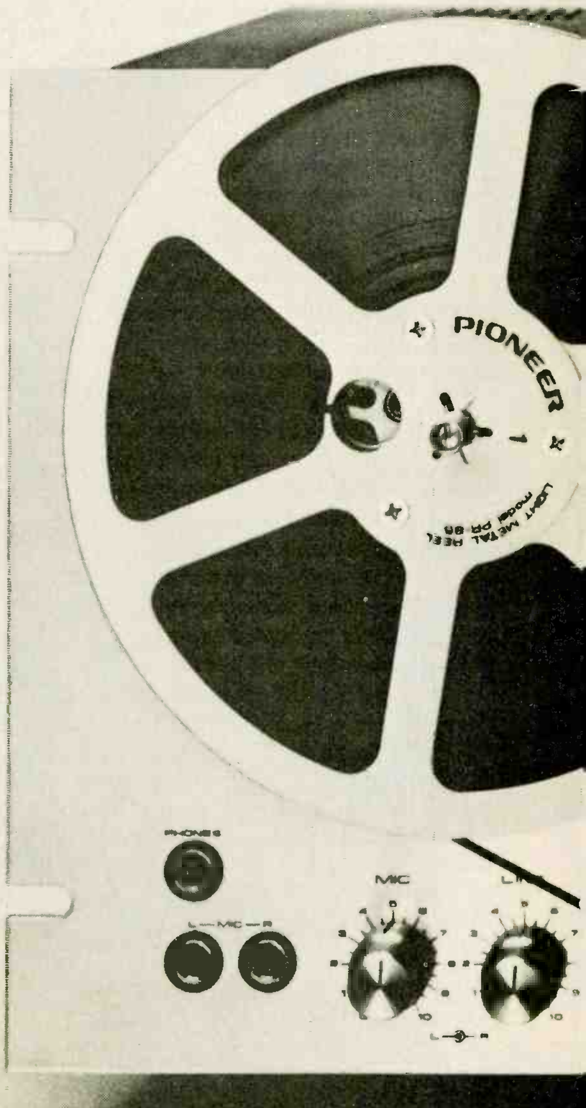
Our direct-drive system also makes pitch control possible. Which allows you to regulate the speed of the tape, giving you even greater control over your recordings.

BEYOND THE RANGE OF MOST 7-INCH TAPE DECKS.

In the past, the most you'd expect from any 7-inch tape deck in terms of frequency response was respectability. But with technology like this it's not surprising that Pioneer's engineers have gone far beyond that.

Our super-sensitive heads, for instance, will pick up and

THE ONLY THING IT HAS IN COMMON WITH OTHER 7-INCH TAPE DECKS IS THE SIZE OF ITS REELS.



deliver frequencies from 20 to 28,000 Hertz. And our pre-amp section is built to handle 30 decibels more than any other 7-inch tape deck without distorting. So you can capture all the depth and presence of each and every instrument.

But great sound isn't everything.

A WHOLE NEW WAY OF LOOKING AT TAPE DECKS.

As you can see, the RT-707 is smaller and more compact than other tape decks. It's also rack-mountable. But unlike *any* other tape deck, it's stackable. So it'll fit right in with the rest of your components.

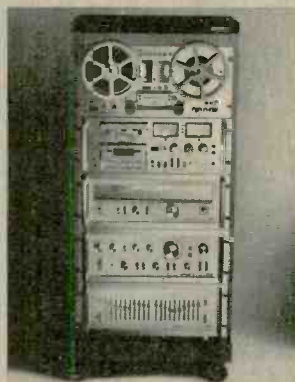
AUTO-REVERSE AND OTHER EXTRAS.

While many tape decks have auto-reverse, chances are you won't find it on other comparably priced equipment. Or a repeat button that lets you listen to your tapes endlessly. Or circuitry that allows you to hook the RT-707 up to a timer, so you can make recordings even when you can't be there to supervise them.

But frankly, all the revolutionary thinking that went into the RT-707 wouldn't mean much if it weren't also built to fit comfortably into your budget. It is.

See your Pioneer dealer for a closer look at this extraordinary 7-inch tape deck.

We think you'll find the only things that the RT-707 has in common with other 7-inch tape decks is the size of the reels. And the size of the price.


Unlike others, the RT-707 can be stacked or rack-mounted

High Fidelity Components

PIONEER®

WE BRING IT BACK ALIVE.

CIRCLE NO 52 ON FREE INFORMATION CARD

FREQUENCY RESPONSE: @7½ ips 20-28,000 Hz* (30-24,000 Hz ± 3 dB).

WOW AND FLUTTER: @7½ ips 0.05 (WRMS)

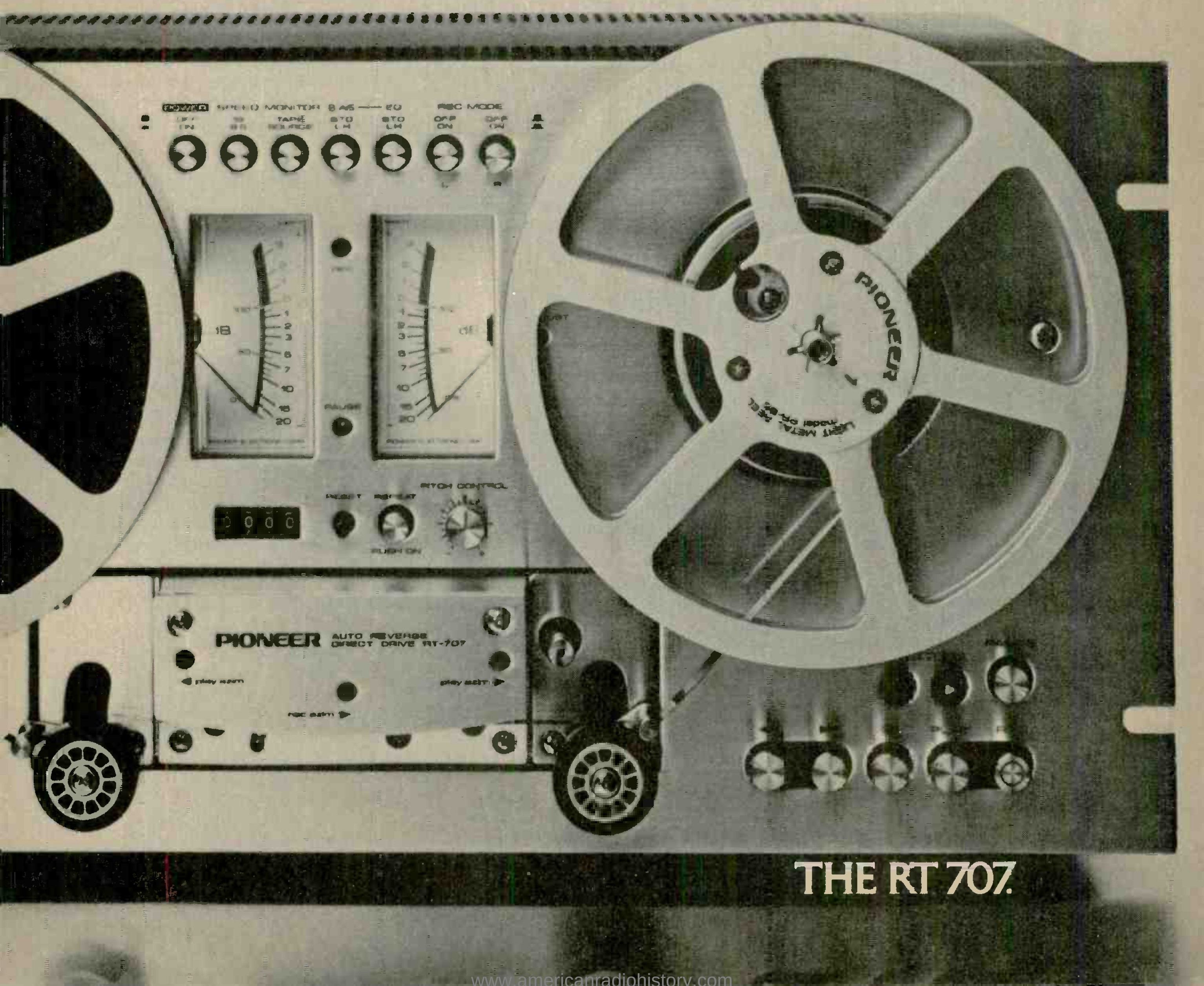
SIGNAL-TO NOISE RATIO: More than 58 dB.

HARMONIC DISTORTION: No more than 1.0%.

SPEEDS: Tape 7½ ips (19 cm/sec.) 3¾ ips (9.5 cm/sec.) ± 0.05%.

MOTORS: FG AC Servo direct-drive motor x 1 (capstan drive), 6-pole inner-rotor special induction motor x 2 (reel drive).

REFERENCE TAPE: Scotch #206.



THE RT 707.

controls—volume, squelch, power, illuminated channel-select dial and talk button—on the microphone. The one control on the remotely located transceiver selects either the built-in speaker, the microphone/speaker, or an external speaker. The main transceiver circuitry includes built in noise blanker and limiter. Receiver sensitivity is rated at 0.5 μV for 10dB S+N/N; adjacent channel rejection, 60 dB; audio output, 4W. Measuring only 7"L x 5 1/4"D x 1 1/2"H (17.8 x 13.4 x 3.8 cm), the main chassis is easily hidden; an optional, 16 1/2-foot (5-m) extension cable allows it to be concealed in the trunk. Price is $169.95; optional extension cable is $29.95.

CIRCLE NO. 99 ON FREE INFORMATION CARD

NORTH STAR HORIZON COMPUTER

This S-100-bus computer with built-in micro-floppy disk memory is available in two models. Both have 4-MHz, Z80A microprocessor, 16k of RAM, serial interface and 12-slot motherboard. Horizon-1 has a single, North Star micro-floppy drive, while Horizon-2 has a dual drive. The system can store 90k bytes, and can load or save a 10 kilobyte program in less than two seconds. Horizon-1 is $1599, kit; $1899 assembled. Horizon-2 is $1999, kit; $2349, assembled.

CIRCLE NO. 100 ON FREE INFORMATION CARD

DREMEL COMPACT VISE

The new Model 2214 D-Vise by Dremel is a compact, die-cast vise designed for secure positioning of small objects. Its jaws open up

to 2 1/2", with precision-machined guide bars supported at 3 points to assure parallel jaw alignment, equalized work pressure and wobble-free operation. Removable, V-grooved jaws and soft jaw protective pads are furnished for holding delicate and odd-shaped parts. The D-Vise provides a full hemisphere of positioning locations, with 180° tilt and 360° swivel. A twist-lock ring on the base locks the head swivel in any position. The base can be used portably, or attached permanently by its three mounting holes. The D-Vise is priced at $21.95. With the addition of the Model 2215 holder for Dremel Moto-Tools, it is $24.95. Address: Dremel Div., Emerson Electric Co., 4915 21st St., Dept. PR, Racine, Wis. 53406.

New Literature

EIA CONSUMER GUIDE TO TV SAFETY

A revised "Consumer Guide to Television Safety" has been published by the Electronic Industries Association/Consumer Electronics Group. The Guide offers a number of basic steps to be followed by consumers for safe and efficient operation of TV receivers. Send self-addressed, stamped envelope to: Sally Browne, Director of Consumer Affairs, EIA/Consumer Electronics Group, P.O. Box 19369, Washington, DC 20036.

TURNER CB ACCESSORIES CATALOG

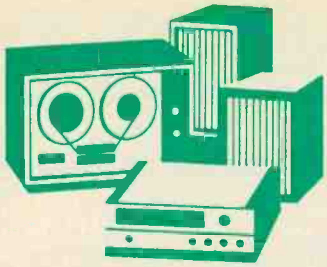
Turner Division of Conrac Corp. has announced availability of a new CB accessories catalog. The four-page color brochure details the company's new "Whip-Flip" antitheft CB antenna mounts and "Insta-Mount" mirror with easy on/off construction that allows for adjustment to vertical and horizontal mirror struts. Also listed are a variety of mounts available for both stainless steel and fiberglass antennas that are designed to work with Turner and other brands of antennas. Address: Turner Division, Conrac Corp., 716 Oakland Rd. N.E., Cedar Rapids, IA 52402.

INTEL MICROCOMPUTER MANUAL

The MCS-48 ™ single-chip microcomputer user's manual includes the 8048 microcomputer with ROM program storage, the 8748 with EPROM (erasable programmable) program storage, the 8035 microcomputer and the 8243 I/O expander. Sections cover microcomputer operation, the use of compatible 8080 and 8085 system peripherals and standard memory components for expansion, and both hardware and software application examples. Data sheets and instruction sets are also included. Address: Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

RCA PRODUCT GUIDE

A 40-page guide, MPG-180, covers the complete line of IC's, support systems, and accessories that constitute the RCA CDP1800 Cosmac microprocessor family. Included is a description of the CDP1802 microprocessor, covering features, architecture, ratings, characteristics, timing diagram, and instruction summary. Along with a discussion of the support systems and accessories for usage with the CDP1802 microprocessor, the guide includes a cross-reference section that lists RCA types equivalent to other manufacturers' devices. Address: RCA Solid State Division, Box 3200, Somerville, NJ 08876.



Stereo Scene

By Ralph Hodges

THE DIGITAL COUNTDOWN AND OTHER TIMELY MATTERS

"YOU MAY be able to get your feet wet, but that doesn't mean you can walk on water," remarked a colleague as he contemplated the flash flood of digital recording, reproducing, and control systems featured at 1977's New York Audio Engineering Society Convention last November. His point was well taken, but many thoughtful people now believe that you won't necessarily take a bath when you try, either.

The previous year's convention was enlivened by some stunningly good digital tape recordings presented by Dr. Thomas Stockham of Soundstream, but there was very little else of substance, unless you count the almost-omnipresent digital delay and reverberation devices designed to process signals recorded in analog form. What made digital the star of this year's show? Read on.

The First Studio Digital Recorder. It is not strictly true that the astonishing machine developed through a joint effort of the 3M Company and the British Broadcasting Corporation is the first digital studio recorder. Nippon Columbia (Denon) has had one in use for some years, the BBC has produced several for its own use, and Mitsubishi and others have made significant contributions. But the 3M/BBC extravaganza is the first of its kind likely to be purchased by the recording companies most people patronize. It fits right into the studio as if it were an ordinary analog recorder, and offers up to 32 tracks of audio recording.

Basic (preliminary) specifications include a frequency response of 30 Hz to 15 kHz ±0.3 dB (response is down a few dB at 20 Hz and 20 kHz), a dynamic range exceeding 90 dB, and harmonic and intermodulation distortion for any audio frequencies or combination thereof measuring less than 0.03 percent throughout the system's dynamic range! Wow and flutter, crosstalk, and print-through are, of course, unmeasurable. If it isn't obvious already, I should point out that these specifications make the typical recording studio's *electronics* look rather bad.

The machine operates at 45 ips and lays its 32 tracks down on 1-inch tape, which actually amounts to a savings in tape when you consider that an analog studio recorder running at 30 ips (for maximum signal quality) must use 2-inch tape for a typical maximum of 24 tracks. The tracks run linearly (i.e., longitudinally, side by side) along the length of the tape, and one track suffices for each of the 32 audio channels, including all necessary error detection and correction information. The sampled input signal (the sampling rate being 50 kHz) is recorded in groups of sixteen-bit bytes. Along with this signal, parity bytes are recorded as well as a cyclical redundancy check (CRC) word. The CRC check word is used to tell if the 16 data bytes are good; if not, the parity information in other groups along with other data bytes are used to reconstruct the missing information. The data and parity used to reconstruct missing data are spaced apart on the tape in such a way that—according to 3M's studies—an error in both data bytes is statistically unlikely. The studies further show that if an error afflicts the parity bits, both signal bytes will probably escape unscathed because of the scheme used to space the information along the tape.

Whether the above description means anything to you or not, the sound of the recordings this machine is capable of making certainly would. A recording of a close-miked solo piano (difficult for any recording technique) that the 3M people brought to the convention was utterly captivating in its vigor and effortless realism. In fact, all around the convention's many digital demonstrations there were astonished comments that the music was immensely satisfying despite the admitted inferiority of the loudspeakers and associated equipment being used. Many have claimed repeatedly that the poor program material available is the principal factor defeating our attempts to achieve high-fidelity reproduction. This point is debatable, I think, but it certainly does seem true that a record/playback process as excellent as today's digital technology is able to put the deficiencies of mediocre playback equipment in the background and let you appreciate the music. (See diagram on page 20.)

The 3M/BBC 32-tracker comes as part of a mastering "system," along with a four-track mix-down recorder. Price (gulp!): about $150,000. But cost notwithstanding, I observed a number of open checkbooks and poised pens. Recordings made with this system could be

3M Digital Audio Mastering System

reaching you fairly soon. And 3M is already talking about a consumer digital recorder. Undoubtedly the tape will still have to run at 45 ips, but the cost will not be anything like $150k. Look for it, perhaps, in a year or two.

The Digital Disc. Of more than seven reported digital products (for consumer use) exhibited at 1977's Tokyo Audio Fair, only a few made it to New York, but they gave a fine account of themselves. The most prominent was the PCM Disc system, an adaption of the Philips/MCA video disc for audio purposes worked out in a joint effort by Teac, Mitsubishi, and Tokyo Denka. Like the Philips/MCA recording, the PCM Disc is scanned (and recorded as well, through a photographic process) by a radial-tracking laser. PCM (pulse-code modulation) is of course virtually synonymous with digital, but communication of the actual code used was a bit obscured by the language barrier. It's my impression that eight bits provide the fine details of sampled amplitude, while four additional bits constitute a "multiplier," if you will, so that the musical material is dealt with in several discrete dynamic ranges rather than in one continuous dynamic range. I balk at reporting other half-understood details, but let it be said that the combined system (disc record, record player, and the admirably compact electron-

(Continued on page 20)

Learn digital computer

NRI is the only school to train you at home on a real digital computer.

Learn computer design, construction, maintenance and programming techniques on your own programmable digital computer.

Qualified technicians are urgently needed for careers in the exciting new field of digital and computer electronics . . . and the best way to learn digital logic and operations is now available to you in NRI's Complete Computer Electronics Course.

This exclusive course trains you at home on your own digital computer! This is no beginner's "logic trainer", but a complete programmable digital computer that contains a memory and is fully automatic. You build it yourself and use it to define and flow-chart a program, code your program, store your program and data in the memory bank. Press the start button and the computer solves your problem and displays the result instantly.

The NRI digital computer is one of 10 kits you receive in the NRI Complete Computer Electronics Course. You build and use your own TVOM, and experiment with NRI's exclusive Electronics Lab. You perform hundreds of experiments, building hundreds of circuits, learning organization, operation, trouble-shooting and programming.

New NRI Memory Expansion Kit

The Model 832 NRI Digital Computer now comes with a new Memory Expansion Kit. Installed and checked out in 45 minutes, it doubles the size of the computer's memory, significantly increasing the scope and depth of your knowledge of digital computers and programming. With the large-scale IC's you get the only home training in machine language programming . . . experience essential to trouble-shooting digital computers.

(Continued from page 15).
ics built into its base) boasts a dynamic range in excess of 98 dB and harmonic distortion of under 0.1 percent overall.

Participants in the convention were played a recording whose source was—at least in part—a Sony U-Matic video cartridge machine with a PCM adapter. So portable is this ensemble that it was actually lugged out into the field to record the departure of a steam locomotive from a country railroad station. In the indoor playback setting I don't think we could have tolerated much more dynamic range than was provided (from the delicate chirruping of birds to the caustic blast of the steam whistle). The only audible noise present on the recording reportedly—and believably—came from the microphone preamplifiers, pitiful analog devices that they were.

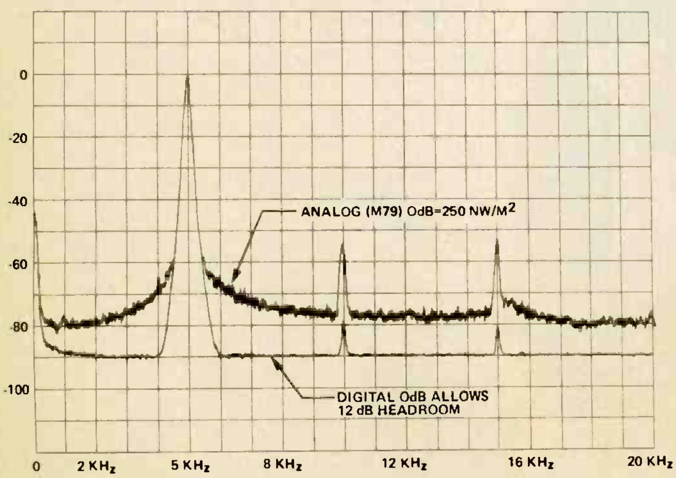

Teac's PCM Disc Machine.

The PCM Disc machine is intended to be a consumer-available product. Tentative price for the audio-only version is in the neighborhood of $600, and it will plug right into your present preamplifier. The software, it is hoped, will come from arrangements made with major record companies to permit the release of master tapes to the PCM Disc duplicators. The disc itself is presently single-sided, but a double-sided version (30 minutes' playing time per side) is in the works. An approximate price of $10 per disc has been suggested. Too bad the quality of the professionally produced master tapes will probably not be up to what's achievable with the aforementioned U-Matic/PCM audio tape recorder, which is also envisioned as a consumer product.

Digital Recordings. Software (recordings available to consumers) is a major hurdle to be overcome by any new recording system, naturally. Even if you have the ability to design flawless recording equipment, you may not have much success with it at public demonstrations unless you can afford to put a large and important musical event in front of its microphones. As reported last month, the direct-to-disc record companies are beginning to manage this. And so are the digital advocates.

At the convention, Soundstream's Dr. Stockham achieved just this with a rendition of Rimsky-Korsakov's *Capriccio Espagnol* with the Boston Pops Orchestra, Arthur Fiedler conducting. The recording project was actually sponsored by Crystal Clear, one of the direct-to-disc outfits, but the engineer, fellow columnist Bert Whyte, backed himself up with Stockham's superb digital recorder, as well as with one of the best analog tape recorders available.

The several versions of the performance made by different recording media should afford an opportunity for rich and important comparison. As yet I have heard only the digital (Stockham) version, but I am satisfied. The recordings, all made simultaneously from the same three-microphone pickup, seem destined to generate even more public outrage about current multi-miking practices, at least insofar as they are applied to classical music. The representation of the musical lines was so precise on the digital recording (at all signal levels)—and the presentation of depth and space so convincing—as to provoke revolutionary rumbles from all auditors. It would be ironic if the emergence of the 3M/BBC recorder, the first studio multitracker worthy of the designation, were to coincide with a return to two- or three-track recording.



Harmonic distortion of analog and digital systems compared. Skirts on analog products are due to pitch ambiguity, which can be heard.

Quadraphonic Capers. To the outside world it may appear that development work on four-channel sound has stopped dead in its tracks. This is not the case, however; in fact, it begins to seem that the real work is just beginning. Only within the last few years have the various quadraphonic disc systems been able to make good on their promises of four discrete-sounding *high-fidelity* channels.

To date, it is JVC that has made the most visible progress. The JVC research group started with binaural headphone sound and its remarkable ability to persuade the listener that he has been transported into the recording environment. From that point of departure they developed the Q-Biphonic Processor, a device that came startlingly close to simulating the binaural experience *with loudspeakers*, given an appropriately processed recording. At the convention, JVC appeared with a recording-studio adjunct to their system. It was intended to interface with the recording console and create a Q-Biphonic recording out of a multi-track production.

Again, details are very sketchy. However, it is possible to make a few educated guesses. One of the factors widely believed to contribute to the startling realism of binaural sound is the right ear's inability to hear the signal that is being delivered to the left headphone earcup, and vice versa. (When listening to loudspeakers, both ears ultimately hear the signals from both speakers, which is unnatural when we're trying to create a "phantom" image divorced from either speaker.) The Q-Biphonic recording processor reportedly first tailors the multi-channel signals at its input to simulate a binaural presentation and then subjects the result to a "crosstalk canceller" that conditions it for loudspeaker listening. The final recording is played back through four loudspeakers in a typical quadraphonic configuration.

Without overcommitting myself, I think I can say that the JVC system is capable of the most devastatingly effective four-channel reproduction yet. ◇

Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

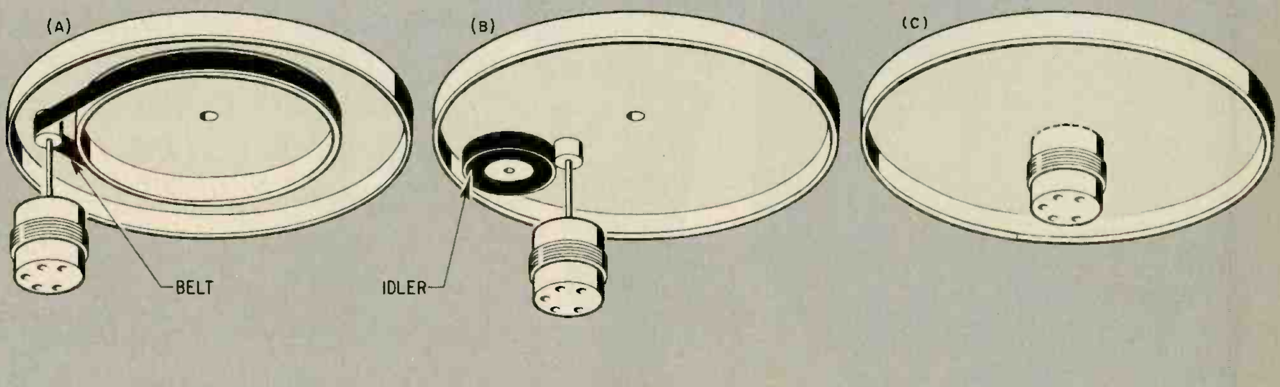
TURNTABLE DRIVE SYSTEMS

WHEN direct-drive turntables were first introduced several years ago, they were expensive but had appreciably less rumble and wow than most existing belt and idler driven models. The direct-drive record player had a glamorous image that enhanced its appeal to the buying public (and still does) even beyond its undeniably excellent performance. Now, the price of direct-drive motors has dropped to the point where they can compete with most good-quality conventionally driven turntables. This process has been accelerated by the development of several variations of the original concept by different companies, introducing more competition into the process. (At first, all turntable manufacturers bought their direct-drive motors from Matsushita, who developed them in their present form.)

To appreciate the initial appeal of the direct-drive concept, one must examine the state of the record player art in the 1960's. Record changers (which were even then being called "automatic turntables") were, as always, powered by 4-pole induction motors or, in some deluxe models, hysteresis synchronous motors. In either case, the motor turned at about 1800 rpm; and a speed-reduction device was needed to convert that to the 33⅓ or 45 rpm required by the platter. The idler drive was the traditional way to do this. A rubber puck, contacting the motor shaft and the inside of the platter rim, accomplished the speed reduction, and transmitted enough torque to the platter so that the record dropping mechanism could be operated without stalling the motor or unduly slowing down the turntable.

Good turntable performance depends on the isolation of the platter system from the motor vibrations and from the inevitable torque pulsations of any motor with discrete poles. Even with soft suspension bushings for the motor and a fairly soft idler wheel, there are practical limits to how much of this undesired vibration can be filtered out of an idler drive. Also, with the basic motor revolution rate of 30 times per second, the fundamental rumble frequency is 30 Hz. Harmonics of that frequency extend well into the audible range, of course.

For years, it has been recognized that a belt drive can provide better isolation from motor vibration than is feasible with a rubber idler wheel. The soft, compliant belt, made of fabric or rubber, acts as a filter to prevent the higher vibration or flutter frequencies from affecting the turntable system. Belt drive is also relatively simple and inexpensive to



(A) Belt Drive. *The flexible belt "soaks up" much of the motor's vibration and speed variations, so that a well-designed belt-driven turntable usually can provide extremely low rumble and flutter.*

(B) Idler Drive. *Simple and reliable, this drive has supplied the high starting torque needed for record changers for many years. However, its isolation between platter and motor is low.*

(C) Direct Drive. *This design does not provide high isolation, but low operating speeds insure that rumble will occur only at very low frequencies where it can be easily and effectively filtered out.*

"If you're going to learn electronics, you might as well learn it right!"

"Don't settle for less. Especially when it comes to career training...because everything else in your life may depend on it. That's why you ought to pick CIE!"

build (the most complex part of it is the speed-change mechanism, usually a fork that shifts the belt to a different shaft diameter). For these reasons, among others, it has been the practice for some time for designers of single-play turntables to use belt drive. The performance specifications of these turntables are almost always better than those of idler-driven turntables, and their prices can be very competitive.

For many years, no belt-driven record player could change records automatically. This problem arose because, among other reasons, the diameter of the shaft of a high-speed motor, through which all of its torque was transmitted to the belt and platter, was very small in relation to the turntable diameter. In recent years, this difficulty has been resolved—in many cases by using a relatively low-speed motor, whose driving shaft diameter was larger and thus able to transmit more torque to the platter without slipping. This also has the advantage of reducing the rumble to a subsonic frequency. Another approach, especially when a 4-pole motor is used, has a low-torque record-dropping and arm-indexing mechanism.

While these developments were taking place, direct-drive motors were appearing in growing numbers. Presently, there are several different constructions used in these motors, depending on their manufacturer. Some are dc motors, while others use ac power. All are servo motors, from which a signal proportional to speed is fed back to the driving amplifiers to maintain a constant speed. The feedback can be in the form of a frequency or a voltage, either being compared to a reference of the same type. A variation of the original direct-drive motor (which was constructed as a complete unit with a protruding shaft that acted as a center spindle when the platter was placed on it) is the motor which uses the platter itself as the rotor element. This was first introduced by Matsushita (Technics), and more recently in a somewhat different form in a Fisher turntable. It has a circular band of magnetic material around the inside of the platter, on which are magnetized a number of permanent magnetic poles. (There are 120 of them in the Fisher unit.) The stator windings and pole pieces are on the motorboard, close to the magnetized strip on the platter. The interaction between the field from the stator and the permanently magnetized poles causes the platter to rotate. Pickup coils (like tape-recorder heads) close to the magnetized strip sense the motion of the platter. The voltage generated in them supplies the feedback control signal to the electronic section. This is unquestionably the simplest type of turntable, from a purely mechanical standpoint, having only one moving part—the platter itself! Of course, there is considerable electronic complexity associated with a direct-drive motor. In newer designs, however, most or all of this is in a single LSI chip, which provides potentially greater reliability and lower cost than a similar circuit made of discrete components.

In spite of the marketing appeal of direct drive, belt-driven turntables are still very much on the scene (the Garrard GT25 tested for this month's reports is a good example). In fact, the record player lines of all major manufacturers include belt-driven models, and belt drive is used extensively in the lower-price models from the Japanese manufacturers who favor direct drive for their higher-priced units. Mechanically, belt drive is hardly more complicated than direct drive, consisting as it does of a motor, a belt, and a platter—three parts in all. There is also the complete elimination of the complex electronic circuitry that is required to run a direct-drive motor, making the belt-drive system as reliable as any type over the long term.

Some belt-drive models have a speed vernier adjustment, usually by electronic means. In these, an oscillator and amplifier drive the motor instead of a direct connection to the power line; the vernier merely adjusts the oscillator frequency. These units may or may not have feedback stabilization (most do not), which requires a tachometer generator on the platter to supply the feedback signal to the amplifier. The overall complexity of an electronically driven belt-drive turntable is not much different from that of a direct-drive unit, nor is its price. Simpler adjustable-speed belt drives use an expanding drive shaft diameter to adjust the speed.

From a practical standpoint, belt drive can be every bit as good as direct drive. Its rumble and flutter can be made just about as low if the mechanical assembly tolerances are held to the same close limits. Even though the direct-drive motor's basic vibration rate is only 0.5 Hz (at 33⅓ rpm), harmonics may be present at much higher frequencies, well into the audible range. A good belt-driven design, especially with a low-speed motor, can achieve very similar results. It is easier to isolate the turntable system from external vibration with belt drive since the motor can be fastened rigidly to the supporting base, and the platter and arm can be linked as a unit and floated on a compliant suspension to prevent transmission of vibration. A direct-drive turntable, on the other hand, cannot suspend only the platter and arm on spring mounts, but must float the entire motorboard or, in most cases, the entire record player. Rarely is this as effective as the systems used with the better belt-drive players. (When the turntable suspension is loose enough to provide good isolation, the record player tends to have a "bouncy" feel when handled.)

Since mechanical assembly precision is the key to good performance, do not expect a low-priced belt-driven record player to match the performance of a good direct-drive unit (or even of a low-priced direct-drive player). Alternatively, a really good belt-drive turntable will be able to outperform all but the finest direct-drive models. (It may be as expensive as they are, however.) There are differences in direct-drive motors as well, so one cannot expect a $200 direct-drive turntable to match the performance of one costing twice as much. However, the differences are likely to be so small that they cannot be heard.

Quite recently, "quartz lock" turntables have been announced by several manufacturers. Originally very expensive, they have now entered the medium- and low-priced categories as well. A quartz-lock system is a direct-drive turntable in which the turntable speed is referenced to a signal derived from a quartz-crystal oscillator. This gives it, for all practical purposes, absolute speed accuracy and stability. On many quartz-lock units, a vernier speed adjustment is also provided. In the lower-price players, this is done by disengaging the quartz-crystal control and substituting a conventional dc voltage as a reference for the turntable speed, as with any ordinary direct-drive motor. Some high-priced units can shift speed in small discrete steps, using synthesizer techniques to maintain crystal accuracy and stability at all times.

Most people have no need of the extremely accurate speed of a quartz lock system. One characteristic of many of them is a very high motor torque, although there does not seem to be any fundamental reason why the same torque could not be achieved without the quartz reference. Their high torque enables these turntables to start up, or to change speed, in a fraction of a second, compared to the delays of several seconds that are common with other direct-drive motors. This is of more importance to a broadcast station than to most home users. The high torque also makes the speed independent of heavy loads, such as record cleaning devices, which is of more interest to hi-fiers who wish to clean discs while they rotate on a platter.

Throughout all this evolutionary process in record-player drives, the old idler system has been the one to lose the most ground. It is rarely found nowadays except in the lowest priced record players. For serious or professional applications, which once called for a heavy duty idler driven turntable because of its ability to come up to speed rapidly, the newer quartz-locked turntables have a clear advantage. For home music systems, at almost every price level, either belt or direct drive is far superior to an idler-driven turntable—and they now dominate the market.

GARRARD MODEL GT25 AUTOMATIC RECORD PLAYER

Belt-drive player can handle up to six discs automatically and features a very-low-mass tonearm.

HIRSCH-HOUCK LABS REPORT

Garrard's new "GT" series could easily be mistaken for conventional single-play record players. A close examination, however, will reveal that these are automatic record players that are capable of playing up to six discs. The one visible clue that the GT series of players have automatic functions is the vertical post near the tonearm pivots.

The Model GT25 tested here falls in the middle of the line of five Garrard GT series players, all of which are belt driven. It measures 17⅝"W × 13¾"D × 7¾"H (44.8 × 34.9 × 19.7 cm) and weighs 16 lb (7.3 kg). The suggested retail price of the Model GT25, including base and dustcover, is $159.95.

General Description. The belt actually turns a smaller 5½" (14-cm) diameter central platter made of molded plastic. The larger cast metal platter rests on it, and the center hole accommodates either a short single-play spindle that turns with the record or a long multiple-play spindle. When records are loaded on the long spindle, their edges are supported by the post near the tonearm pivot, but the dropping action is entirely through the center spindle.

Basic operation of the player is via three knobs on a metal plate located along the right side of the motorboard. The middle control has settings labelled OFF, MANUAL, AUTOMATIC, and REPEAT. To its rear is a two-position record indexing knob, for 7" and 12" (17.8- and 30.5-cm) records. At the front of the control panel is a knob that initiates the automatic cycling of the player, by a momentary movement to its AUTO START/REJECT setting. (It is spring loaded to return to its original position.)

The tonearm consists of a mildly S-shaped aluminum tube and a very light perforated magnesium four-pin, locking-type bayonet head shell. A rotating counterweight also carries the tracking force scale that is calibrated from 0 to 3 grams at 0.25-gram intervals. The CUE lever, located near the base of the arm, operates through a curved horizontal bar. Also near the base of the arm is an antiskating dial, with two scales calibrated for elliptical and CD-4 styli.

Although the tonearm is quite conventional in appearance and is a full 9" (22.9 cm) from stylus to pivot, its very low effective mass is rated at 12 grams. As is the case with the other GT series players, the Model GT25 also features an automatic control mechanism made of Delrin, a rugged, self-lubricating plastic that makes it unusually quiet in operation. The "Delglide" system is driven from the turntable shaft through a separate belt under the motorboard.

The operation of the record player is straightforward. For manual single play operation, the record is placed on the platter, the control knob is turned to MANUAL (which starts the motor) and the tonearm is cued by hand. After playing, the arm automatically returns to its rest position and the motor shuts off. Alternatively, the control can be set to AUTOMATIC, which also starts the motor. Then when the front knob is moved to AUTO START/REJECT, the arm indexes to the selected diameter and the record is played. If the first control is set to REPEAT, at any time, the record being played will be repeated until the unit is shut off manually. To play a stack of records, the long spindle is inserted into the hole in the center of the platter, the records are placed on the spindle and edge post, the center knob is set to AUTOMATIC, and the AUTO knob is turned.

The signal outputs in the rear of the player are in duplicate. There is the conventional pair of phono jacks, with an adjacent ground terminal as well as a DIN socket. The signal cable supplied with the player is fitted with a mating DIN plug at one end and phono plugs at the other end. The power cord also plugs into the player.

Laboratory Measurements. After we installed a Shure Model M95ED cartridge in the tonearm, using the plastic jig supplied with the record player, the tracking error was less than 0.5°/in. for playing radii from 2" to 6" (5.08 to 15.24 cm). The arm could be balanced unambiguously, since the slightest movement of the counterweight made a plainly visible change in the height of the tonearm near balance. This suggests a very low vertical bearing friction. After balancing in accordance with the instructions, the calibration of the tracking force scale was exact at forces up to 1.5 grams and had a maximum error of 0.1 gram at its highest settings.

The capacitance to ground of each signal channel, measured with the cartridge shell removed, was about 115 pF. This is suitable for CD-4 cartridges, but a higher capacitance might be preferable for some stereo cartridges. (Higher capacitance cables can easily be substituted for the plug-in cable supplied.) The claim of low arm mass was verified by measurement. With the Model M95ED cartridge mounted in the shell, the total mass of the tonearm, referred to the stylus, was only 17 grams. Subtracting the 6-gram cartridge mass left a net tonearm mass of only 11 grams. This is by far the lowest mass we have measured on any conventional pivoted tonearm and is especially impressive on a moderately priced record player. The arm mass resonated with the compliance of the Model M95ED cartridge at about 9 Hz, a nearly ideal frequency, with an amplitude of about 6 dB.

The cueing lift mechanism operated smoothly, but the tonearm drifted outward somewhat during its descent, repeating about five or six seconds of the record each time it was lowered. The antiskating calibration was accurate, yielding equal distortion on both channels when set to match the tracking force.

The turntable speed was slightly slow, about 1% at 33⅓ rpm and 0.3% at 45 rpm. It did not change detectably with line potentials between 95 and 135 volts. The unweighted rms rumble was −35 dB, including vertical components, and −39 dB with vertical rumble cancelled out. Applying ARLL audibility weighting resulted in a −54-dB rumble measurement. The major rumble frequencies were 30 and 60 Hz, with other discrete components detectable at 10 and 20 Hz. The wow was 0.1% (also an unweighted rms measurement), and flutter was a low 0.035%. The flutter was predominantly found at frequencies below about 10 hertz.

The mechanical operation of the player was smooth, quiet, and trouble free. The "Delglide" mechanism was quiet, as claimed, with none of the clicking and other noises that usually accompany the operation of an automatic record player. However, we could hear a distinct sound from the rotation of the platter, apparently originating under the motorboard. When a record dropped on to the platter it made the usual "thump." When the cover was lowered, the player was at least as quiet as any automatic record player we have used. The automatic cycle required about 14.5 seconds to complete, which is typical of most automatic players.

The record player's soft rubber feet were reasonably effective in isolating base-conducted vibration. The player's most sensitive frequencies for transmission through the feet were at 30 Hz and about 100 Hz, but the overall degree of isolation was roughly what we have measured on other automatic record players mounted in a similar fashion.

User Comment. The Garrard Model GT25 left us with some definite impressions. It cannot be dismissed as just another record player. For one thing, it is surprising to find the lowest mass pivoted tonearm we have so far encountered on a very moderately priced record player. (The other players in the Garrard GT line also use a similar tonearm design.)

In spite of the lack of fanfare about the pivot design, the free-floating arm impressed us as having exceptionally low pivot friction. Although Garrard rather modestly suggests that this player is suitable for use with cartridges rated to track at ¾ gram or more, that category includes just about every cartridge known to us. Our experience suggests that the tonearm on the Model GT25 is compatible with *any* cartridge presently manufactured, no matter how compliant it may be.

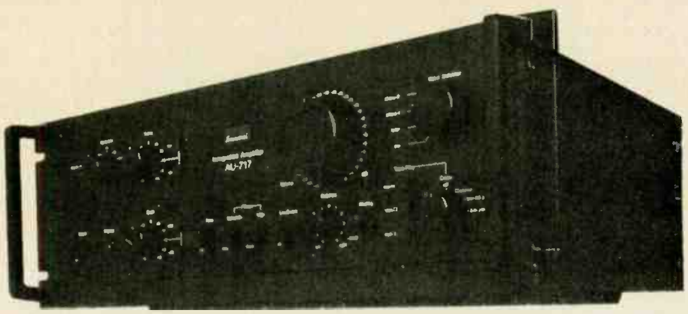
We especially appreciate a record player whose setup is free of guesswork and built-in errors. Setting the stylus overhang and balancing the tonearm of the Model GT25 are as straightforward as can be and result in the promised performance. (It is surprising how few record players can be set up properly without external aids.) Even the anti-skating dial is one of the small handful in our experience whose calibrations agree with the tracking force when adjusted for equal distortion on both channels with high velocity records.

Although the measured rumble and flutter of the Model GT25 were not exceptional, they do reflect competent performance. We also found the player to be compatible with extended-range speaker systems (rumble was not audible) and with critical program material (flutter was not audible on piano recordings). The only aspect of its performance that left us less than enthusiastic was one it shares with the majority of record players we have used—the outward drift of the tonearm during the cueing descent. Fortunately, the arm handles so easily that it can be cued by hand without "getting away" from the user (again, not something that one finds on every record player, by any means).

In sum, the Model GT25 is an excellent medium-priced record player. It provides a level of performance that is wholly consistent with the full range of modern phono cartridges.

SANSUI MODEL AU-717 INTEGRATED AMPLIFIER

Medium-high-power amplifier has impressive transient-handling ability.



HIRSCH-HOUCK LABS REPORT

Sansui's newest and finest integrated stereo amplifier, the Model AU-717, is said to have been designed to "solve audible problems of Transient Intermodulation Distortion (TIM)." Although there is still much controversy about audible effects of TIM and other slew-rate induced distortions, it is generally recognized that a very high slew rate—the ability to deliver a large change of voltage to a load in a very short time—is desirable for low TIM. Interestingly, the specifications in the AU-717's instruction manual make no mention of slew rate! However, the more conventional specifications are impressive enough in their own right.

The Model AU-717 measures 17"W × 15⅜"D ×6⅝"H (43 × 38.9 × 16.8 cm), and weighs about 39 lb. (17.8kg). Its suggested retail price is $450.

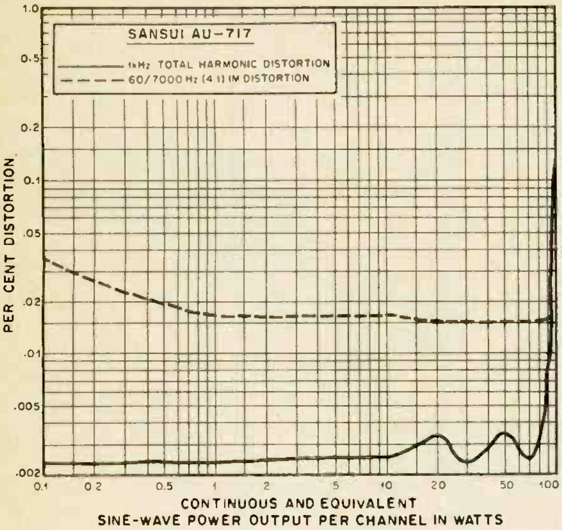
General Description. The Model AU-717 is rated to deliver at least 85 watts per channel to 8-ohm loads, between 20 and 20,000 Hz, with less than 0.025% total harmonic distortion. Its power amplifier section is fully direct-coupled, from the POWER AMP IN jacks at the rear of the unit, to the speaker outputs, and through the feedback loops as well. Normally, the power amplifier inputs are internally connected to the preamplifier outputs, but a slide switch breaks that connection; a third switch position places a capacitor in the input circuit to handle situations where a d.c. component could be present in the signal fed to the power amplifier inputs.

Differential amplifier circuitry is used throughout the AU717, including its phono preamplifier and tone control stages. Like some other contemporary amplifiers, the AU717 has completely separate power supplies, including power transformers, for each channel.

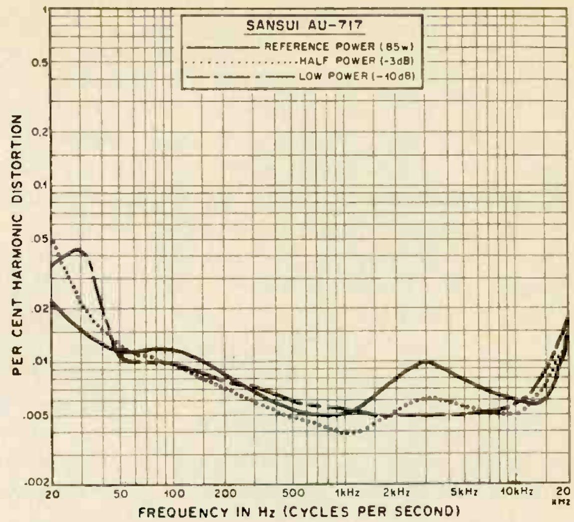
The amplifier is finished entirely in black, with legible white markings and red index lines on the black knobs. A small red LED glows on the panel when power is applied, blinking on and off while operating conditions are stabilizing. The INPUT SELECTOR, located at the upper right of the panel, provides a choice of two high-level and two magnetic-phono sources. LED indicators near the knob identify the input selected.

A large VOLUME knob operates a 32-step attenuator, with 1-dB steps near the top of its range, 2-dB steps at lower settings, and still larger steps near the bottom of its range. The TONE controls (BASS and TREBLE) are each 11-position step controls. Buttons next to the knobs are used to select turnover frequencies. For BASS, the choice is 200 or 400 Hz; for TREBLE, 3 kHz or 6 kHz. A SPEAKERS switch activates either, both, or neither of two pairs of speaker outputs. There is a PHONES jack on the panel, and a lever switch for POWER.

The TAPE circuits of the AU717 are exceptionally comprehensive. Mechanically interlocked buttons connect either the selected program SOURCE or the TAPE PLAY signals to the amplifiers. There are provisions for two tape decks, with a button allocated to each. The exceptional part is the COPY switch, a knob near the buttons, which controls the signal fed to the recorders. In its SOURCE position, the tape recorders are fed the signal from the INPUT SELECTOR switch. But other settings of the COPY switch feed the recorders from any of the AU717's inputs, regardless of the INPUT SELECTOR's setting, or from any of the three tape recorder inputs (which are not controlled by the INPUT SELECTOR switch). Thus, one can record from the tuner (for example) while listening to a record, tape or other program source. Of course, one can listen to any other program through the amplifier while dubbing from one tape deck to the other or monitor the playback from either tape deck with the appropriate TAPE PLAY button. Finally, there is an OFF setting that removes al



Total harmonic distortion and 60/7000-Hz IM distortion.



Harmonic distortion at three power levels.

signals from the TAPE OUT jacks in the rear of the amplifier, in order to prevent any possible loading of the amplifier circuitry by the tape decks when you are not recording.

The BALANCE control is a small knob, with a center detent, located below the VOLUME knob. Lever switches drop the volume by 20 dB (MUTING), engage the LOUDNESS compensation, turn on the HIGH filter (with a 6 dB per octave slope above 10 kHz) or the SUBSONIC FILTER (cutting off at 6 dB/octave below 16 Hz), and bypass the tone-control circuits.

In the rear of the AU-717 are insulated spring clips for speaker connections, and the various signal input and output jacks, plus preamplifier output and main amplifier input jacks and the slide switch that couples them. There are three a.c. outlets, one of which is switched.

Laboratory Measurements. The AU-717 did not become unduly warm during the one hour preconditioning period at one-third power. Fully heated, the outputs clipped at 100 watts per channel, driving 8-ohm loads at 1,000 Hz. Into 4 and 16 ohms, the amplifier delivered 128 and 64 watts, respectively.

The 1,000-Hz harmonic distortion was exceptionally low at most power levels. It was under 0.004% from 0.1 watt to 80 vatts output, reaching 0.01% at 100 atts, just before clipping occurred. Inmodulation distortion was 0.036% at watt, and a nearly constant 0.015% most of the power range up to 90 The full-power THD was less than from 40 to 20,000 Hz. Although red to rise at lower frequencies, cts the increased distortion of rd test oscillator at those frequencies. So far as we could determine, the distortion of the amplifier was negligible compared to the measured values of 0.03% or slightly more.

At maximum gain, the AU-717 could be driven to a reference output of 10 watts by 49 millivolts at the high-level inputs, and 0.84 millivolts at the PHONO inputs. Unweighted S/N ratio, referred to 10 watts, was a very good 83.4 and 77.1 dB, respectively. The phono preamplifier, in spite of its very high gain, overloaded only at the very high input level of 380 millivolts. Tone control characteristics were very good, affecting only a limited portion of the frequency range. The loudness compensation boosted both low and high frequencies at low volume settings. Although compensation was somewhat excessive, using the MUTING switch to drop audio gain by 20 dB, it was possible to operate the VOLUME control at a higher setting and thus reduce the loudness compensation to more suitable levels.

The filter slopes at 6 dB per octave, were too gradual to be very effective, although the SUBSONIC filter began to show its effect at about 50 Hz and probably reduced subsonic output substantially. The HIGH filter response was down 3 dB at 7,000 Hz. RIAA phono equalization was at least as accurate as our measuring instruments, with less than ±0.5 dB of error over the extended range from 20 to 20,000 Hz. It did not change detectably when measured through the inductance of a phono cartridge.

It was in its transient handling, though, that the Sansui AU-717 was most impressive. The rated rise time of 1.8 microseconds would be considered very good; however, we measured the rise time as about 1 microsecond, from the AUX input through the entire preamplifier and power amplifier combination. A 2-μF capacitor shunted across the 8-ohm load slowed down the rise time to 6 microseconds, but did not produce any instability. The slew rate of the AU-717 was by far the fastest we have yet measured—about 60 volts per microsecond.

One distortion test that evaluates an amplifier's high frequency power handling ability is a difference-tone IM measurement using two tones near the upper limit of the audible range, such as 19 and 20 kHz. Driven to within 0.2 dB of the clipping point by such a signal, the AU-717 produced a 1,000-Hz distortion component some 75 dB below the level of either tone and no other visible distortion components within the 80-dB range of our Hewlett-Packard spectrum analyzer. This is, by by any standard, excellent performance, especially for an integrated amplifier.

User Comments. Sansui's Model AU-717 integrated amplifier is a splendid example of melding high electronics technology with a sense of packaging panache. As one of Sansui's new "DC" stereo amplifier models, its advanced circuit designs are impressive. More important, it has resulted in impressively fine laboratory measurements and the test sample did not add any sound of its own. Reinforcing this attribute, there are no switching transients or other unwanted side effects caused by use of its switches or controls.

Control flexibility is excellent, though not unlimited, and the controls operated smoothly. The relay protective systems proved to be among the better ones

around, always cutting the output before any damage could occur during our examinations.

The AU717's black-color enclosure and rack-mounting adaptor bestow a professional look upon the model, an appearance often desired by the more serious audio enthusiast.

In sum, the AU717 is highly recommended for those who wish a medium-high-power control amplifier and the flexibility of choosing one's own FM tuner. Considering its power rating, low distortion and price class, there are only a very few competitors in the race.

SHERWOOD MICRO/CPU 100 FM TUNER

Microprocessor provides programmed tuning and display of station's call sign.

HIRSCH-HOUCK LABS REPORT

This remarkable new FM-only tuner is the second of two audio components we've examined to incorporate a microprocessor. (The other was the ADC Accutrac record player.) But it won't be the last. The microprocessor adds many unusual features, such as a display that shows a station's call letters as well as its frequency, a unique self-diagnostic test program, and a four-station memory-tune system that is unusually easy to program. Even without the microprocessor, though, the Sherwood Micro/CPU 100's receiving circuitry would be novel enough to merit special attention in its own right. Its tuning, for example, is all-electronic, with no variable capacitors or potentiometers. And a high proportion of its circuits are digital.

The tuner has a satin-finished aluminum front panel, a black metal cabinet, and walnut-grain wood side panels. It is approximately 20" W x 15" D x 6 3/8" H (508 x 37.9 x 16.2 cm), and weighs 34 lb (15.4 kg). The manufactuer's suggested price is $2000.

General Description. The Micro/CPU 100 is digitally tuned, with a crystal-controlled, phase-locked digital frequency synthesizer generating only the frequencies needed for accurate tuning. Tuning moves in 200-kHz steps from one channel frequency to another, with a minimum rated accuracy of 0.0024%. Since frequencies between channels are never covered, no center-channel meter is necessary. A switch on the rear panel programs the synthesizer for either the odd-numbered station frequencies (92.1 MHz, 92.3 MHz, etc.) used in this country or for the even-numbered channels used elsewhere. For high rejection of image and spurious response, a six-section, varactor-tuned front end tracks with this synthesized local oscillator. There are two, separate i-f amplifiers, one each for normal- and wide-bandwidth operation.

The detector, which recovers the audio information from the FM signal, is also digital; a true pulse-counting type. It generates a pulse each time the received signal crosses the zero-voltage axis, then averages these constant-width, constant-amplitude pulses together to produce the audio signal.

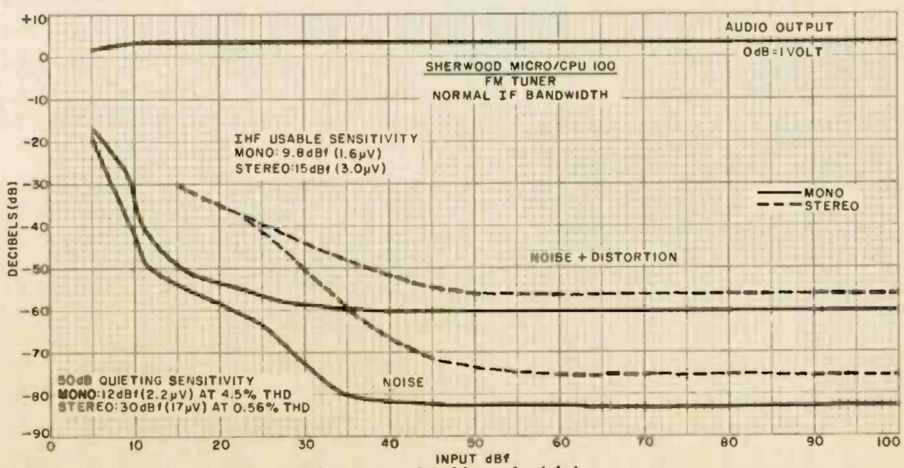
The detector's averaged output is proportional to the FM frequency, which varies with the transmitter's audio input, so the detector is extremely linear, and reproduces the modulating waveform with great accuracy.

From the detector, the signal goes to a phase-locked-loop multiplex demodulator. This is followed by the audio muting switch and an automatic high-blend circuit that partially combines the two channels when a weak stereo signal is received, thus reducing the noise level.

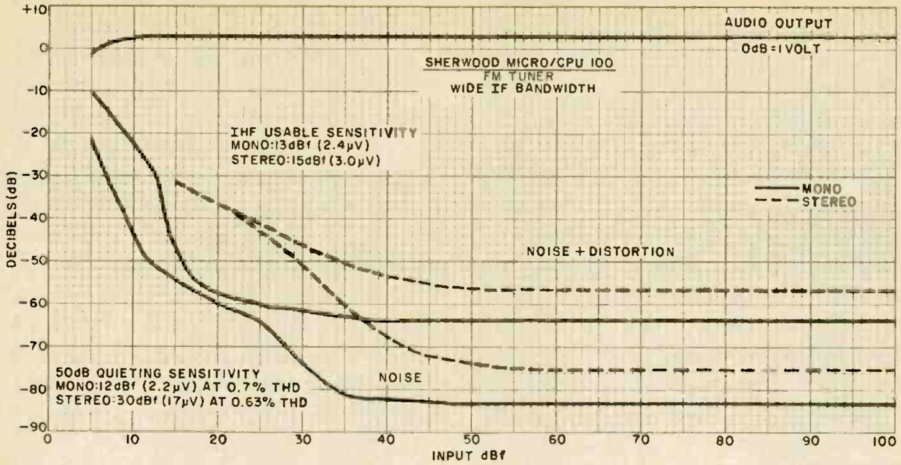
The Sherwood has three tuning modes. The most obvious of the few controls on the front panel is a conventional-looking tuning knob, but with an unconventional feel. It turns with unusual lightness and freedom because it operates no mechanism at all. Instead, it is linked only to a flywheel and a notched metal disc which resembles a multi-bladed fan. The "blades" interrupt a light beam as the knob is turned, sending control pulses to the microprocessor.

Like many digital tuners, the Micro/CPU 100 also offers autoscanning operation. Above the tuning knob are pairs of small contacts marked LEFT and RIGHT, though perhaps DOWN and UP would have been more accurate. A touch on the LEFT pair starts the tuner scanning downward from whatever frequency to which it had previously been tuned. If it encounters a signal strong enough to override the muting circuit, it stops. If no signal is received before the tuner reaches the lower end of the FM band, it flies back to the starting frequency and scans upward from there. If nothing is found in that part of the band either, it returns to the original frequency and stops. Between the LEFT and RIGHT turning contacts is a pair of contacts labeled STEREO, which sets the tuner to respond only to stereo signals when in scan mode; a second touch restores normal automatic stereo/mono operation.

More unusual is the tuner's MEMORY feature, capable of storing the frequen-



IHF usable sensitivity with normal i-f bandwidth.



IHF usable sensitivity with wide i-f bandwidth.

cies of four stations and returning to any of them at a touch. Storing them in the memory requires no punched cards or other physical programming, a departure from previous practice. Instead, when the tuner is set to the desired channel, a pair of fixed contacts marked STORE is touched, followed by a touch of one of the four pairs of MEMORY contacts. (A neon lamp behind each contact glows when it has been activated.) To return to that station at any future time, only a touch of the appropriate MEMORY contact is required. This memory information is retained when the tuner is turned off. Even when it is unplugged, according to Sherwood, the memory holds its contents for up to a year without power.

The MICRO/CPU also has three ways of indicating to which station it is tuned. As you'd expect in a digital synthesis tuner, there is a numerical frequency display—0.5" (12.7-mm) red characters, behind a dark section at the right side of the tuner's display panel above the tuning knob. In the center of the panel is a conventional-looking dial, calibrated from 88 to 108 MHz in 1-MHz steps. But instead of a moving pointer, this dial has a moving spot of light, a red LED glowing beneath the calibration line nearest to the tuned frequency, and shifting as one tunes.

Between these two displays is the tuner's most remarkable and distinctive feature, a four-character alphanumeric display, with 3/8-inch-high LED characters that can display a standard computer-terminal character set, with numbers, upper-case letters, and a variety of logical and punctuation signs. When you first use the tuner, nothing appears on this display. But it can be programmed to display the call letters of the stations to which you regularly listen.

To program this call-letter display, you first tune in a station, then press a contact pair marked ALPHA. Turning the tuning knob will not change the station, but will light up the first character of 'the display with a series of characters, beginning with "A". When the first letter of the station's call sign is reached, a touch of the STORE contact places it in the first position, and the letter "A" now appears to its right. The knob is turned again until the second letter of the call sign appears. That letter is stored, and the process continues until the full four-character call is displayed. Now the knob returns to its normal tuning function—with the difference that, whenever that frequency is reached, the programmed call letters appear between the frequency digits and the "dial" scale.

The tuner's memory can store up to 48 call signs, enough for most listening areas. To erase a call sign, display it and touch ALPHA and MEMORY A in succession. That call sign then disappears, and a new one can be programmed if desired. When the full 48 signs have been stored, any attempt to add another will cause the word "FULL" to flash on the display for a few seconds.

At the left side of the panel are illuminated SIGNAL and MULTIPATH meters. The former reads relative signal strength, over a very wide range, while the latter fluctuates in proportion to the amount of multipath distortion present in the received signal. This MULTIPATH meter is not only one of the very few such meters that actually work, but it is in our opinion the best of the lot we've seen, by a wide margin. Even a trace of multipath distortion produces a visible pointer deflection! When the antenna is oriented so that this meter is stationary, one can be sure that the program is virtually as free of distortion as it was when it left the transmitting antenna.

Additional controls are concealed behind a hinged door at the bottom of the control panel. These include audio output level adjustments (there is also a pair of fixed-level outputs), the muting threshold adjustment, and switches for MUTING, AUTOSTEREO FILTER, STEREO/MONO mode, DE-EMPHASIS (from the normal 75 microseconds to the 25 microseconds required when using a Dolby decoder with the tuner) and the NORMAL/WIDE selectivity selector.

Although it has nothing to do with the tuner's performance, the tuner has a unique capability to analyze and check out its own operation. Its built-in "computer" can do this far more rapidly than a human technician could do. It even displays the part numbers of defective IC stages on its alphanumeric display. For this purpose, specially programmed read-only memory (ROM) IC's are used. Substituting one for one of the IC's on the computer board, and turning on the power, causes a rapidly changing display of numbers and letters on the panel of the tuner. The test is completed in about a minute. If all goes well, the words "TEST DONE" flash alternately on the display until it is shut off.

Another ROM is used in a similar manner to check the operation of the tuner's non-computer functions. This ROM scans rapidly through the tuner's full frequency range. All of the functions related to the touch contacts are checked out in sequence, to the accompaniment of an impressive display of flashing lights and changing digits. The speed of the checkout is controlled by the tuning knob; at its slowest, it took only about 5 seconds, and at the fastest, it was done several times per second. As a nice final touch, setting the EVEN/ODD switch to EVEN causes a message to pass across the alphabetic display, from right to left, reading "THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK." This shows that the display is operating properly.

Laboratory Measurements. Most of the performance measurements were made twice, using both NORMAL and WIDE i-f bandwidths. The IHF usable sensitivity was exceptional: 9.8 dBf or 1.6 µV in mono and 15 dBf (3 µV) in stereo. A more important specification is the 50-dB quieting sensitivity, which defines the weakest signal that will actually produce a listenable output. This measured 12 dBf (2.2 µV) in mono and 30 dBf (17 µV) in stereo. Both are very much better than average, even for very good tuners. These figures were essentially the same with both i-f bandwidths, except for IHF usable sensitivity, which improved to 13 dBf (2.4 μV) in mono when we used the WIDE setting.

Distortion was 0.1% in mono and 0.13% in stereo for a 65-dBf (1,000-μV) input and the NORMAL i-f bandwidth. Not surprisingly, the WIDE bandwidth setting improved the monophonic distortion still further, to 0.07%. (The tuner's distortion is therefore very close to the residual distortion of the Sound Technology signal generator we used, which is rated at 0.1%.) With L − R stereo modulation, stereo distortion was 0.4% at 100 Hz, 0.067% at 1,000 Hz, and 0.089% at 6,000 Hz with NORMAL i-f bandwidth. Corresponding figures for the WIDE setting were measured at 0.56%, 0.10%, and 0.056%, respectively.

The Micro/CPU 100 delivered an amazing 82.5-dB S/N in mono, and 75 dB in stereo, in either i-f bandwidth mode. In contrast, the finest tuners and receivers we have tested so far have rarely exceeded 72 dB in mono or 70 dB in stereo. The Sherwood, in fact, showed us that our signal generator's residual noise was much lower than we had believed! (And note, on our sensitivity graph, how quickly the signal reaches 70 dB of quieting—even in stereo, where only 43 dBf is sufficient.)

The tuner's stereo frequency reponse was also remarkable. It was so flat (±0.3 dB from 30 to 15,000 Hz) that we wondered how the tuner could possibly have a low-pass filter in its multiplex output, since such filters usually cause a frequency roll-off around 15 kHz. But there was such a filter, capable of suppressing the 19-kHz pilot carrier to a satisfactory −62 dB. It takes an exceptional filter to have this much effect at 19 kHz, yet have so little at 15 kHz. The stereo crosstalk curve was almost as flat as the frequency response curve. It was −45 dB ± 1.5 dB from 30 to 5,000 Hz, and still a very good −40 dB at the 15,000-Hz upper limit. In WIDE, we had expected the crosstalk to be even lower, but it was essentially unchanged except between 10,000 and 15,000 Hz, where it fell to 36.5 dB.

The capture ratio at the NORMAL bandwidth setting was a very good 1.06 dB at a 45-dBf (100-μV) input, and 1.25 dB at a 65-dBf input. With the WIDE setting, it was almost immeasurable. The best estimates we could come up with were 0.7 and 0.6 dB at the two signal levels. Capture ratios of this magnitude are nearly impossible to measure accurately; suffice it to say that the MICRO/CPU 100 exhibited one of the best capture ratios we have ever encountered.

AM rejection was also very good: 68 dB at 65 dBf (WIDE) and 72 dB at 45 dBf (WIDE). Image rejection was greater than we could measure, exceeding 106 dB.

The alternate channel selectivity was a very good 87 dB with NORMAL i-f bandwidth, and 38 dB with WIDE. Whereas most tuners exhibit slightly better selectivity to one side of the tuned frequency than to the other (published selectivity measurements are usually an average of the two sides), the Sherwood's i-f response was almost perfectly symmetrical. Adjacent-channel selectivity measurements were 8.4 and 4.8 dB.

The lowest muting threshold was about 15 dBf (3 μV); the muting could also be shut off entirely, of course. On our test sample, even the 30,000-μV maximum output of our signal generator did not trigger tuner operation with the muting threshold set at maximum. Automatic stereo switching threshold was at 15 dBf (3 μV). And hum and noise in the tuner output were unusually low—80 dB below 100% modulation.

User Comment. The Sherwood MICRO/CPU 100 is an FM tuner that will titillate even the most hardened audiophile. Its extremely ingenious tuning system has been paired with a tuner whose performance transcends that of most other "super tuners" in many respects, and rivals them in others.

Furthermore, the tuner's physical handling is as smooth as its performance. Once the novelty of programming the channels has worn off, one soon begins using the tuner as it was meant to be used, with a mere touch of a finger on a MEMORY contact, an effortless slip of the tuning knob to select a station. The self-checking feature might never be used, but it does suggest some of the potential in combining hi-fi with computers.

A $2000 price tag is still formidable for a tuner. But the lucky few who can afford one (and who use it with a good FM roof antenna) will be able to take comfort in the knowledge that whatever they hear from the MICRO/CPU 100 will be limited in quality only by the broadcast station's transmitting equipment and program material—neither of which is likely to approach this tuner's signal quality in the foreseeable future. The MICRO/CPU 100's most distinguished attribute is its ability to pull in more truly listenable broadcast signals than has previously been possible. And what better praise can a tuner have than that?

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LOW-COST EPROM PROGRAMMER

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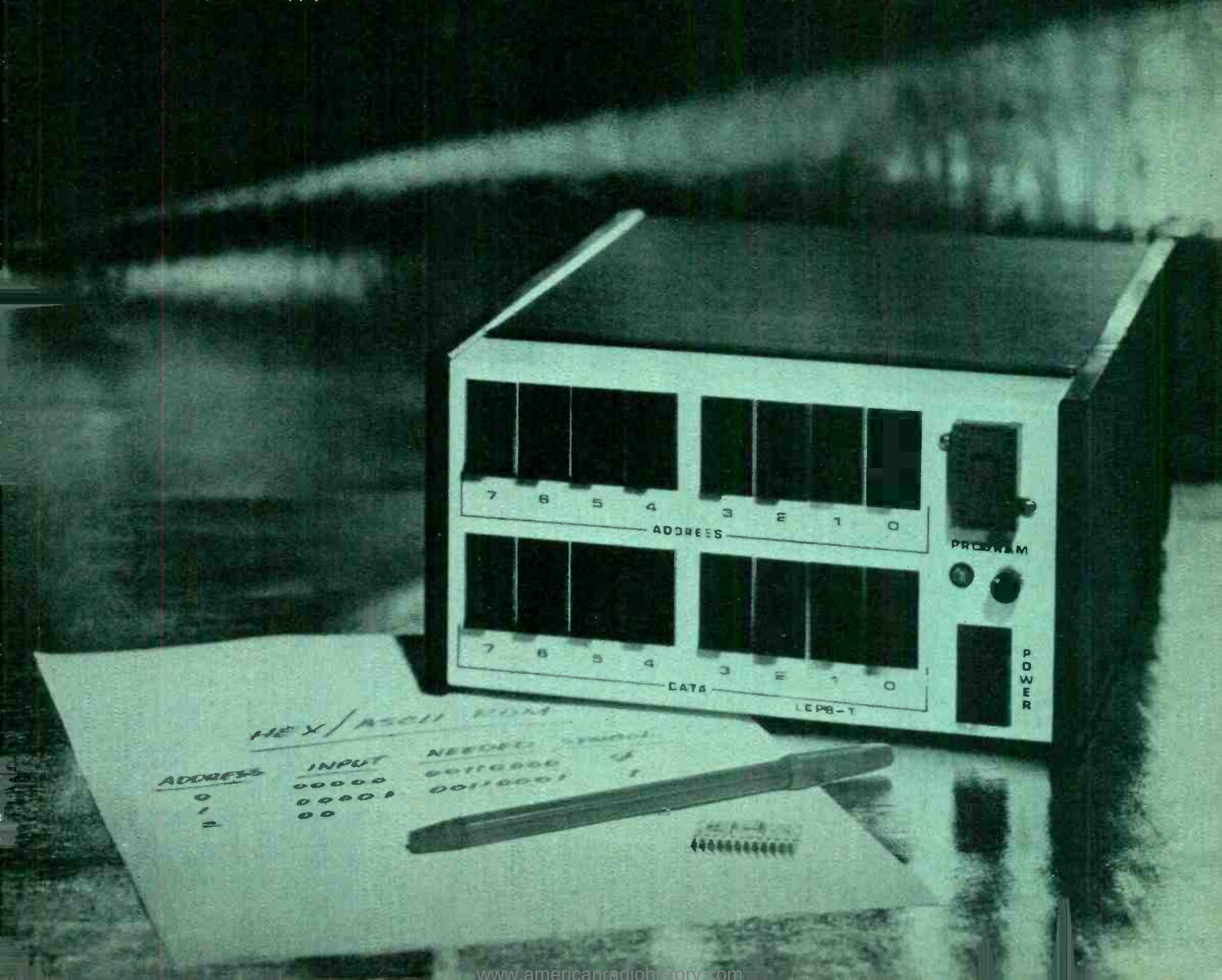
Now, you can program 1702A, 4702A, and 8702A EPROM's inexpensively.

PART 1

PROGRAMMING erasable read-only memories (EPROM's) has generally been beyond the reach of most electronics experimenters owing to the high cost of the machine required to do the job. Thus experimenters have been virtually limited to PROM's in which fuse links are burned out and which therefore can never be reprogrammed. Now, with the low-cost EPROM Programmer presented here ($40 without power supply, $80 complete), it's anticipated that more and more electronics enthusiasts will use erasable (and reprogrammable) ROM's, where mistakes can be corrected as well as an entire program changed should this become necessary.

The EPROM Programmer is designed to operate with the highly popular 256-word-by-8-bit 1702A, and associated family (4702A, 8702A), EPROM's. Note that it is not compatible with other similar devices such as a 1701 or 1702. Also,



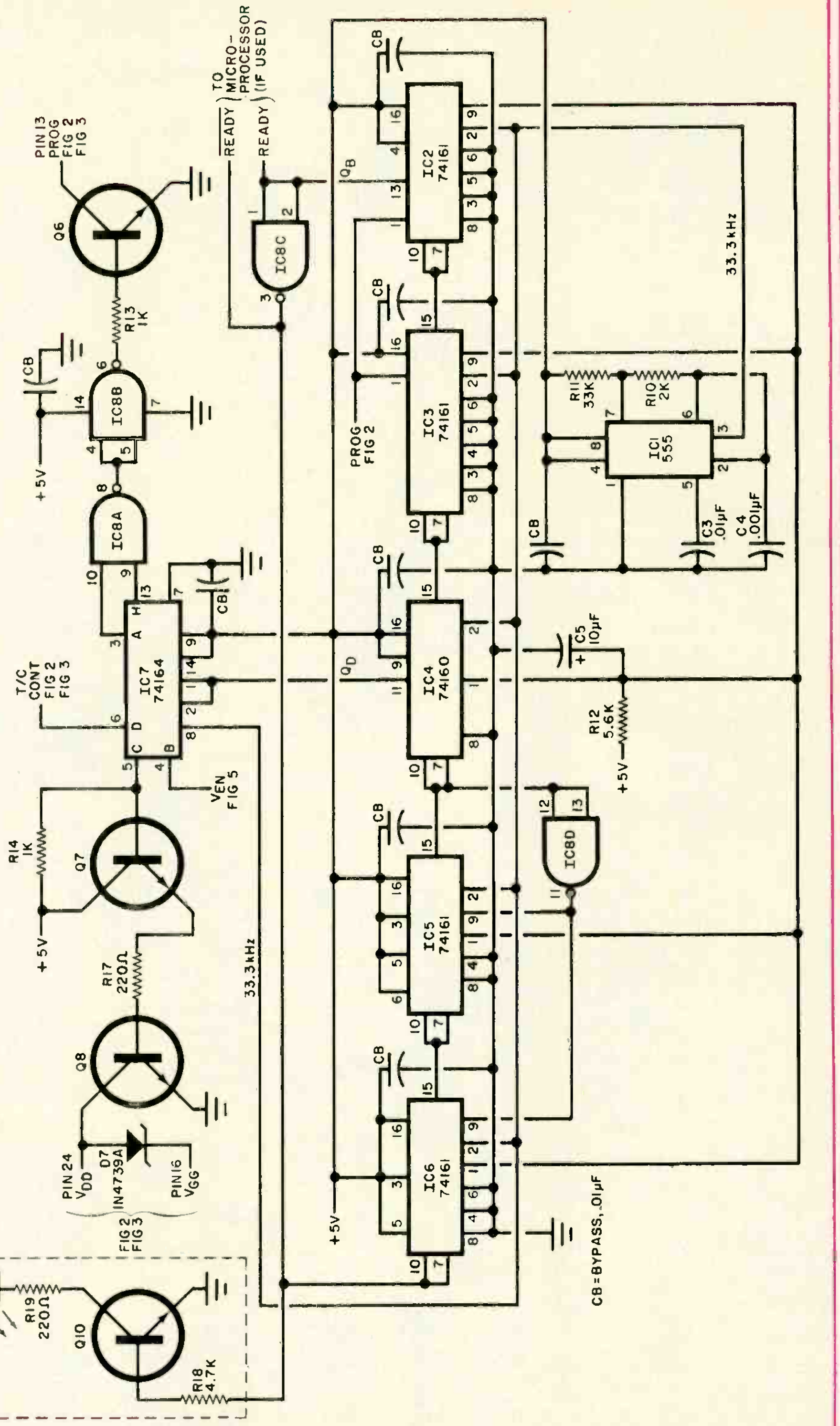


Fig. 1. System clock is IC1. Countdown chain and IC1 develop correct system timing for 1702A. LED1 is optional pulse timing monitor.

PARTS LIST

C3,C8—0.01-µF, 25-V ceramic capacitor
C4—0.001- µF, 10%, 25-V ceramic capacitor
C5—10- µF, 15-V electrolytic
D7—9.1-V, 10%, 1-W zener diode (1N4739 or similar)
D8—Red LED (optional)
IC1—555 timer
IC2,IC3,IC5,IC6—74161 binary counter
IC4—74160 decade counter
IC7—74164 8-bit shift register
IC8—7400 quad 2-input NAND gate
Q6,Q7,Q8,Q10—MPS-A05 60-V silicon npn transistor
The following are ¼-W, 10% resistors unless otherwise noted:
R10—2000 ohms, 5%
R11—33,000 ohms, 5%
R12—5600 ohms
R13,R14—1000 ohms
R17,R19—220 ohms
R18—4700 ohms
Misc.—Suitable chasis or enclosure, heat sink, thermal grease, transistor insulating hardware, #6-32 mounting hardware, line cord, grommets, fuse holder, 5-volt at 1-ampere power supply.
Note—See Parts List for Fig. 5 for availability of kits.

the programmer is a write-only machine, the assumption being that, if you're programming the device, you already have some type of reading provision.

Perhaps the greatest utility for EPROM's among experimenters is in the microcomputer field. For example, there is a host of different monitors available for every microprocessor chip. Although the monitors share some common instructions, some have more (or better) features than others. Without a monitor, of course, the basic computer can't "do something" when it's turned on.

One could load monitor data from a cassette tape machine, naturally, but this is a cumbersome method. It's best for convenience and speed to have a monitor program in ROM (read-only memory) so that it's all there when you turn the computer on, and data will not be lost if there's a momentary loss of line power or when computer is turned off. Some computers have built-in ROM monitors; many do not have monitors, so the computer owner must either buy

PARTS LIST

C6—0.01-µF, 25-V ceramic capacitor
Q11,Q12,Q13—MPS-A05 silicon npn transistor
R21,R22,R23,R24,R25,R31—1000-ohm, ¼-watt, 10% resistor
R26,R27—10,000-ohm, ¼-W, 10% resistor
R28,R29,R30—47,000-ohm, ¼-W, 10% resistor
S2 through S17—Spdt toggle switch
S18—Spdt momentary (break-before-make) toggle switch
S01—25-pin IC socket (preferably zero-insertion-force)
Note—See Parts List for Fig. 5 for availability of kits.

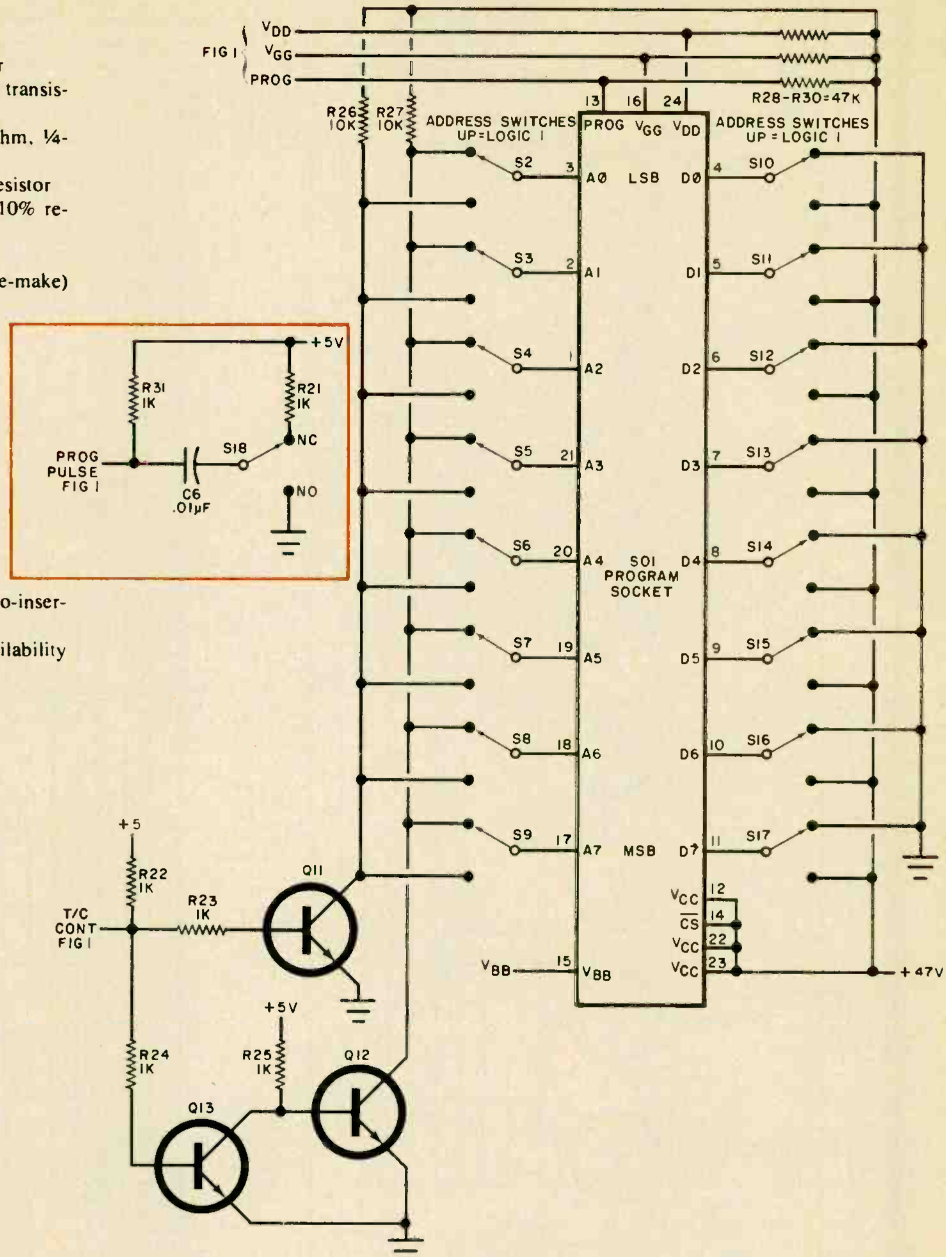


Fig. 2. Circuit provides switch address and data inputs. Pushbutton in insert starts up programming.

a ROM monitor, have a supplier prepare ROM's or program his own.

The latter route, using EPROM's could be the least expensive in the long run if a person continually upgrades his system whenever a better program or monitor comes along. An EPROM can be erased and reprogrammed very easily. The device's bit pattern can be erased (all set to "zero") by exposing the chip's transparent quartz window to ultraviolet light. In essence, the UV light's photons displace electrons that were induced in the silicon gate to form the equivalent of "1's" in the bit pattern. Then, using the EPROM Programmer, the memory can be electronically reprogrammed. Once programmed, it will maintain data when power is removed, but unlike a fuse-link ROM, it can lose data if exposed to strong UV light.

The EPROM Programmer described here—which costs about ⅓ to ¼ of commercial models—complements the appealing economic picture of the popular 1702A. The device's original tag was about \$100, where today its cost ranges from \$3 to \$12, depending on quantity purchased and source. In addition, since commercial houses charge as much as \$40 to program an EPROM, doing it yourself can represent a substantial saving.

Circuit Operation. The 1702A EPROM itself is fully static, easily interfaced, requires no clocks, and is input/output TTL compatible. The three-state output buffers are rated for one full TTL load. However, it does require a −9-volt supply in addition to the conventional 5-volt operating supply.

The Programmer can be built as a stand-alone device using switches for address and data selection, or as a TTL-compatible peripheral for use with either switches or microprocessor ports. The circuit shown in Fig. 1 provides all the timing necessary for the Programmer. The 33.3-kHz clock, generated by *IC1* ,

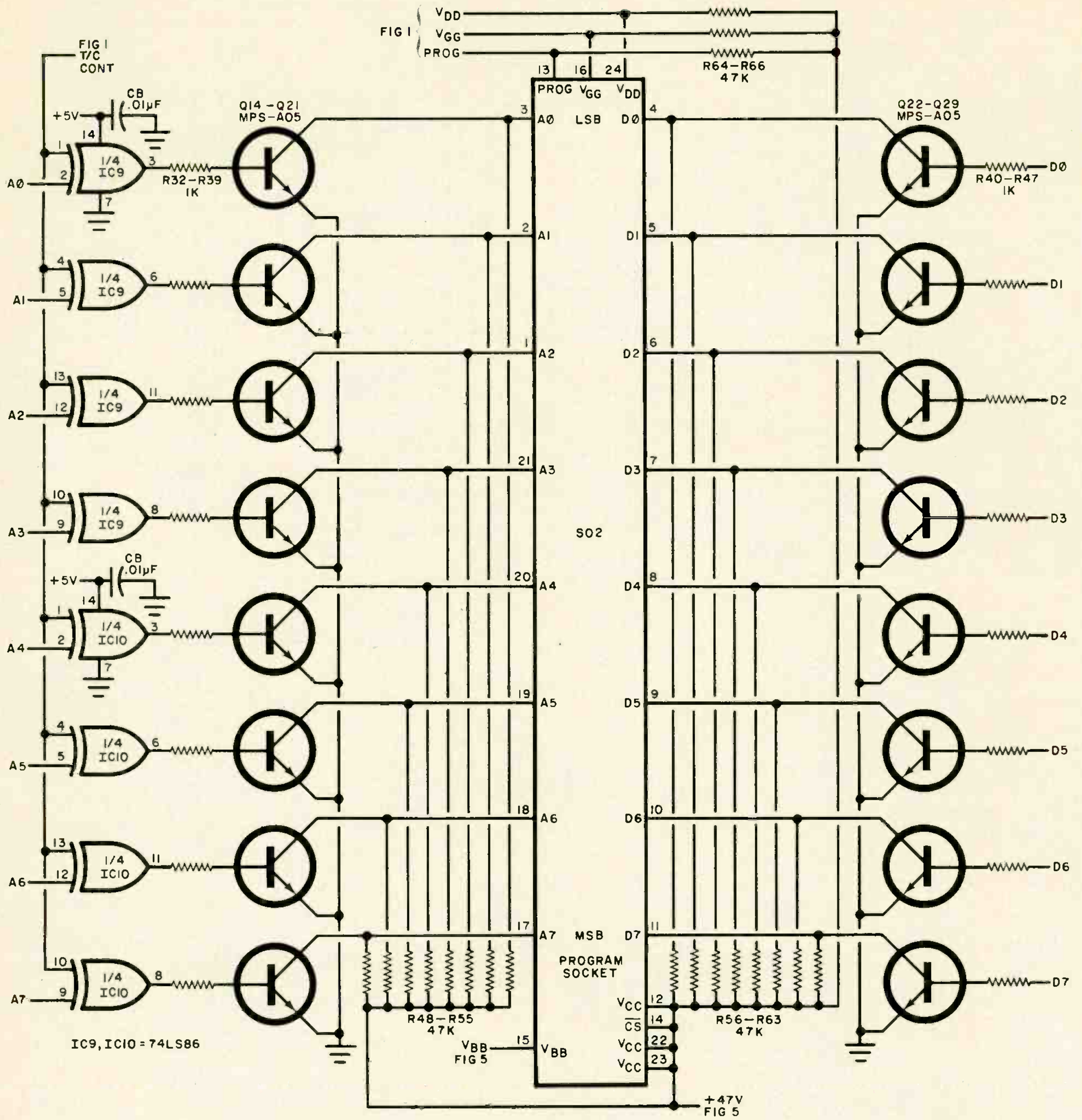


Fig. 3. TTL option is used with switch address and data inputs or accept data from microcomputer.

PARTS LIST

IC9,IC10—74LS86 quad 2-input exclusive-OR gate
Q14 through Q29—MPS-A05 60-V silicon npn transistor
R32 through R47—1000-ohm, ¼-W, 10% resistor
R48 through R66—47,000-ohm, ¼-W, 10% resistor
SO2—24-pin IC socket (preferably zero-insertion-force)
Note—See Parts List for Fig. 5 for availability of kits.

is routed to 8-bit shift register *IC7* and to a synchronous counter chain consisting of *IC2* through *IC6*. Integrated circuits *IC4*, *IC5* and *IC6*, in conjunction with *IC8D*, form a divide-by-430 counter whose carry output enables a divide-by-32 counter formed by *IC2* and *IC3*. Capacitor *C5* and resistor *R12* provide the power-up initialization for the chain.

Circuit action begins with the programming command (PROG), a negative-going pulse used to asynchronously clear *IC2* and *IC3*. The pulse width should be limited to less than five milliseconds. The *Qb* output of *IC2* (pin 13) is inverted by *IC8C* to control the operation of the divide-by-430 counter. The output of this divider is taken from pin 11 of *IC4* and is a 77.52-Hz (33.3 kHz/430) signal having a 20% duty cycle with 2.58 ms on and 10.32 ms off. This waveform meets the V_{DD} /V_{GG} programming duty cycle restrictions of the 1702A EPROM. Also, the 2.58-ms pulse falls under the 3-ms maximum specified for the 1702A programming pulse.

This signal is applied to the serial input of *IC7* and causes its eight outputs to sequence high in 30-μs intervals, the period of the clock. Output B of *IC7* begins the programming cycle by turning on the +47-volt supply through *Q2* of the power supply. This action sets the address and data lines to their proper levels. The address is complemented at this time. Thirty microseconds later, V_{DD} and V_{GG} move to their negative levels controlled by output C of *IC4* driving transistors *Q7* and *Q8*. Output D (T/C or true/complement) of *IC7* follows on the next clock pulse and inverts the address lines to their true state. Outputs E, F, and G of *IC7* are not used. When output H goes high, it is AND'ed with output A by *IC8A*. This output is inverted by *IC8B* to drive *Q6* and provide the program pulse to *SO1* (Fig. 2 or 3).

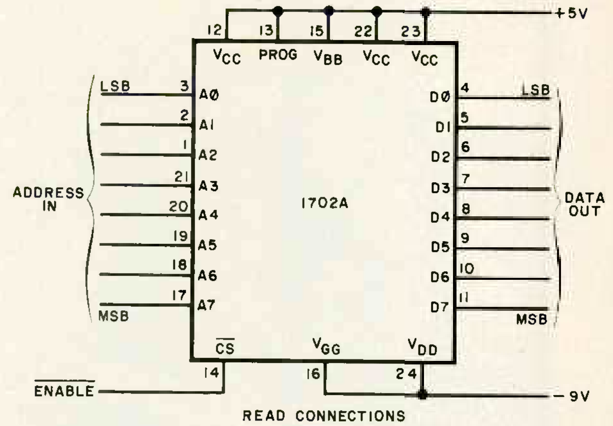
These conditions are stable until the termination of the 2.58-ms pulse. At this point, output A of *IC7* goes low, thus ending the program pulse. Then output B disables the +47-volt supply. The shift register (*IC7*) is completely cleared in six more clock pulses.

During the last 30 microseconds of the 2.58-ms pulse, a carry is generated by *IC4*, causing the divide-by-32 counter (*IC2*, *IC3*) to advance. This sequence repeats until the end of the 32nd iteration, when pin 13 of *IC2* goes true and shuts down the counter through *IC8C*. The total elapsed time for programming one 8-bit word is therefore about 413 ms. This period can be monitored by the optional status indicator (formed by *Q10*, *R18* , *R19* and *LED1*) shown in Fig. 1.

Switch Option. Address and data selection during programming are provided by the 16 spdt switches shown in Fig. 2. A logic 0 on the address lines is accomplished by switching the line to the collector of *Q11*. Using the V_{CC} as a reference, this will result in a level of −47 volts during the program pulse when the address true/complement (T/C) signal from *IC7* is high, thus selecting the true address. Placing the address switch in the 1 position ties that line to the complement of the signal present at the collector of *Q12* , resulting in a logic 1.

For data input, connecting an output line to ground through the data switch results in a −47-volt level during the program cycle. This programs a logic 1 on the selected address output. Connection to the V_{CC} line will leave the bit unchanged—a logic 0 during read.

Fig. 4. Illustration shows READ pin out for 1702A.



The small insert schematic in Fig. 2 is used to manually generate the programming command through pushbutton switch *S18* .

HOW AN EPROM WORKS

The 1702A belongs to a family of electrically programmable, ultraviolet-light-erasable, read-only memories. Each memory cell in the ROM has the appearance of a flip-flop with a new element—a "floating gate," that is isolated from the silicon substrate by a narrow band of silicon dioxide (glass). This element is not connected to anything electrically. The output signal from each flip-flop, a 1 or a 0, depends on the charge (or lack of it) on the gate.

The application of a train of electrical pulses to a cell "charges" the floating gate, and causes the associated flip-flop to produce a 1 at its output. This charge on the floating gate leaks off after many ten's of years. Since there is no electrical connection between the floating gate and the remainder of the ROM internal circuit, the charge is not affected by the removal of the chip's operating power.

The upper surface of the chip has a quartz window that is transparent to ultraviolet (UV) light. If strong UV light is allowed to pass through the window, it will displace the electrons from their shallow energy levels on the floating gate and cause them to migrate to the silicon substrate where their charge is neutralized. Typically, it takes several minutes of strong UV exposure to erase a device, and conventional room lighting will not do the job—though exposure to direct sunshine may. After the UV exposure, all the cells go to a 0 output.

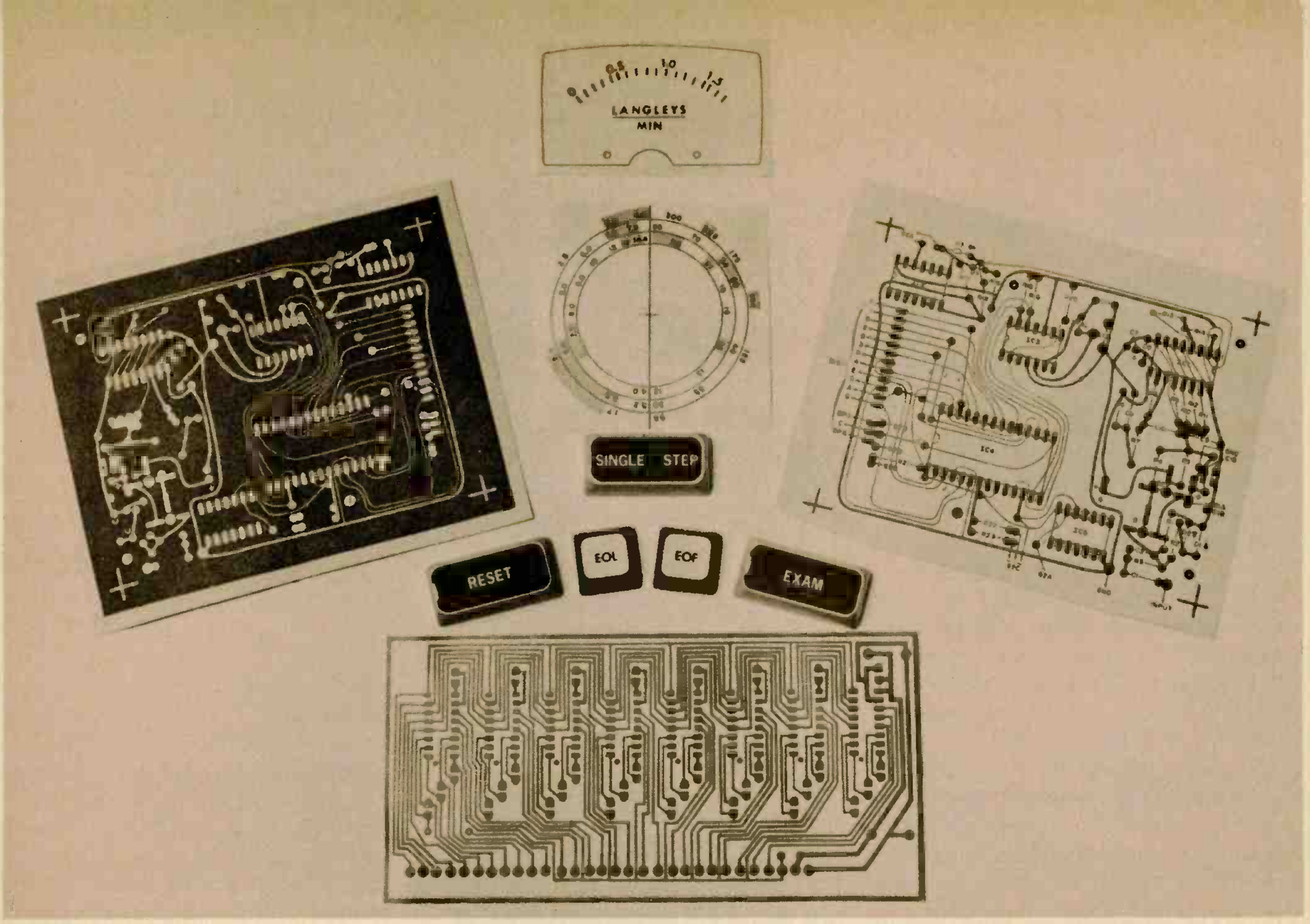
TTL Input Option. The circuit shown in Fig. 3 is similar to the switch option circuit shown in Fig. 2, except that the switches are replaced by 16 transistors and 8 exclusive-OR gates. Programming voltage levels are the same as those described in the switch option. The transistors provide logic inversion as well as high-voltage isolation so that conventional TTL logic levels can define address and data selection.

The gates in *IC9* and *IC10* are turned on by the T/C signal to invert the address at the proper time. Resistors *R48* through *R66* provide leakage-current paths and insure good dynamic response.

The address lines present one "LS"-load to the driving circuit and should be no problem to interface to a microcomputer. The data lines must be driven by circuits capable of sourcing at least 1 mA at 1.7 V. Standard TTL devices will handle this, as well as many of the LSI I/O chips designed for microprocessors. Switches, connecting the inputs to the +5-volt line or ground, may be used.

1702A Data. The read connections for the 1702A (and family) are shown in Fig. 4. The EPROM may be erased by exposure to high-intensity short-wave ultraviolet radiation of 2537 angstroms. The recommended integrated dosage is 6W-sec/cm_2. Depending on the ultraviolet light source, the erasure may take from 10 to 20 minutes. ◇

Note: Part 2 of this article, next month, will describe the power supply, pc board, and construction.



Now TRANSFER PRINTED PC PATTERNS WITH NO CAMERA OR CHEMICALS!

BY G.D. FISHER

EVERY experimenter and hobbyist dreams of being able to transfer an etching and drilling guide from the printed page to a pc blank without the mess and bother of chemicals or photography. Now you can do just that with a new direct-transfer film that has a number of other uses of interest to the experimenter who builds his own projects.

Called PCP-A Contact Film, this new plastic film has an adhesive on one side that permits it to be placed directly over printed artwork. Then, the only "chemicals" needed to complete the transfer are soap and water.

The PCP-A Contact Film is available in sheets of various sizes and in three packagings. The small package containing six 6" × 4" pieces of film is $5.49; the medium package with four 9" × 6" pieces is $6.95; and the large package of three 12" × 9" pieces is $7.95. It is made by Printed Circuits Products Co., 116 Harwood, Box 4034, Helena, MT 59601.

Guides made from the film are used as exposure masks for photosensitized printed-circuit blanks. They yield high-definition artwork with no stretching or distortion. Hence, they can be used in any type of pc-pattern layout.

Working With the Film. Using the direct-transfer film is extremely simple. First, you cut the PCP-A film to a size just slightly larger than the etching guide you are transferring. If the guide is relatively small (up to about 5" square), peel away the entire backing from the film and apply it directly to the paper on which the guide is printed, taking care to get it down right the first time because once it touches the paper, it cannot be lifted. For larger guides, peel the backing only part way and work slowly until the film is completely down on the guide.

Once the film is down, use a smooth, blunt instrument to burnish it in place and force out all air bubbles. (Do NOT lance the air bubbles, either in the paper guide or the plastic film.) This done, place the artwork in a dish of warm, soapy water for 15 to 20 minutes. Then start to rub off the paper with your finger, stroking back and forth with just enough pressure to assure good cleaning action. Do not use steel wool or abrasive powder cleaners.

Preparation of the Board. The copper must be free of oil and contaminants. This is best accomplished by scrubbing with scouring powder, then rinse the blank under running water and allow it to dry completely. Then dip the blank into lacquer thinner or board developer and stand it on edge to air dry.

When the board is dry, select a well-ventilated and dust-and-lint-free location in which to work, and lay it copper-side up on a couple of thicknesses of newspaper. Switch to safe lighting. (You can use a yellow bug lamp or indirect light from a 15-watt incandescent lamp no less than 8' away for safe-lighting conditions.) *Always use safe-lighting conditions during sensitizing and until a sensitized pc blank is developed.*

There are basically two types of aerosol photoresist sensitizers on the market. The one that permits you to use the film guide directly is called "positive" photoresist, such as GC Electronics' No. 22-230 (use only GC No. J4-630 developer). While you can use "negative" photoresist, you must first reverse the image on the film guide before you can expose the pc blank. (Note: Some magazines, including POPULAR ELECTRONICS, print etching-and-drilling guides in both the positive and negative formats. In the positive format, the copper trace pads and lines are black on white, while in the negative format the pads and lines are white-on-black. If you transfer the *negative* format on your film, use only negative resist and its appropriate developer; do NOT reverse the image. Transferring the positive format to film requires the use of positive photoresist or a reversal to use negative resist.)

Spray the resist onto the copper surface of the PC blank in continuous, even strokes from a distance of about 10" (25.4 cm) away. The sensitized blank can then be air-dried overnight while lying flat (switch off all lighting, including the safe light, during this period), or it can be force dried in a warm (about 150° F) oven for 20 to 30 minutes. Do not rush the forced drying by using higher heat; if you do, the resist will bake on and lose its photosensitive properties. Needless to say, when you transfer the wet blank to the oven, use safe lighting all the way.

Processing the Blank. The next step is to expose the sensitized blank either directly through your previously prepared film guide or through a separate reversed exposure mask (see above).

It is best to use a contact frame to keep the exposure mask in intimate contact with the PC blank during exposure. (Exposure frames are available from most pc supplies dealers.) Alternatively, you can sandwich the mask and blank together with two sheets of plate glass—*not plastic*—and hold them together with a clothes pin at each corner.

From this point on, until you are directed to do otherwise, use only safe-lighting conditions. Now, place your sensitized blank in the contact frame, copper side up. Place the exposure mask over the blank and close the contact frame.

To expose the blank, you can use any good source of strong ultraviolet radiation, such as direct sunlight, a photoflood lamp, fluorescent lamp, etc. It is a good idea to make up a few test pieces of sensitized blank to determine the proper exposure time for the UV source you decide to use. Times will vary from 2 to 15 minutes, depending on the intensity of the UV radiation from the source. In any event, do not place the source closer than 12" (30.5 cm) from the frame or you will run the risk of "under cutting" and lose the sharp quality of the pattern.

Once the blank is exposed, you can switch back to normal lighting. Open the contact frame, remove the exposure mask and set it aside, and immediately immerse the exposed blank in board developer solution, copper side up. (Note: do not use plastic trays for the developer because the solution will dissolve most plastics. Use only glass or metal trays.)

Agitate the developer gently over the blank with a slow tilting of the tray. After a short time, you will begin to see the circuit pattern taking form. Continue to agitate until the resist is completely removed from the areas to be etched and the copper shows through bright and shiny. Remove the blank from the developer and rinse it under slowly running water to stop the developing process. Do not touch the blank, except by its edges, at this time or attempt to dry it with a cloth or paper towel as the resist will be soft and easily damaged. You can let the blank air dry overnight or place it in a 150° F oven for 20 to 30 minutes to force-dry it and set the resist.

Pour the developer back into its container for later use. The developer can be used several times, until it becomes saturated. You will know the saturation point has been reached when the developer no longer removes the resist from an exposed pc blank.

To etch the board, you must use a plastic or glass tray. Never use a metal pan because the corrosive action of the etchant will eat it away. Place your pc blank in the tray and pour over it the etchant to a depth of ¼" to ½" (6.4 to 12.7 mm). Left alone, the etchant (ferric chloride or ammonium persulfate) will completely remove unwanted copper from a pc blank measuring up to 5" square in 10 to 30 minutes, depending on the quality of the etchant. You can speed up the etching process by rocking the tray to agitate the etchant, preheating the etchant (place the bottle in very hot water for 10 minutes or so, never in a pan and heating over a burner), and using a heat lamp over the tray.

Leave the pc blank in the etchant bath only long enough to remove all unwanted copper. If you leave it in the bath too long, the etchant will begin to undercut the copper traces. When etching is completed, use a pair of plastic tongs to remove the board from the tray and thoroughly rinse it under running water to stop the etching action.

Finishing the Board. The etched board can now be stripped with a lacquer-thinner-soaked cotton ball. Follow up with a vigorous scrubbing with scouring powder and steel wool and a thorough rinsing.

Trim the board to the required size and then drill all holes. Since most pc board drilling is with small-size drill bits (No. 58 through No. 64), it is best to use a Moto Tool or a battery-powered hand drill, such as the Radio Shack No. 64-2178 drill to obtain maximum control and minimize bit breakage. Of course, if you have a drill press, you can use it if it will accept very small size bits.

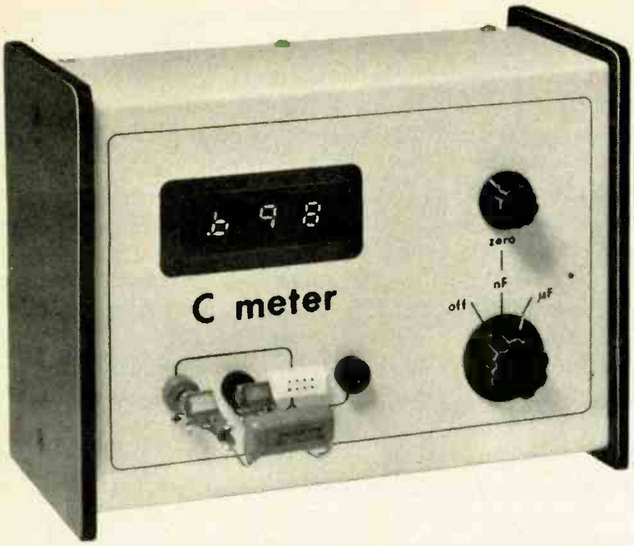
Last but not least, you can tin plate your finished board with plating solution, such as Dynachem No. EBS-250 (Dynachem Corp., 2632 Michelle Dr., Los Angeles, Cal). The tin plating seals the copper traces against the elements to resist corrosion and makes it easier to solder when wiring the board.

More Film Uses. The ability of the PCP-A film to retain its adhesive property after the transfer process can be put to good use. For example, you can copy the component-placement guides that generally accompany etching and drilling guides in published literature and stick them down right on the boards before mounting the components. (If the guides are a different size from the boards, as is frequently the case, you can stick them to an inside surface of the enclosure used for the projects.) Once you put down the guide, seal its edges to the board with clear lacquer, punch through all holes with an awl or other sharp instrument, and mount the components in their respective locations.

Another good use for the film is to transfer custom meter scales from the printed page to standard meter movements. Just place the film over the printed scale, burnish it down, and rubber cement it to the meter movement.

You can also transfer custom front-panel decals, make custom keytops, etc., as desired. The film is designed to pick up and transfer just about anything on a printed page, including colors. In all cases, once the film is down, seal its edges with clear lacquer. Also, if the decal is to be applied to a painted surface, it is best to place it down while the paint is still tacky.

Decals made with the transfer film are virtually scratch-proof. In addition, since the transfer images are on the adhesive side of the film, they cannot wear away when they are touched. ◇



BUILD AN

Autoranging Digital Capacitance Meter

BY DAVID H. DAGE

Autoranges from 1 pF to 1 μF and from 1 μF to 4000 μF. Updates readings automatically.

THE DIGITAL-READOUT capacitance meter described here is a most useful instrument when one has to determine values of unmarked capacitors or those with unknown codes, or when checking the tolerances of marked components. Its autorange function greatly simplifies what would ordinarily be a measurement chore without this feature. Moreover, the meter's accuracy of over 1% (dependent on the tolerances of a few passive components) from 1 pF to 4000 μF enhances its utility. The project is easy on the budget, too, as low-cost 7400 series logic and 555 timer IC's are used throughout.

To operate, simply turn on the unit, connect a capacitor to the test terminals, and read the digital value displayed for any capacitor up to 1 μF. Switching a mode switch from nF to μF extends the autorange function to 4000 μF and beyond, limited only by the leakage characteristics of the test capacitor.

How it Works. Traditionally, capacitance has been measured on an ac bridge by balancing known components against the reactance of an unknown capacitance at a given, fixed frequency. However, instruments are now appearing which employ a different method to determine capacitance—they measure time. Here's how.

Mathematically, the voltage across a capacitor discharging through a resistor in a simple RC network can be expressed by the equation:

$$V_C = V_O(1 - e^{-t/RC})$$

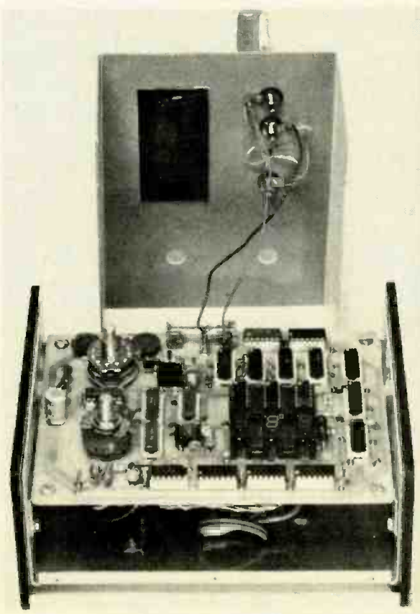
where V_O is the voltage across the capacitor when fully charged, R the resistance in ohms, C the capacitance in farads, t the time in seconds, and e the exponential constant or base for natural logarithms (approximately equal to 2.718). If we let a capacitor that has charged to a known voltage discharge through a fixed, stable resistance to some given voltage, the discharge time will be directly proportional to the component's capacitance, which then can be readily determined.

The meter described here employs this method of measurement, which readily lends itself to use with a digital readout and eliminates null adjustments. As shown in Fig. 1, the capacitance to be measured is charged through R_A and R_B. When the voltage across the capacitor equals V_{REF}, comparator A sets the flip-flop, turning on the transistor. The capacitor then discharges through R_A until the voltage across it drops to one-half V_{REF}. At this point, comparator B resets the flip-flop, which in turn cuts off the transistor. The capacitor then starts to charge up to V_{REF}, and the cycle is repeated.

A reference oscillator output at a fixed frequency is gated by the flip-flop output signal. The gated reference pulses are counted by a digital counter, decoded, and displayed directly as capacitance. The two comparators, flip-flop, transistor, reference voltage sources, and an output driver are all contained in one package—the common 555 timer IC.

The meter's autorange circuit functions during a single capacitor discharge cycle. If the three-decade counter overflows, the reference frequency input is automatically divided by ten. Simultaneously, the decimal point in the digital display is shifted one position to the right. If necessary, the process is repeated once

Interior photo of prototype.



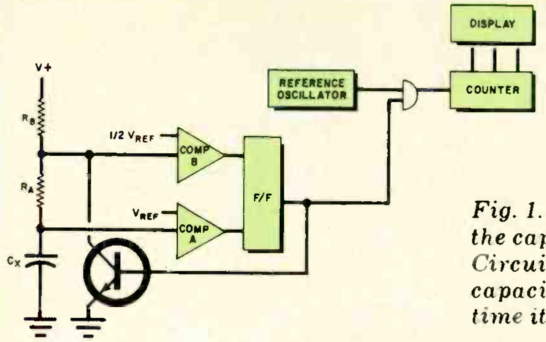


Fig. 1. Block diagram of the capacitance meter. Circuit determines unknown capacitance by measuring time it takes to discharge.

PARTS LIST

- C1—4000-µF, 16-V electrolytic capacitor
- C2,C4,C8 through C16, C23—0.01-µF disc ceramic capacitor
- C3—0.0033-µF, 10% Mylar capacitor
- C5—0.1µF disc ceramic capacitor
- C6,C17—4.7-µF, 16-volt tantalum capacitor
- C7—220-µF, 16-volt electrolytic capacitor
- C18—0.01-µF, 5% polystyrene capacitor
- C19—820-pF, 5% polystyrene capacitor
- C20—470-pF, 5% polystyrene capacitor
- C21—220-pF, 5% polystyrene capacitor
- C22—0.005-µF, 10% Mylar capacitor
- D1,D2—1N4002 silicon diode
- D3 through D5—1N4154 or HEP R0600 silicon fast-recovery diode
- DIS1 through DIS3—DL707 common-anode, seven-segment LED display
- F1, F2—¼-ampere fast-blow fuse
- IC1,IC2,IC3,IC17,IC18,IC19—7490 decade counter
- IC4,IC15—7404 hex inverter
- IC5—74125 Tri-State quad buffer
- IC6,IC20—555 timer
- IC7,IC8,IC22—7400 quad Two-input NAND-gate
- IC9,IC10,IC11—7447 BCD to seven-segment decoder/driver
- IC12,IC13—7474 dual D edge-triggered flip-flop
- IC14,IC21—74121 monostable multivibrator
- IC16—7493 4-bit binary counter
- IC23—LM309K 5-volt regulator
- L1—13-µH inductor
- LED1, LED2—20-mA light emitting diode
- R1—100,000-ohm pc mount trimmer potentiometer
- R2—1-megohm, 1% tolerance, 50 ppm/°C metal film resistor
- R3—100-ohm pc mount trimmer potentiometer
- R4—1000-ohm, 1% tolerance, 50 ppm/°C metal film resistor
- R10—25,000-ohm, panel mount linear taper potentiometer
- The following are ¼-watt, 5% tolerance carbon composition resistors.
- R5—1000 ohms
- R6, R7—100,000 ohms
- R8, R9—1500 ohms
- R11,R12,R13—100 ohms
- R14, R15—3300 ohms
- R16 through R20—470 ohms
- R2:1, R1:2, R3:3, R5:4, R4:6, R7:5, R6:7 (one set for each of three decades)—330 ohms
- S1—3-pole, 3-position rotary switch
- T1—16-volt center-tapped transformer
- Misc.—Suitable enclosure, banana jacks or binding posts for C_X terminals, printed circuit board, fuseholders, knobs, hook-up wire, IC sockets or Molex Soldercons, hardware, solder, etc.

Note—The following items are available from Dage Scientific Instruments, Box 1054, Livermore, CA 94550: CM-6 complete kit of parts, including tested IC's, cabinet, hardware, miscellaneous items, calibration capacitor, and assembly manual, $69.95 in U.S. and Canada. CM-68 partial kit includes etched and drilled double-sided pc board, 13-µH inductor, polystyrene capacitors (C18 through C21), calibration capacitor, and assembly manual for $20 in U.S. and Canada. U.S. residents add $1 postage and handling, Canadians add $2. California residents add sales tax.

or twice, resulting in four automatically selected ranges. Additional overflow pulses are displayed by two LED's located to the left of the display.

Circuit Details. Refer to the appropriate schematic (Figs. 2 through 6) for the following detailed circuit description. Free-running 555 timer *IC20* (Fig. 2) is the basic capacitance measuring circuit, comprising the comparators, reference voltages, flip-flop, and discharge transistor described previously. The timer's discharge period is used to measure the component under test. When MODE switch *S1* is in the nF position, the discharge period is determined by *R1, R2,* and C_X. In the µF position, the interval is determined by *R3, R4,* and C_X.

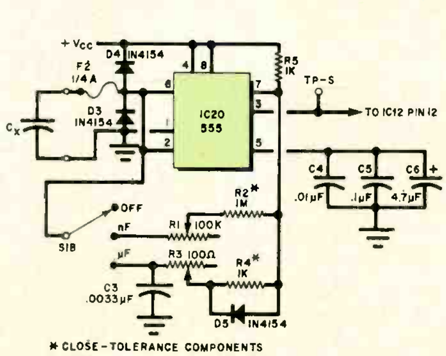


Fig. 2. Input stage has free-running 555 timer.

A second free-running 555 timer, *IC6* Fig. 3), is employed in an autocycling circuit which automatically updates the capacitance measurement. The reference frequency (about 1.4 MHz) is supplied by a Colpitts oscillator made up of IC4, L1, and *C18* through *C21*. Signals from the reference oscillator and timers *IC6* and *IC20* are combined by dual-D flip-flops *IC12* and *IC13*. One half of *IC12* synchronizes the output of *IC20* with the 1.4-MHz reference frequency, providing dual-phase (Q and $\bar{Q}$) outputs. The other half of *IC12* and *IC13* select one discharge pulse from *IC20* after the output of autocycle timer *IC6* goes high. The flip-flops disable *IC6* until the discharge pulse is completed.

The reference oscillator output is gated by *IC7* so that it passes to the counting stages during one discharge period of C_X per measuring interval. Monostable multivibrator *IC14*, when triggered by

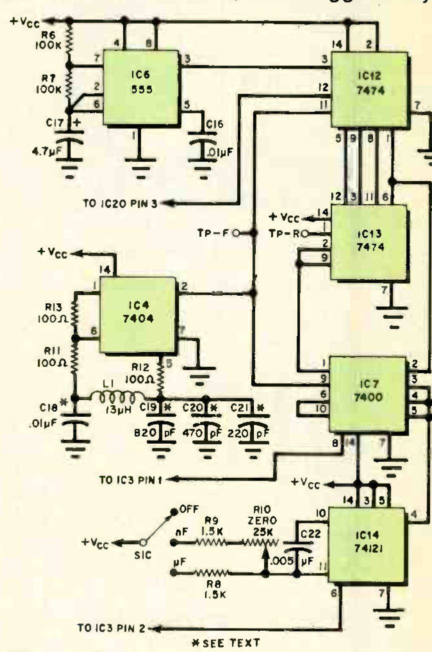


Fig. 3. Oscillator, sync., and reset circuits.

the leading edge of the synchronized discharge pulse, resets decade counters *IC16* through *IC19* and dividers *IC1* through *IC3*. When *S1* is in the nF position, the width of the reset pulse generated by *IC14* is controlled by the setting of ZERO trimmer potentiometer *R10*. This allows the user to keep stray capacitance out of the measurement.

The gated reference signal is divided by decade counters *IC1, IC2* and *IC3*. Output signals from these counters, at 1/1000th, 1/100th, and one-tenth the input frequency, are applied to Tri-State logic switch *IC5* (Fig. 5), which passes the appropriate pulse train to decade counter *IC19*. Overflow pulses from this BCD decade counter are applied to counter *IC18*, whose overflow pulses in turn are counted by *IC17*. Binary coded decimal outputs from these three decade counters are decoded by *IC9, IC10*

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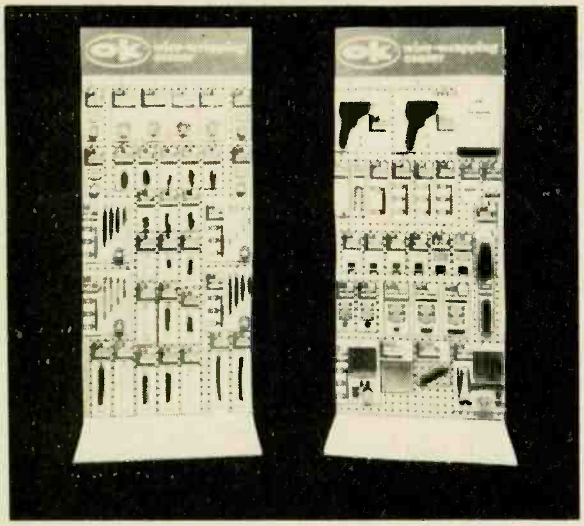

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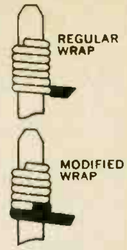

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Wire-wrapping, stripping, unwrapping tool for AWG 30 on.025 (0,63mm) Square Post.

Regular Wrap	WSU-30	$6.95
Modified Wrap	WSU-30M	$7.95

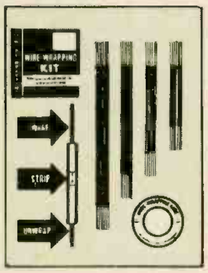
WIRE-WRAPPING TOOL

For .025" (0,63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

For AWG 30	BW-630	$34.95*
For AWG 26-28	BW-2628	$39.95*

Bit for AWG 30	BT-30	$3.95
Bit for AWG 26-28	BT-2628	$7.95

*USE "C" SIZE NI-CAD BATTERIES (NOT INCLUDED)



WIRE-WRAPPING KITS

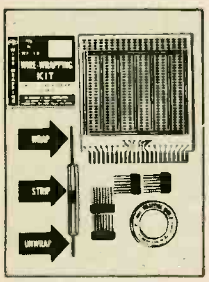
Contains: Hobby Wrap Tool WSU-30, (50 ft.) Roll of wire Prestripped wire 1" to 4" lengths (50 wires per package) stripped 1" both ends.

Wire Wrapping Kit (Blue)	WK-2-B	$12.95
Wire Wrapping Kit (Yellow)	WK-2-Y	$12.95
Wire Wrapping Kit (White)	WK-2-W	$12.95
Wire Wrapping Kit (Red)	WK-2-R	$12.95

ROLLS OF WIRE

Wire for wire-wrapping AWG-30 (0.25mm) KYNAR® wire, 50 ft. roll, silver plated. solid conductor, easy stripping.

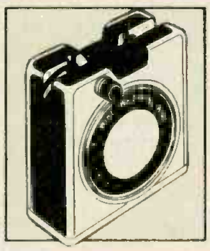
30 AWG Blue Wire 50ft Roll	R-30B-0050	$1.98
30-AWG Yellow Wire 50ft Roll	R-30Y-0050	$1.98
30-AWG White Wire 50ft Roll	R-30W-0050	$1.98
30-AWG Red Wire 50ft Roll	R-30R-0050	$1.98



WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30, Roll of wire R-30B-0050, (2) 14 DIP's, (2) 16 DIP's and Hobby Board H-PCB-1.

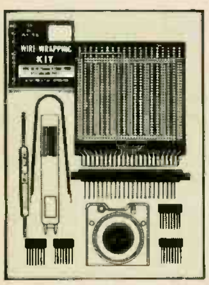
Wire-Wrapping Kit	WK-3B (Blue)	$16.95



WIRE DISPENSER

- With 50 ft. Roll of AWG 30 KYNAR® wire-wrapping wire.
- Cuts the wire to length.
- Strips 1" of insulation.
- Refillable (For refills, see above)

Blue Wire	WD-30-B	$3.95
Yellow Wire	WD-30-Y	$3.95
White Wire	WD-30-W	$3.95
Red Wire	WD-30 R	$3.95



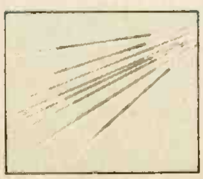
WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1

Wire-Wrapping Kit	WK-4B (Blue)	$25.99

PRE CUT PRE STRIPPED WIRE

Wire for wire-wrapping, AWG-30 (0.25mm) KYNAR® wire, 50 wires per package stripped 1" both ends.



30-AWG blue Wire, 1" Long	30 B 50 010	$.99
30-AWG Yellow Wire, 1" Long	30-Y 50-010	$.99
30-AWG White Wire, 1" Long	30-W-50 010	$.99
30 AWG Red Wire, 1" Long	30-R-50-010	$.99
30-AWG Blue Wire 2" Long	30-B-50-020	$1.07
30 AWG Yellow Wire, 2" Long	30-Y-50-020	$1.07
30 AWG White Wire, 2" Long	30 W-50-020	$1.07
30 AWG Red Wire, 2" Long	30 R-50-020	$1.07
30 AWG Blue Wire, 3" Long	30-B-50 030	$1.16
30-AWG Yellow Wire 3" Long	30 Y 50 030	$1.16
30-AWG White Wire, 3" Long	30 W-50-030	$1.16
30 AWG Red Wire, 3" Long	30-R-50-030	$1.16
30 AWG Blue Wire 4" Long	30 B 50-040	$1.23
30-AWG Yellow Wire 4" Long	30 Y 50-040	$1.23
30-AWG White Wire 4" Long	30-W-50 040	$1.23
30-AWG Red Wire, 4" Long	30-R 50-040	$1.23
30 AWG Blue Wire, 5" Long	30 B-50-050	$1.30
30 AWG Yellow Wire, 5" Long	30-Y-50-050	$1.30
30 AWG White Wire, 5" Long	30 W 50 050	$1.30
30 AWG Red Wire, 5" Long	30 R 50 050	$1.30
30 AWG Blue Wire, 6" Long	30 B 50-060	$1.38
30-AWG Yellow Wire, 6" Long	30 Y 50 060	$1.38
30-AWG White Wire, 6" Long	30 W 50 060	$1.38
30 AWG Red Wire, 6" Long	30-R-50 060	$1.38

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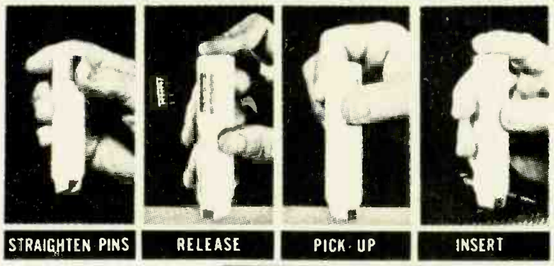
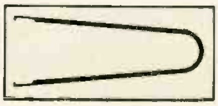
ok

DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER



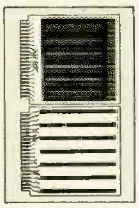
14-16 Pin Dip IC Inserter	INS-1416	$3.49

DIP/IC EXTRACTOR TOOL



Extractor Tool	EX-1	$1.49

P.C. BOARD



The 4 x 4.5 x 1/16 inch board is made of glass coated EPOXY Laminate and features solder coated 1 oz. copper pads. The board has provision for a 22/44 two sided edge connector, with contacts on standard .156 spacing. Edge contacts are non dedicated for maximum flexibility.

The board contains a matrix of .040 in. diameter holes on .100 inch centers. The component side contains 76 two-hole pads that can accommodate any DIP size from 6-40 pins, as well as discrete components. Typical density is 18 of 14-Pin or 16-Pin DIP's. Components may be soldered directly to the board or intermediate sockets may be used for soldering or wire-wrapping.

Two independent bus systems are provided for voltage and ground on both sides of the board. In addition, the component side contains 14 individual busses running the full length of the board for complete wiring flexibility. These busses enable access from edge contacts to distant components. These busses can also serve to augment the voltage or ground busses, and may be cut to length for particular applications.

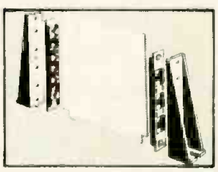
Hobby Board	H-PCB-1	$4.99

PC CARD GUIDES

Card Guides	TR-1	$1.89

QUANTITY – ONE PAIR (2 pcs.)

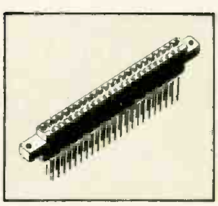
PC CARD GUIDES & BRACKETS



Guides & Brackets	TRS-2	$3.79

QUANTITY – ONE SET (4 pcs.)

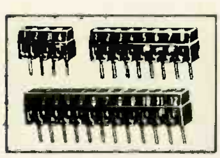
PC EDGE CONNECTOR



44 Pin, dual read out, .156" (3,96 mm) Contact Spacing, .025" (0,63 mm) square wire-wrapping pins.

P.C.. Edge Connector	CON-1	$3.49

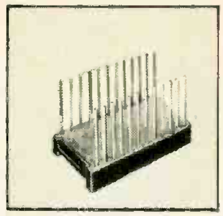
P.C.B. TERMINAL STRIPS



The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1, 8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 incn (5mm) centers.

4-Pole	TS- 4	$1.39
8-Pole	TS- 8	$1.89
12-Pole	TS-12	$2.59

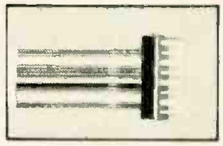
DIP SOCKET



Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins .025 (0,63mm) sq., .100 (2,54mm) center spacing.

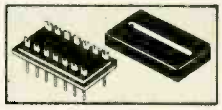
14 Pin Dip Socket	14 Dip	$0.79
16 Pin Dip Socket	16 Dip	$0.89

RIBBON CABLE ASSEMBLY SINGLE ENDED



With 14 Pin Dip Plug 24" Long (609mm)	SE14-24	$3.55
With 16 Pin Dip Plug 24" Long (609mm)	SE16-24	$3.75

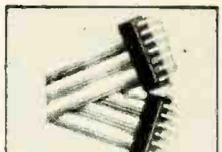
DIP PLUG WITH COVER FOR USE WITH RIBBON CABLE



14 Pin Plug & Cover	14-PLG	$1.45
16 Pin Plug & Cover	16-PLG	$1.59

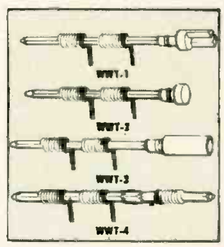
QUANTITY: 2 PLUGS, 2 COVERS

RIBBON CABLE ASSEMBLY DOUBLE ENDED



With 14 Pin Dip Plug - 2" Long	DE 14-2	$3.75
With 14 Pin Dip Plug - 4" Long	DE 14-4	$3.85
With 14 Pin Dip Plug - 8" Long	DE 14-8	$3.95
With 16 Pin Dip Plug - 2" Long	DE 16-2	$4.15
With 16 Pin Dip Plug - 4" Long	DE 16-4	$4.25
With 16 Pin Dip Plug - 8" Long	DE 16-8	$4.35

TERMINALS

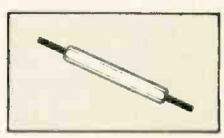


- .025 (0,63mm) Square Post
- 3 Level Wire-Wrapping
- Gold Plated

Slotted Terminal	WWT-1	$2.98
Single Sided Terminal	WWT-2	$2.98
IC Socket Terminal	WWT-3	$3.98
Double Sided Terminal	WWT-4	$1.98

25 PER PACKAGE

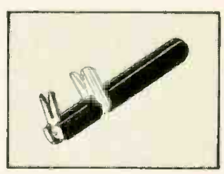
TERMINAL INSERTING TOOL



For inserting WWT-1, WWT-2, WWT-3, and WWT-4 Terminals into .040 (1,01mm) Dia. Holes.

INS-1	$2.49

WIRE CUT AND STRIP TOOL



Easy to operate . . . place wires (up to 4) in stripping slot with ends extending beyond cutter blades . . . press tool and pull . . . wire is cut and stripped to proper "wire wrapping" length. The hardened steel cutting blades and sturdy construction of the tool insure long life.

Strip length easily adjustable for your applications.

DESCRIPTION	MODEL NUMBER	ADJUSTABLE "SHINER" LENGTH OF STRIPPED WIRE INCHES	TO	INCHES	Price
24 ga. Wire Cut and Strip Tool	ST-100-24	1 3/16"	—	1 5/16"	$ 8.75
26 ga. Wire Cut and Strip Tool	ST-100-26	1 3/16"	—	1 11/16"	$ 8.75
26 ga. Wire Cut and Strip Tool	ST-100-26-875	7/8"	—	1 1/8"	$ 8.75
28 ga. Wire Cut and Strip Tool	ST-100-28	7/8"	—	1 1/8"	$11.50
30 ga. Wire Cut and Strip Tool	ST-100-30	7/8"	—	1 1/8"	$11.50

THE ABOVE LIST OF CUT AND STRIP TOOLS ARE NOT APPLICABLE FOR MYLENE OR TEFLON INSULATION

MINIMUM ORDER $25.00. SHIPPING CHARGE $1.00. N.Y. CITY AND STATE RESIDENTS ADD TAX

OK MACHINE & TOOL CORPORATION

3455 Conner St., Bronx, N.Y. 10475 ■ (212) 994-6600 ■ Telex 125091

CIRCLE NO. 33 ON FREE INFORMATION CARD

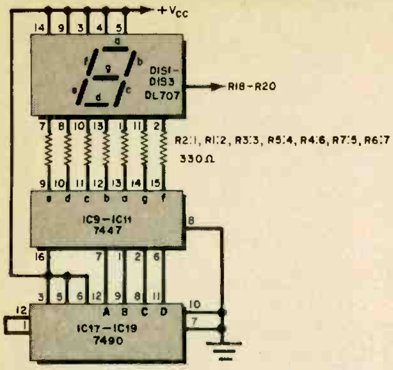


Fig. 4. Display and drivers.

and *IC11* (Fig. 4), which also drive seven-segment displays *DIS1*, *DIS2*, and *DIS3*. Current limiting for each display is performed by resistors *R2:1*, *R1:2*, *R3:3*, *R5:4*, *R4:6*, *R7:5*, and *R6:7*. (This method of identifying the resistors is discussed in the Construction section of the article.)

Now we'll examine the capacitance meter's autorange circuitry (Fig. 5). Overflow pulses from the last BCD decade counter (*IC17*) are applied to 4-bit binary counter *IC16*. This IC has four weighted binary outputs, A, B, C, and D, which are inverted by *IC15*. Lines A, Ā, B, and B̄ are decoded by the NAND gates in *IC8* to provide control signals for the Tri-State logic switches in *IC5* and selection of the proper display decimal point. Outputs C and C̄ either sink or block current from overrange indicators *LED1* and *LED2*.

Assume that counters *IC17* through *IC19* have counted 999 pulses and the display reads ".999." Upon receipt of the next pulse, the decimal point is shifted one position to the right and the display reads "0.00." Tri-State switch *IC5* then passes the ÷10 reference output of *IC3* to decade counters *IC17* through *IC19*. One-shot *IC21* and *IC22* then produce a pulse which advances the most significant counter and (leftmost) display by one so that the displays now read "1.00." If necessary, this process is repeated once or twice, resulting in an autorange function of 1000:1. After the third counting sequence, the overflow pulses cycle the two overrange LED's to indicate a count of 1000 pulses.

The 7400 series IC's require +5 volts, which is provided by the projects's power supply (Fig. 6). Transformer *T1* reduces the line voltage to a convenient value. The low-voltage ac is rectified by *D1* and *D2* into pulsating dc and smoothed by *C1*. A regulated dc output at +5 volts is provided by *IC23*. Although the regulator IC can provide a 1-ampere output, the capacitance meter circuitry requires only about 700 mA.

Construction. For the most part, the circuit is not critical and any assembly technique can be used to reproduce it. However, the measuring circuit comprising *IC20* and its associated components is critical, and should be properly shielded and decoupled from the other stages. Etching and drilling and parts placement guides for a suitable printed circuit board are shown in Figs. 7 and 8.

The pc board holds all components of the capacitance meter, less those in the power supply. It is a double-sided board on which many connections must be made between the top and bottom foil patterns. If you cannot make plated through holes, you must use wire feedthroughs to make the necessary connections. Component leads must be soldered on both sides of the board when pads are available.

Sockets or Molex Soldercons should be used to hold the integrated circuit and display packages. However, it is impossible to solder leads to pads on the component side of the board when they are under an IC socket. Because of this, all feed-through pads are accessible to the sides of the sockets. Molex Soldercons present no problem, as they can be soldered on both sides of the board. The 42 feedthrough points are identified by circles on the component placement guide (Fig. 8).

Sockets or Molex Solercons are mandatory for the LED displays and decoder/drivers. By cutting a socket lengthwise or using Molex Soldercons on the outside pin rows, as shown in Fig. 9A, a trough is provided under the displays and decoder/drivers into which the current-limiting resistors are placed. Numbering the holes from the center both up and down will allow quick resistor placement. For example, the leads of *R2:1* occupy the second hole up and the first hole down. (See Fig. 9B.) Use small, ¼-watt resistors and, where necessary, insulate leads with sleeving.

The critical components on the board are *L1*, *C18* through *C21*, which determine the frequency of the reference oscillator, and *R1* through *R4* which with *IC20* form the basic capacitance measuring circuit.

High-quality polystyrene capacitors and metal-film fixed resistors with temperature coefficients of less than 50 ppm/°C should be used. These components, together with *IC20*, will determine the long-term accuracy of the meter and measurement error as a function of temperature. If high-quality components are used and the meter is properly calibrated, its accuracy will be at least 1% at room temperature.

Checkout and Calibration. A properly functioning unit will respond as follows, and should then be calibrated. Rotate *R1*, *R3*, and *R10* fully counterclock-

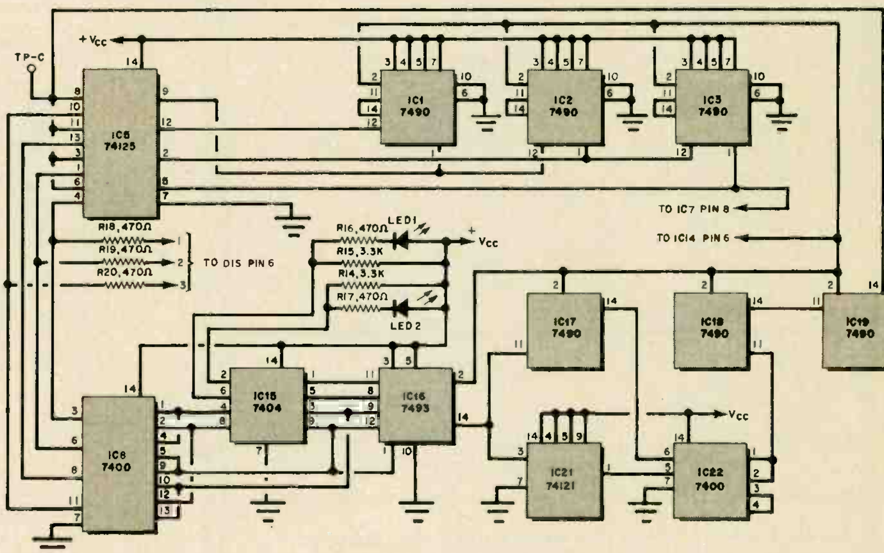


Fig. 5. Schematic of meter's autorange circuit.

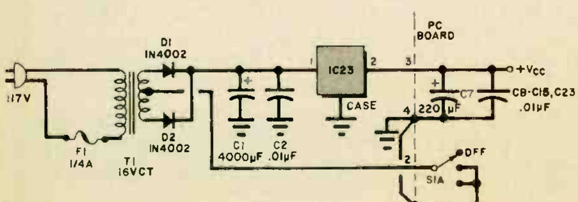


Fig. 6. Power supply circuit has a voltage regulator IC.

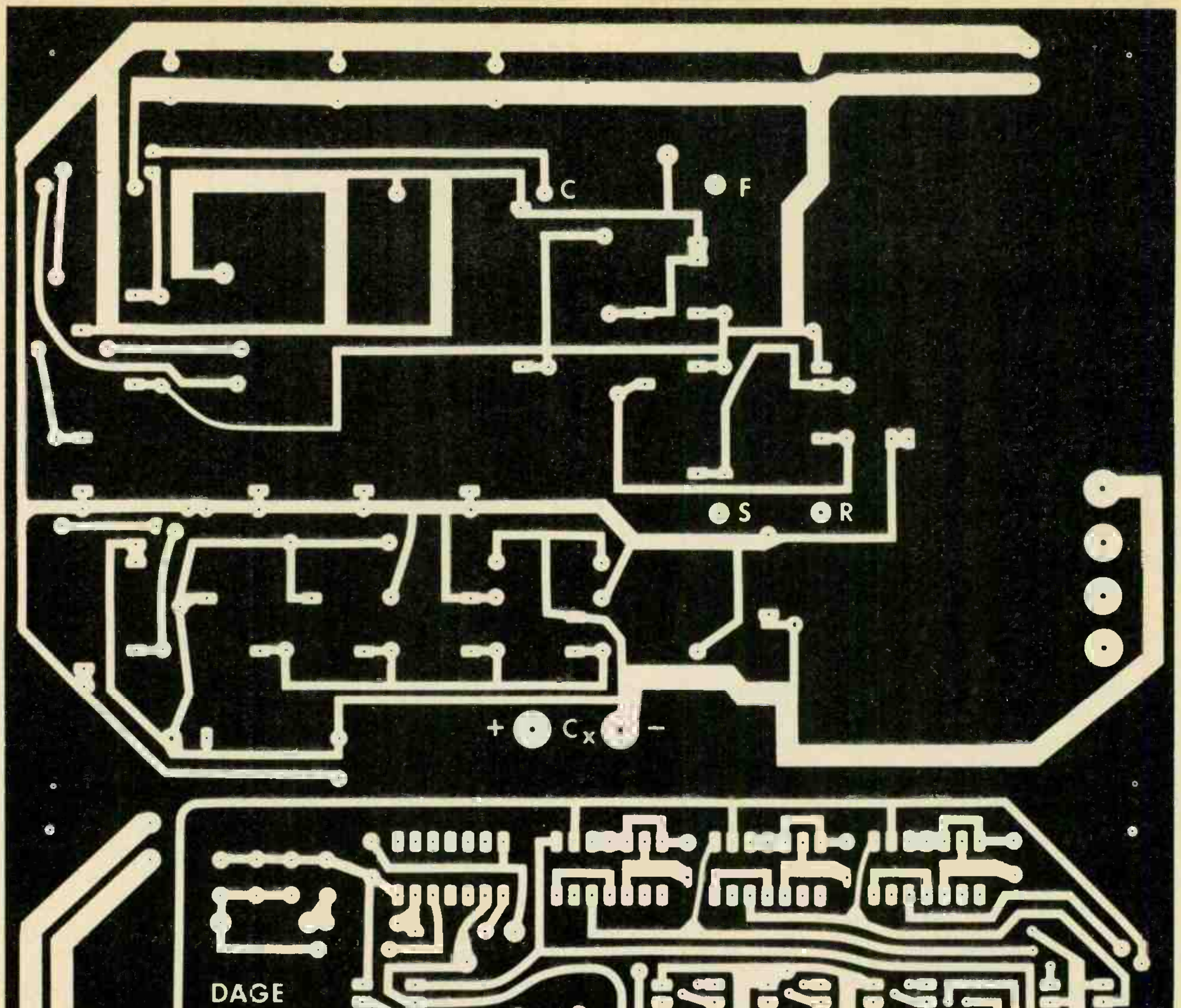


Fig. 7. Actual-size etching and drilling guides for the double-sided pc board.

wise, set *S1* to the nF position and apply power to the project. The display will light and within 2 seconds will reset to ".000." Rotate ZERO potentiometer *R10* fully clockwise. The display will indicate a few picofarads (.003 to .030 nF). Slowly rotate the ZERO potentiometer counterclockwise until the display reads ".001." Rotate the control slightly counterclockwise until it reads ".000."

Connect a reference capacitor with a known value of 0.68-µF to the C_X terminals of the meter. The display will count up for about one-half second and stop at some value which is not critical at this time. Place *S1* in the μF position. The display will read a similar value, but will not appear to flicker. Finally, place a 5000-to-8000-μF capacitor across the C_X terminals. Within a few seconds, the display will advance and the overrange LED's will cycle top on only, bottom on only, both on, both off, and repeat the sequence. The meter is now ready for calibration.

The most direct method of calibration is to measure a reference capacitor whose value is about 0.7 μF. A precision capacitor will be very expensive, so if you have access to a precision (0.1% or better) capacitance bridge, measure the value of a good-quality Mylar capacitor on it. If the capacitor is used at approximately the same temperature as the bridge environment, it will be a suitable reference component.

The 0.7-μF capacitor will be used as a reference for both the nF and μF switch positions. Setting one point for each position is all that is required, as absolute linearity is provided by the project circuitry. The reference oscillator's mean output frequency is designed to be slightly high when only *C18* and *C19* are included in the circuit. If trimmer potentiometers *R1* and *R3* cannot be adjusted to bring the display reading into agreement with the value of the reference component, install *C20* and/or *C21*. Calibration is now a matter of merely connecting the reference capacitor to the C_X terminals, placing *S1* in the μF position, and adjusting *R3* until the display matches the value of the reference component. Then, *S1* should be placed in the nF position and *R1* adjusted for the same displayed capacitance.

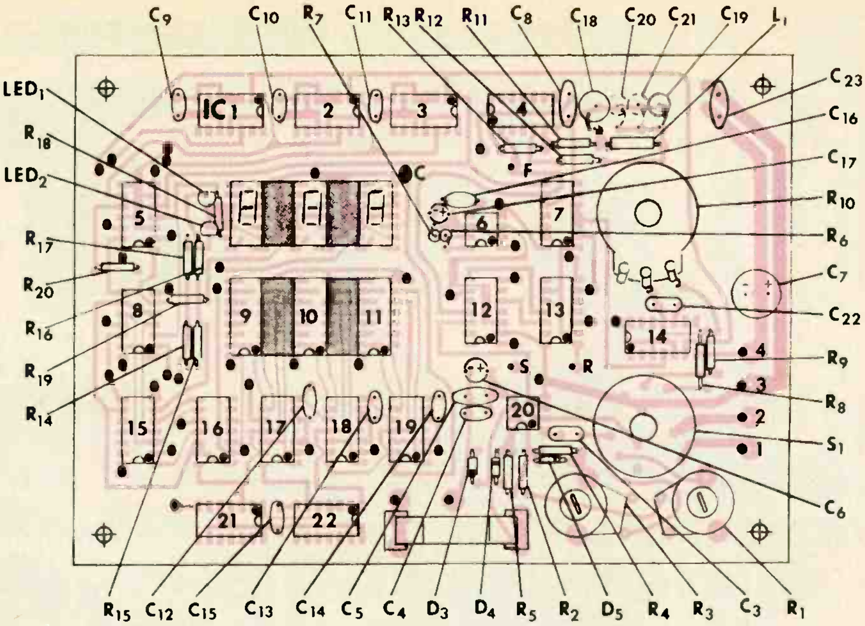
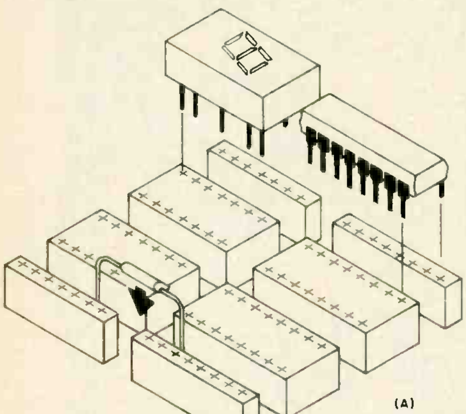


Fig. 8. Component placement guide. Numbered circles are feedthroughs.

Using the Meter. Apply power to the project by placing *S1* in the nF position. Zero the display by slowly rotating the shaft of *R10* counterclockwise until the display reads, ".001," advancing the control slightly more until a ".000" reading is obtained. Once zeroed, no further adjustments are necessary. The μF position does not require zeroing.



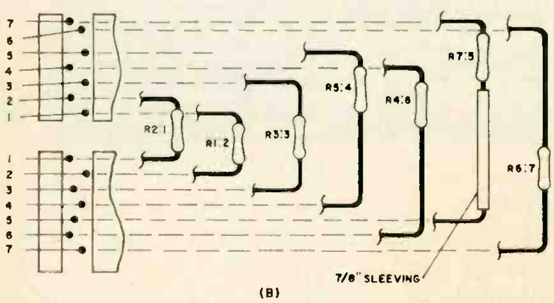


Fig. 9. A trough is provided for the current-limiting resistors as shown in (A). Diagram at (B) shows how numbering the holes allows quick resistor placement.

Connect the capacitor to be measured across the C_X terminals. Polarized capacitors must be oriented positive to positive, negative to negative. Do *not* connect charged capacitors to the project. Although the input circuitry is protected with clamping diodes and a fuse, charged capacitors might damage the project.

Capacitance is displayed in either nF or μF, depending on the setting of *S1*. Values greater than 1000 nF should be read in the μF position. Capacitance greater than 1000 μF is determined by observing the overrange LED's to the left of the display. Because these two LED's cycle every ⅔ second, they are easily observed. If the top LED glows, 1000 μF is indicated; if the bottom LED glows, 2000 μF; if both, 3000 μF.

This sequence will then repeat, with two dark LED's representing 4000 μF; the top LED glowing, 5000 μF; the bottom LED, 6000 μF; both on, 7000 μF; both dark, 8000 μF; and so on until the cycling stops. Values up to several thousand microfarads can be measured. The upper limit is determined mainly by capacitor leakage, and to a lesser extent by your patience! Capacitors, with high leakage will never charge to V_{REF}, and thus will not trigger the discharge cycle.

When using the capacitance meter with *S1* in the nF position, treat the reading as if it were in picofarads if the decimal point is to the left. That is, ".084" should be read as 84 pF, and ".003" as 3 pF. With a little experience, you will quickly become familiar with the autorange function and the behavior of the overrange LED's. ◇

BY PAUL E. MILLER

BUILD A STEREO BLEND CONTROL

Vary channel separation to suit your taste with this inexpensive circuit.

AUDIO designers usually try to maximize their products' stereo separation. There are times, however, when a measure of crosstalk between channels is desirable. For example, the disquieting "orchestra in the cranium" effect experienced with stereo headphones can be mitigated by reducing the program material's channel separation. The stereo blender described here allows the user to vary channel separation to suit his taste. Also, the two channels can be transposed with adjustable separation—left input to right output, and vice versa. The blender employs inexpensive components, and can be bypassed at the touch of a switch.

About the Circuit. The schematic diagram of the stereo blender is shown in Fig. 1. The heart of the circuit is contained in two variable voltage dividers, comprising *R1* through *R4* and *R9* for the left channel, and *R5* through *R8* and *R10* for the right channel. Input signals are applied to the voltage dividers via coupling capacitors *C1* and *C2* and voltage followers *IC1A* and *IC1B*.

A dual 10,000-ohm, linear-taper potentiometer is used for *R9* and *R10*. When the potentiometer wipers are at one extremity of their travel, the stereo separation and spatial location of the input signals are preserved. At the other end, there is still no introduction of crosstalk but the channels are transposed. Adjusting the wipers for the center of their travel gives a complete "blend," with both inputs mixed equally and fed to both outputs. Between the center and either extreme, partial blending of the two channels is obtained.

The voltage dividers have an insertion loss of approximately 4.7 dB. This loss is compensated for by the gain introduced by *IC2A* and *IC2B*. To ensure that the voltage divider losses and op amp gains cancel each other, resistance tolerances should be kept fairly close. If this is done, no audible change in volume will occur when the project is switched on or out of the signal path.

Another reason for using close-tolerance resistors lies in an important characteristic of the voltage dividers. That is, the overall output should remain constant regardless of the setting of the dual potentiometer BLEND control. Actually, the signal level at the output will be 3 dB below the input when the BLEND control is at its mid-position. But this loss is compensated for by the fact that the inputs are mixed equally and fed to each output. To maintain this relationship, actual resistances should be close to the components' nominal values.

Signals from the op amps are coupled to the output jacks via capacitors *C3* and *C4*, which also block any dc offsets generated by the gain stages. Fairly large values are required if output impedances are to be kept fairly low. At 20 Hz, a 1-µF capacitor has a reactance of approximately 8000 ohms. Therefore, the circuit should drive a load with a fairly high input impedance—a condition satisfied by most power amplifiers and tape deck record preamplifiers.

The output coupling capacitors must

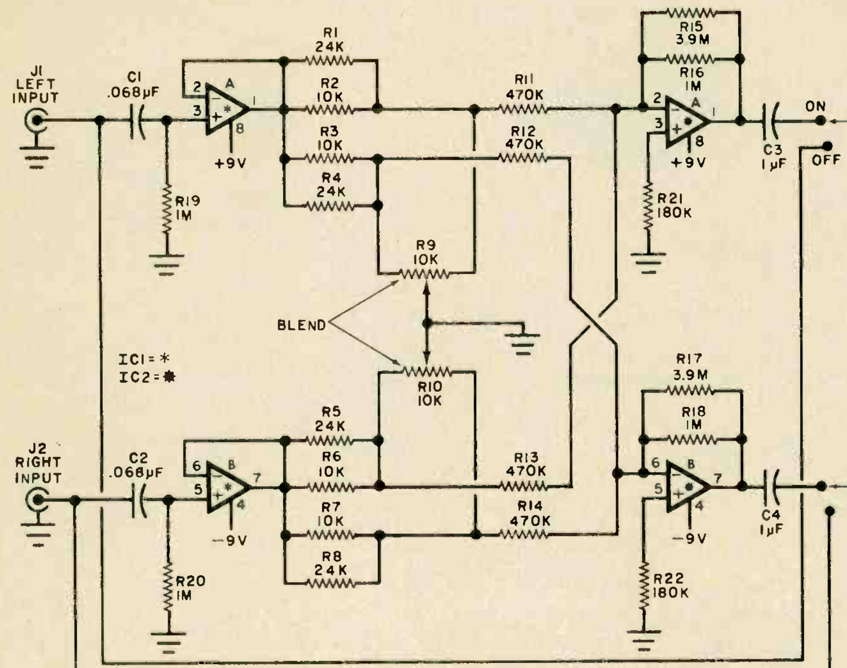


Fig. 1. Schematic diagram of the stereo blend.

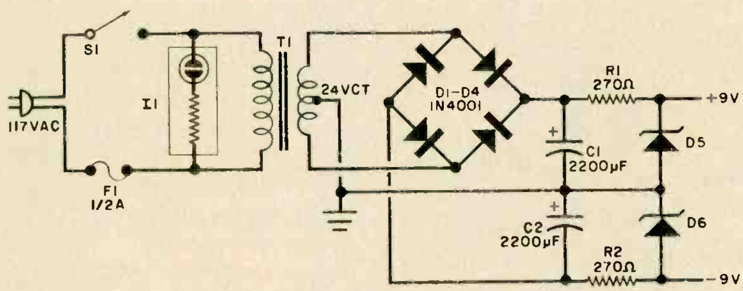


Fig. 2. Ac power supply features zener diode regulation.

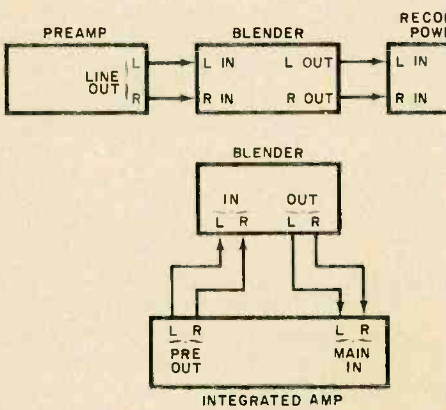


Fig. 3. Connecting the project to your system.

PARTS LIST

B1,B2—9-volt transistor batteries (battery powered version only)
C1,C2—0.068-µF Mylar capacitor
C3,C4—1-µF monolithic or nonpolarized electrolytic
IC1,IC2—MC1458 or 5558 dual op amp
J1 through J4—RCA phono jack
The following are 1/4-watt, 5% (or better) fixed resistors.
R1,R4,R5,R8—24,000 ohms
R2,R3,R6,R7—10,000 ohms
R11 through R14—470,000 ohms
R15,R17—3.9 megohms
R16,R18,R19,R20—1 megohm
R21,R22—180,000 ohms
R9,R10—dual 10,000-ohm, linear-taper potentiometer
S1—4pdt (battery powered version) or dpdt (line powered version) toggle or slide switch
Misc.—IC sockets or Molex Soldercons, printed circuit or perforated board, shielded or coaxial cable, hookup wire, suitable enclosure, battery clips, battery holders, machine hardware, solder, etc.

AC SUPPLY PARTS LIST

C1,C2—2200-µF, 25-volt electrolytic capacitor
D1 through D4—1N4001 rectifier
D5, D6—9.1-volt, 1-watt zener diode
F1—1/2-ampere fuse
I1—Neon indicator assembly with integral current-limiting resistor
R1, R2—270-ohm, 1/2-watt, 10% tolerance carbon composition resistor
S1—spst switch
T1—24-volt center tapped, 85-mA transformer (Stancor No. P8394 or equivalent)
Misc.—Line cord, fuse holder, terminal strips, strain relief, hookup wire, machine hardware, solder, etc.

be nonpolarized because the ac signals are not riding on a large dc level. The author suggests the use of monolythic capacitors because of their high capacitance-to-volume ratio. Other types can be used if space permits. Nonpolarized electrolytics, which are commonly used in speaker crossovers, are readily available in unit quantities.

Much smaller coupling capacitors are used at the project inputs. Although they have fairly high capacitive reactance at audio frequencies, the resistance of *R19* and *R20* and the very high input impedances of the voltage followers prevent significant signal attenuation.

Two 9-volt transistor batteries power the circuit of Fig. 1. Total current drain is fairly low, so fairly long battery life can be expected if the project is used intermittently. However, you might prefer to power the project from the ac line. A suitable regulated bipolar supply is shown schematically in Fig. 2.

In the battery-powered version, *S1* is a 4pdt switch. The circuit is inserted into the signal path and the batteries connected to the op amps when the switch is placed in its ON position. The batteries are disconnected and signals at the input jacks routed directly to the output jacks, effectively removing the project from the signal path, when the switch is placed in the OFF position. In the line-powered version, *S1* becomes dpdt switch and is used only to insert or remove the circuit from the signal path. To keep the line-power ac away from the low-level signal lines, a separate spst switch is used to control the primary of the power supply.

Construction. The circuit can be assembled on either a printed circuit or perforated board. Shielded wire or small diameter (RG-174-U) coax should be used for all signal leads. If the line-powered supply is to be housed in the same enclosure as the signal processing circuitry, the two should be physically isolated as much as possible. A metal utility box should be used to house the project.

Use. The blender should be connected to your audio system as shown in Fig. 3 by means of shielded patch cords terminated with suitable connectors. As mentioned earlier, it can be used to make listening through stereo headphones more enjoyable. The project also allows home recordists to introduce interesting special effects when taping program material. Imaginative users will no doubt find other applications. ◇

THE NEW MICRO/ MINI CASSETTE TAPE FORMATS

BY IVAN BERGER

TAPE buyers used to have three tape formats to choose from. Now they have eight! In addition to open-reel, cassette, and 8-track, new formats have been added: the large Elcaset and four sub-compact cassette systems, the latter designed primarily for portable dictation and note-taking.

Compact Cassette System. The standard compact cassette system uses thin tape about 1/7 inch wide, running at 1⅞ inches per second from one hub within the cassette to the other. Monophonic cassettes have two tracks, one in each direction. To play the second side, the cassette must be removed, flipped over, and reinserted, unless the machine can play in two directions. Stereophonic cassettes have four tracks, each stereo pair side by side so that both will be reproduced when played on a monophonic machine, and so that a stereo deck can play monophonic tapes through both of its channels. Four-channel cassettes have been demonstrated, but have not really reached the market. Tapes are available in several lengths: C-30 (15 minutes per side, 30 minutes total), C-60, C-90, and C-120 are the most common.

Cartridge System. The 8-track cartridge system uses tape ¼ inch wide, running at 3¾ inches per second in an endless loop that feeds back into the hub of the cartridge's single, built-in reel. The tape's eight tracks all run in the same direction. The tape heads shift position as each set of tracks is played, sequencing automatically to the next set. Stereo 8-track cartridges have four pairs of tracks, playing tracks 1 and 5 together, then tracks 2 and 6, and so on. Quadraphonic 8-track cartridges have two sets of four tracks. Stereo recordings can also be played on quadraphonic tape machines.

Recorders for 8-track tapes are far less common, as the frequent breaks required for track-switching make it difficult to fit music in without unwanted interruptions, and the absence of rewind or truly fast fast-forward (it's only about double normal playing speed) make rechecking what's been taped most inconvenient. Blank tapes are available, in 30-to-100-minute lengths, though the blanks are not as widely available as cassettes are. Prerecorded tapes, on the other hand, are probably easiest to find in this tape format, though classical selections are rare.

Open-Reel System. Open-reel recorders normally use ¼-inch tape, too, which must be manually threaded from one reel, over the tape deck's heads and capstan, and onto another reel. Most home machines record in stereo on four tracks, interleaved so that tracks 1 and 3 make a stereo pair going in one direction, while tracks 2 and 4 carry another stereo program going the opposite way. Some machines reverse automatically to play the second track pair. Running speeds of 7½ and 3¾ inches per second, and a maximum reel size of 7 inches are also typical. There are many variants to suit special needs, however. Many decks now use all four tracks in one direction, either for quadraphonic use or to record four synchronized tracks for later mixdown to a stereo pair. Still other decks divide the tape into two wider tracks for improved signal-to-noise ratio. "Full-track" monophonic recorders, using the whole tape for one channel, are also available though they're hardly common nowadays.

Reel size and tape speed vary, too. While the 7-inch reel carries from 1200 to 3600 feet of tape, depending on the tape's thickness (thicker tapes are sturdier and less prone to "print-through" of signals from one layer to another), more and more machines carry 10½-inch reels with double this capacity. Battery-operated, open-reel portables usually have a 5-inch maximum reel-size capacity, with half the capacity of the normal reel. Most recorders offer two speeds, but many offer three; these speeds may range from a high of 15 inches per second to a low of 15/16 inch-per-second. With each halving of speed, fidelity diminishes but the amount of time a given tape will play is doubled. A standard 7-inch reel will play for 30 minutes in each direction at 7½ inches per second. Timings for other speeds, tape thicknesses, and reel sizes can be calculated from this.

Open-reel tape is the preferred medium for truly serious recordings for several reasons. Its wider track and higher speeds mean greater fidelity, including more extended frequency response, better signal-to-noise ratio, more "headroom" for high recording levels without distortion (especially at higher frequencies), and lower wow and flutter. And open-reel tape is easily edited. Open-reel is also easily adapted to a multiplicity of special uses. Broadcasters, for instance, use 10½-inch-reel machines operating at 15/16 inch-per-second to record up to 25 hours of programming on a single reel as an automatic log of what has gone out over the air. Most commercial recordings originate on open-reel tape, and a trend is growing towards semi-professional home studios using the larger open-reel decks.

The major inconvenience of open-reel tape is the necessity of threading it.

Elcaset System. The Elcaset, a new arrival, seeks to combine the major advantages of open-reel and cassette tape. Operating at 3¾ inches per second on ¼-inch tape, it offers higher fidelity than is possible from cassette tape at a similar level of development. Stereo recordings are made in a format similar to the cassette's with the two tracks of each stereo pair running side by side, each pair running in a different direction. However, a fifth track between the two stereo pairs can be used for control signals, such as digital location markers for each taped selection.

The tapes load like cassettes, which they resemble in all but size. But where the cassette player's heads must enter the cassette shell for playing or recording, the Elcaset machine pulls the tape out of the shell and brings it to the heads. This allows for more accurate tape positioning, increasing fidelity again. It also means that Elcaset tapes can be edited more easily than cassettes, at least with regard to removing undesired sections. Splicing tapes from one reel onto another may be more difficult than with open-reel, however.

Elcaset tapes are available in lengths of 60 to 90 minutes; prerecorded tapes are not yet available. Also, there are few machines available to play Elcaset tapes, and they are quite expensive.

Subcompact Systems. Sub-compact cassettes are the Elcaset's opposite in many ways. Smaller than conventional cassettes, and with noticeably less fidelity, they were developed for dictation and note-taking on the run. Here, their low fidelity is little disadvantage, and their ultra-small size is a major benefit.

So far, however, there are at least four sub-compact tape systems, each incompatible with the others. The two most popular such systems are the Philips Mini-cassette and the Olympus Pearlcorder Micro-cassette. The Philips system, used by Norelco, Dictaphone, Scors, Lafayette, Penny's, Compur-Hermes, Webcor, Montgomery Ward, Unitrex, Radio Shack, and GE (who calls its version a "micro"), uses a ⅛-inch tape whose speed varies. The tape is pulled by the take-up spindle, and the amount of tape pulled through by each spindle revolution increases as the tape builds up on the take-up reel. The mini-cassette is a monophonic system that records for 15 minutes on one track, then must be flipped over to record 15 more minutes on the other one. Extra-length cassettes using thinner tape are also available from GE and Certron (20 minutes per side) and American headset (26 min./side).

The Olympus Micro-cassette system, shared by Lanier, Panasonic, and Sony, is capstan-driven like most other tape recorders. It operates at a steady speed, in this case 15/16 inch per second. The tape is 1/7 inch wide, and plays for 30 minutes per side, for a 60-minute total. Panasonic and Olympus have two-speed versions which can also run 60 minutes per side at 15/32 ips.

Courterport makes a thin-tape, 45 minute-per-side Micro-cassette and another 2-speed Micro-cassette recorder. (But they also make a 2-speed model using the Norelco Mini-cassette.)

The Microcassette system may yet turn into a rival of the larger Compact Cassette judging from some new models now appearing. One new Olympus Pearlcorder model has a built-in FM/AM radio, and another takes plug-in, accessory AM and FM tuners.

Sankyo's Micro-mini is a similar cassette, so far not shared with any other company, which also records 30 minutes per side. Tape width is 5/16 and it runs at a speed of 15/16 inch per second.

Another one-company tape is the DeJur Amsco Stenocassette 30 which records for 30 minutes straight through; it records on one side only. A tape-position counter is built into the cassette, not the machine.

When selecting a sub-compact system, be sure that it will be compatible with sub-compacts owned by any others you intend to exchange tapes with. Take extra care when buying blank tapes, too, to be sure they are the type that fit your machine. Prerecorded tapes are not available for any of these miniaturized tape systems, as in their present state of development they're not too suitable for music reproduction. However, neither was the compact cassette when it was first introduced. ◇

The most portable tape formats are the new "mini" and "micro" tapes, used in machines like this Olympus Pearlcorder.

OSCAR:

COMMUNICATIONS SATELLITES FOR EVERYONE

YOU DON'T HAVE TO BE A LICENSED RADIO AMATEUR TO MAKE USE OF OSCAR TRANSMISSIONS

BY HARRY L. HELMS, JR.

CHANCES are you have heard of the OSCAR communications satellites built by and for radio amateurs. Yet only a handful of amateurs and SWL's have ever made use of the OSCAR's. This might be due, in part, to the mistaken idea that expensive, complex equipment is required and that esoteric space communications techniques must be employed. Another possible explanation is the (again, wrongful) notion that only licensed hams can make use of OSCAR satellites, leaving nothing to offer the SWL or casual radio hobbyist.

The truth of the matter is that a receiver covering the amateur 10-meter band (28-29.7 MHz) and a wire antenna are all you need to get started in OSCAR communications. Although having an amateur license certainly increases OSCAR enjoyment, unlicensed SWL's can participate in OSCAR communications and collect enviable QSL's for their efforts. Many students have used OSCAR as a basis for award-winning science fair projects. In fact, the OSCAR program offers to the general public the easiest, most direct access of any space science endeavor—truly space technology for the people!

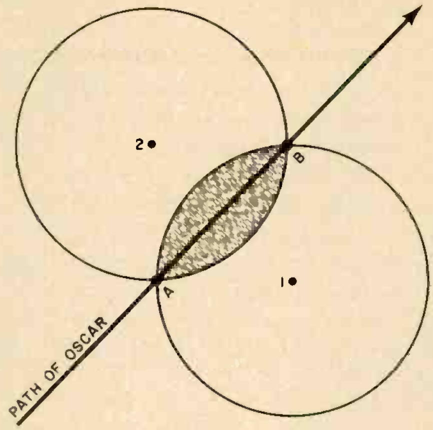
What's an OSCAR? OSCAR is an acronym for Orbiting Satellite Carrying Amateur Radio. OSCAR's are space satellites designed and constructed by radio amateurs on a nonprofit, nongovernmental basis. They hitch a ride into orbit during launches of scientific or communications satellites, replacing the dead weight ballast ordinarily used to tailor the weight of the uppermost booster stage. Early OSCAR's were designed to give amateurs and other radio hobbyists experience tracking and tuning in signals from orbital satellites. The emphasis has now shifted to designing and launching "orbiting repeaters" which receive signals from amateur stations on Earth and retransmit them from space, greatly extending the normal range of the ground stations. Participation by amateurs is international in scope, with operators in more than 100 countries actively transmitting and receiving signals through the various OSCAR satellites.

The Beginnings. Amateurs and SWL's have been involved in space communications ever since October 4, 1957, when the Soviet Union launched Sputnik I into orbit. Owners of general-coverage receivers were able to tune in the 20-MHz "beep-beep-beep" beacon signals of Sputnik as it passed overhead in orbit.

The strong signals from Sputnik I told amateurs that a beacon satellite operating in the ham bands was feasible. Further exploration of the possibilities with NASA indicated that such a satellite could be carried aboard a regularly scheduled launch in place of the ballast normally used. A group of California hams went to work and produced OSCAR I, the world's first nongovernmental satellite. OSCAR I was launched into a polar orbit on December 12, 1961 from Vandenberg Air Force Base in California. Even though its 144.98-MHz CW beacon had a power output of only 100 milliwatts, more than 5000 reception reports were received from 28 countries during the 20 days it operated. OSCAR I's beacon had a typically amateur touch, sending out the simple message "HI", the traditional Morse code expression for laughter.

OSCAR II was launched on June 2, 1962, and was essentially a repeat of OSCAR I. Results of the first two missions convinced amateurs that the time had come to try their hand at a true communications satellite. The result was OSCAR III, launched March 9, 1965 and becoming the world's first free-access, active communications satellite. OSCAR III accepted signals from Earth at approximately 144.1 MHz and retransmitted them on 145.9 MHz with an output power of one watt. Almost 100 amateur stations in 16 countries took advantage of the new mode of communication, establishing several records in the process. HB9RG in Switzerland and DL6EZA in Germany became the first nongovernment stations to establish contact by communications satellite, and W1BU and DL3YBA made the first trans-Atlantic amateur contact via satellite. OSCAR III functioned for only 15 days before its batteries failed. OSCAR IV, launched on December 21, 1965, was the first amateur satellite to use a repeater that covered two different bands. It received signals at 144.1 MHz and retransmitted them with an output power of three watts on 431.938 MHz. Unfortunately, a malfunction in its booster rocket caused it to go into a highly elliptical orbit with a very low perigee. Only a dozen confirmed two-way contacts were made before the satellite re-entered the atmosphere and burned up. One of these, however, between K2GUN and UP20N, was the first direct satellite communication between the United States and the Soviet Union.

The last of the early OSCAR's was OSCAR V, launched on January 23, 1970. Although not a relay satellite, it did test several new control and transmissions systems that would play an important part in later OSCAR missions. Underlining the international nature of the OSCAR program, the satellite was designed and built in Australia.



Stations 1 and 2 can communicate through OSCAR 7 or OSCAR D only when satellite is in shaded area between points A and B. Circles represent possible communication areas for land stations.

The Second Generation. Increasing complexity of the OSCAR satellites made impossible the informal "backyard" construction procedures used for the first few in the series. In 1969, AMSAT, the Radio Amateur Satellite Corporation, was founded in Washington, D.C., to design and build future OSCAR satellites. OSCAR V was the first satellite to be launched under AMSAT auspices.

The first of the new generation of OSCAR's from AMSAT was OSCAR VI, launched into a polar orbit on October 15, 1972. Although designed for only one year of service, it continued functioning until June 1977. OSCAR VI carried aboard a *transponder*, as opposed to the repeaters carried aboard OSCAR's III and IV. A transponder is designed to receive and retransmit a band of frequencies, not one specific pair. The OSCAR VI transponder operated in what is known as *mode A*. In this mode, the OSCAR satellite receives signals from ground stations in the 2-meter band and transmits them back to Earth in the 10-meter band. OSCAR VI received signals from 145.9 to 146.0 MHz and relayed them back on 29.45 to 29.55 MHz. Transponders aboard the OSCAR series can handle most any type of signals received including SSB-CW, AM, RTTY, or SSTV.

OSCAR VII was launched on November 15, 1974. Its 910-mile (1456-km) high polar orbit is virtually identical to that of OSCAR VI. OSCAR VII carries a mode-A transponder similar to that on OSCAR VI, but operates on slightly different frequency ranges. In addition, OSCAR VII has a *mode-B* transponder, which receives signals on 432.125 through 432.175 MHz and retransmits them on 145.975 through 145.925 MHz. Mode B was an unexpected, rousing success, providing signals far stronger than those on mode-A. Moreover, it proved to be far easier to access, with several stations working through the satellite with as little as *50 milliwatts* output! Many foreign stations can be found on mode B, and the day is not far off when someone will work more than 100 countries through the OSCAR satellites.

The latest in the series, OSCAR D, is scheduled for launch early in 1978 and should be aloft by the time you read this. Like OSCAR VI and VII, OSCAR D will have a mode-A transponder aboard. A new feature will be a *mode-J* transponder, designed and built by a group of amateurs in Japan, who have formed the Japanese AMSAT Association. In mode J, the satellite will receive signals from Earth between 145.9 and 146.0 MHz and transmit them back to Earth within a 435.1-to-435.2-MHz passband.

The Soviet Union has announced that it will shortly place its first amateur satellite into orbit. Called RS-1, but designated OSCAR VIII by AMSAT, the satellite will use passbands similar to those employed by OSCAR VII in mode A. The uplink passband of the first Russian satellite will be 145.8 through 145.9 MHz, and the downlink is announced as 29.3 through 29.4 MHz. Operators who have gained experience with OSCAR VI and VII should have no trouble using RS-1.

The latest information about the operational status of any of the OSCAR satellites can be obtained from AMSAT headquarters or from the American Radio Relay League and its bulletins over station W1AW. The addresses of both organizations can be found in the box accompanying this article.

Using Oscar. The first step in getting acquainted with the OSCAR's, whether you're an amateur or SWL, is to develop the capability of receiving signals from the satellites. The various CW telemetry beacons operating on frequencies given in the Table are good targets. Most people will find the 10-meter beacons the easiest to hear, at least at first.

Almost any receiver with coverage of the 10-meter amateur band (28.0 through 29.7 MHz) can be used to receive the OSCAR CW beacons. However, some older receivers might not have adequate sensitivity to copy the beacons. This can be remedied by adding an outboard preamplifier covering ten meters. Suitable preamps are available from many amateur equipment suppliers, or you can build one yourself. Most modern solid-state receivers are sufficiently sensitive to copy the beacons without help from additional equipment.

No fancy antennas are needed. The old reliable dipole, cut for 10-meters will do an excellent job. Plans for a 10-meter dipole can be found in any edition of *The Radio Amateur's Handbook*, available at virtually any library.

An omnidirectional CB antenna will also work well in most cases. This author has received the 10-meter beacons from an apartment QTH using just several feet of random wire fed to his receiver through an antenna tuner. The point is that nothing fancy is necessary. Just try to have the antenna resonant at 10 meters and outside, if at all possible.

Both OSCAR VII and D travel in polar orbits. OSCAR VII is approximately 910 miles (1456 km) above the Earth's surface and OSCAR D is planned to orbit at approximately 575 miles (920 km). The higher altitude of OSCAR VII means that it provides greater communication range than OSCAR D. When OSCAR VII is within approximately 2450 miles (3920 km) of your location, its CW beacons should be audible. The lower orbit of OSCAR D will give it a range of approximately 1550 miles (2480 km). You can plot the ranges for yourself by drawing circles with radii of 2450 and 1550 miles (3920 and 2480 km) centered on your location. Whenever one of the OSCAR's passes within its respective circle, you should be able to hear it. (See diagram.)

How long you will be able to hear each satellite also depends on how close it is to your listening location. The OSCAR's might be audible for only a minute or two whenever their orbits just cross the edge of your "listening circles." The greatest period of audibility will occur when the OSCAR's pass overhead. When this happens, you can hear the satellites for up to 25 minutes at a time. Due to orbital characteristics, each OSCAR will be within range at least four times every day. OSCAR VII has one overhead pass each day between 6 and 10 p.m., local time at any listening location in the world. This is an ideal time for the beginner to listen for its beacon.

Plotting OSCAR orbits and predicting when the satellites can be heard are beyond the scope of this article, but the techniques involved are not difficult and require no advanced mathematics. W1AW broadcasts orbital information on a regular basis, and AMSAT offers a computer printout of orbital predications for the entire year. Simple tracking devices are available from both ARRL and AMSAT that enable precise tracking of the OSCAR satellites, allowing prediction to within a few seconds of when the satellites will first be heard and when the signals will be lost.

WHERE TO GET MORE INFORMATION

AMSAT. The Radio Amateur Satellite Corporation, Box 27, Washington, DC 20044. Membership is $10 per year, including quarterly newsletter. AMSAT is a nonprofit corporation and solicits tax-deductible contributions to defray costs of the OSCAR satellites. It also actively solicits reception reports of OSCAR CW beacons and issues QSL cards to confirm correct reports. Also available are attractive certificates and awards to amateurs using the OSCAR series.

ARRL. The American Radio Relay League, 225 Main St., Newington, CT 06111. The national association of radio amateurs transmits latest OSCAR information in bulletins on station W1AW. Complete schedule of bulletins available for stamped self-addressed envelope. Publications of interest to OSCAR users include *Getting to Know* OSCAR From the Ground Up and *Specialized Communications Techniques for the Radio Amateur*.

What You'll Hear. While the satellites are still out of range, you'll find the beacon frequencies and transponder outputs completely quiet except for terrestrial stations (if any). Suddenly, the beacon frequencies and downlink passband will "come alive" with signals. The signals will become stronger as the satellite approaches, then drop off as the satellite becomes more distant from the listener. They will "break off" just as suddenly as they became audible.

Newcomers to OSCAR are often confused by the effects of Doppler shift. As the satellite approaches a ground station, the frequency of signal coming from the satellite appears higher than the actual transponder output frequency. When the satellite is directly overhead, the received frequency and the actual frequency will be the same. As the satellite moves away from the listening location, the received frequency will seem to decrease. This is similar to the effect noticed when a train whistle changes pitch as the locomotive passes by.

Doppler shift increases with frequency. Signals on 10 meters will not be greatly affected, but the phenomenon must be taken into account when tuning for the 145- and 435-MHz beacons. Many amateurs are bothered by Doppler shift when they first attempt to transmit through one of the OSCAR's. Adjusting their transmitters to compensate for the "drift" they hear, they end up "waltzing" all over the transponder passband! Fortunately, simple mathematical formulae enable amateurs to predict and accurately compensate for Doppler effects.

The OSCAR beacons send telementary information in CW at a rate of 20 words per minute. Although this is rather fast, signals can be recorded and later decoded, even if one does not know Morse code. (See "End that Utility Futility," July, 1977 POPULAR ELECTRONICS.) The telemetry gives details about internal characteristics of the satellites, such as battery voltage and satellite temperature. AMSAT encourages reports on reception of the telemetry beacons, and offers free technical sheets to interested persons so that they can interpret the data for themselves. AMSAT also offers QSL cards to anyone who correctly reports reception of any of the OSCAR satellite beacons. These will be of particular interest to the SWL, as many all-band SWL clubs give country status to "outer space." At present, the only way to secure a verification from outer space is through an OSCAR reception report to AMSAT! You can send your reports to AMSAT at its Washington address.

After you have become adept at receiving the beacons, you can start tuning the transponder passbands for ama-

TABLE OF OSCAR SATELLITE FREQUENCIES

OSCAR VII

Mode A:
Uplink: 145.900-146.000 MHz
Downlink: 29.450-29.550 MHz
Beacon: 29.450 MHz.

Mode B:
Uplink: 432.125-432.175 MHz
Downlink: 145.975-145.925 MHz
Beacon: 145.972 MHz

OSCAR D

Mode A:
Uplink: 145.850-145.950 MHz
Downlink: 29.400-29.500 MHz
Beacon: 29.400 MHz

Mode J:
Uplink: 145.900-146.000 MHz
Downlink: 435.100-435.200 MHz
Beacon: 435.095 MHz

Phase III (to be launched in late 1979)

Mode J:
Uplink: 145.850-145.990 MHz
Downlink: 435.150-435.290 MHz
General Beacon: 435.145 MHz
Engineering Beacon: 435.300 MHz

Mode B:
Uplink: 435.150-435.290 MHz
Downlink: 145.850-145.990 MHz
General Beacon: 145.995 MHz
Engineering Beacon: 145.845 MHz

teur stations communicating with other amateurs through the satellite. Unlike some amateurs, OSCAR communicators tend to be excellent QSL'ers, and AMSAT has set up an OSCAR QSL bureau.

Transmitting through OSCAR. Anyone holding a Technician or higher class amateur license can use the OSCAR satellites for two-way communications. As with receiving, elaborate equipment is not really necessary.

Mode A is again the best place to start, with many amateurs using one of the new multi-mode 2-meter transceivers to transmit into the OSCAR (the "uplink") and their usual receiver or transceiver to receive the signals retransmitted by OSCAR (the "downlink"). Others use transverters to convert their transmitter's output (usually in the 10-meter band) up to 2 meters. High power isn't necessary to work through OSCAR and is not really desirable. AMSAT requests that no more than 100 watts of effective radiated power be used for uplink transmissions to OSCAR. Thus, a 10-watt, 2-meter transceiver feeding an antenna with 10 dB of gain will give 100 watts of effective radiated power. Higher signal levels overload OSCAR transponders and can shorten the useful life of the satellites. Most OSCAR work is via SSB or CW, with other modes restricted to special tests authorized by AMSAT.

For overhead passes, many have found that verticals used in 2-meter FM work well. But serious OSCAR users employ beams mounted on rotors to follow the satellite as it passes overhead to ensure a good signal into the satellite. Some employ a separate rotor to change the beam's elevation because the path of an OSCAR orbit is usually located well above a beam's horizontal plane. Others compromise and leave the beam elevated at an angle of 30°.

To minimize signal fading, some amateurs use antennas employing circular polarization. Omnidirectional antennas with circular polarization have an effective negative gain, so more than 100 watts of output power must be fed into them to give efficiency equal to a small beam and rotor. Antenna polarization is not critical in OSCAR work because signals from Earth are rotated in polarization by the Earth's magnetic field as they pass through the ionosphere. Also, OSCAR VII and D are tumbling as they orbit, causing further polarization shifts.

Mode B and Mode J Techniques. As noted earlier, OSCAR's VII and D make use of 145- and 432-435-MHz frequencies for their uplink and downlink transmissions, as shown in the Table. Some amateurs and many SWL's may find it necessary to add equipment to their shacks to cover these other modes.

The mode-B downlink can easily be received on a 2-meter multi-mode transceiver or on a general-coverage receiver equipped with a 2-meter converter. Mode-B signals from OSCAR VII have been quite strong, much more so than mode-A; and mode-J is expected to be a similar improvement. Mode-J's 435-MHz downlink transmissions will require an outboard converter ahead of an hf receiver or multi-mode vhf transceiver. Most 2-meter and 435-MHz converters produce output signals in the 10-meter amateur band, and can be obtained from amateur equipment dealers. (For most amateurs and SWL's, the addition of two such converters will be the only extra equipment needed for reception of all three OSCAR downlink passbands.)

The omnidirectional verticals so popular in 2-meter FM work will give excellent results when receiving mode-B signals. Mode-B and J directional transmitting antennas should be mounted on rotors for best results and either be elevated at an angle of approximately 30 degrees or have a separate elevation rotor.

A mode-J uplink can use the same equipment as that for mode A. For mode B, many amateurs use a frequency tripler with an existing 2-meter transmitter to convert a 144-MHz signal to 432 MHz. Such an approach is suitable only for CW work; for SSB, a more complex transverter must be used. Recently, commercial transceivers for 432-MHz SSB/CW have been introduced, and additional manufacturers are planning for the higher OSCAR frequencies.

Coming Up: Phase III. Exciting as OSCAR communications are, there are limitations. Maximum communications time is now limited to about 25 minutes, and range is relatively short by the standards of 20 and 15 meters, the prime hf DX bands. However, all of this will change dramatically in 1979, when the first of the OSCAR Phase III satellites is launched. Like their predecessors, these OSCAR's will travel in polar orbits, but will have an apogee of 24,000 miles over the North Pole. This will allow all amateurs in the Northern Hemisphere to communicate with each other—without fading, skip zones, or ionospheric disturbance! This type of hemispheric communications is presently impossible on any other amateur band. What's more, most amateurs will be able to work through the Phase III satellite for approximately 14 to 16 hours each day.

Phase III will also be easier to use than the previous OSCAR satellites. The relatively slow movement of the Phase III satellite through the sky will eliminate the need for complicated beam and rotor antenna systems for maximum performance. With Phase III, any apartment dweller with a view of the northern horizon will be able to enjoy fade-free communications with most of the world, using only simple gear and less than 100 watts of output power.

Phase III's orbit will be highly elliptical. A synchronous orbit—one that keeps pace with the Earth's rotation so that the satellite appears stationary—was ruled out because of the limited number of amateurs it would serve. Three satellites in synchronous equatorial orbits—having satellite-to-satellite communications links—would be necessary for global communications. A synchronous orbit over the North Pole is physically impossible, so AMSAT was forced to select from compromise orbits. More than 90 per cent of the world's amateur population resides in the Northern Hemisphere, so an elliptical orbit giving maximum coverage of the Northern Hemisphere was chosen. As mentioned earlier, the apogee of the Phase III orbit will be approximately 24,000 miles over the North Pole and the perigee will be 910 miles over the South Pole. While in the Southern Hemisphere, the satellite will function much like the current OSCAR VII and D satellites.

Underscoring the international character of Project OSCAR, Phase III will be launched late in 1979 by the European Space Agency from the Guiana Space Center in French Guiana, South America. Amateurs in Japan, West Germany, Britain, and the United States are all joining in the effort to build Phase III. Currently, discussions are being held concerning the launch of a second Phase III satellite in 1980 or later aboard the Space Shuttle.

Phase III will make use of frequencies in the same general range as the mode-B and mode-J frequencies currently in use. This is in agreement with AMSAT's policy of not rendering obsolete gear currently being used for OSCAR communication.

AMSAT and the Future. If you're interested in keeping up with the latest news on the OSCAR program and helping its future development, you should consider joining AMSAT. Dues are $10 per year, which includes a subscription to the quarterly *AMSAT Newsletter.* AMSAT also engages in numerous fund-raising projects to help pay the costs of the OSCAR program and will gladly supply additional information on request. The address is Box 27, Washington, DC 20044.

Be sure to report reception of any of the OSCAR's to AMSAT to get one of their QSL cards. And why stop at mere listening? A Technician class amateur license, with its leisurely five-words-per-minute code speed, allows you to work other amateurs through OSCAR. Several manufacturers are currently designing walkie-talkies to work through Phase III. Just imagine the fun of being able to hold five-hour ragchews with amateurs in Japan and Europe through a hand-held radio once Phase III is aloft! That's what the future holds when you're involved in OSCAR communications. ◇

HOW TO UPGRADE A BASIC ELF MICROCOMPUTER

TTY COMMUNICATION
TAPE CASSETTE READ/WRITE
MUSICAL PROGRAMS
FREQUENCY/TIME INTERVALS
MEMORY PRENUMBERING

IF YOU OWN a basic (256 bytes of RAM) Elf computer, for less than $5 in hardware costs you can:

- Read and write data using a conventional cassette tape machine.
- Create musical programs.
- Communicate with a TTY.
- Measure frequency/time intervals.
- Memory prenumbering.

Here's how to upgrade an Elf to accomplish the foregoing. These applications require a 2-MHz crystal, or the timing programs modified.

Cassette Storage. The "Kansas City" tape cassette standard uses 8 cycles of 2400-Hz tone for a logic "1", and 4 cycles of a 1200-Hz tone for a logic "0". Eleven bits are required for each byte. First, there is a 0 to indicate the beginning of transmission, followed by eight 1's and 0's to form the actual data byte, and finally two 1's to finish. The byte rate is about 27 per second.

The hardware required for a simple cassette interface is shown in Fig. 1. Note that a resistor network is required to reduce the Q-signal output down to the level required by the cassette recorder MIC or AUX input. The values of these resistors have to be determined by experimenting with your own recorder. (Try 47k as the value for the series resistor. You may or may not need the resistor to ground.) The transistor circuit accepts the tone data from the cassette recorder, using a 2N2222 to provide clean data for the EF2 input of the Elf.

The program shown in Table I writes the 152 bytes in locations 68 through FF

BY EDWARD M. McCORMICK

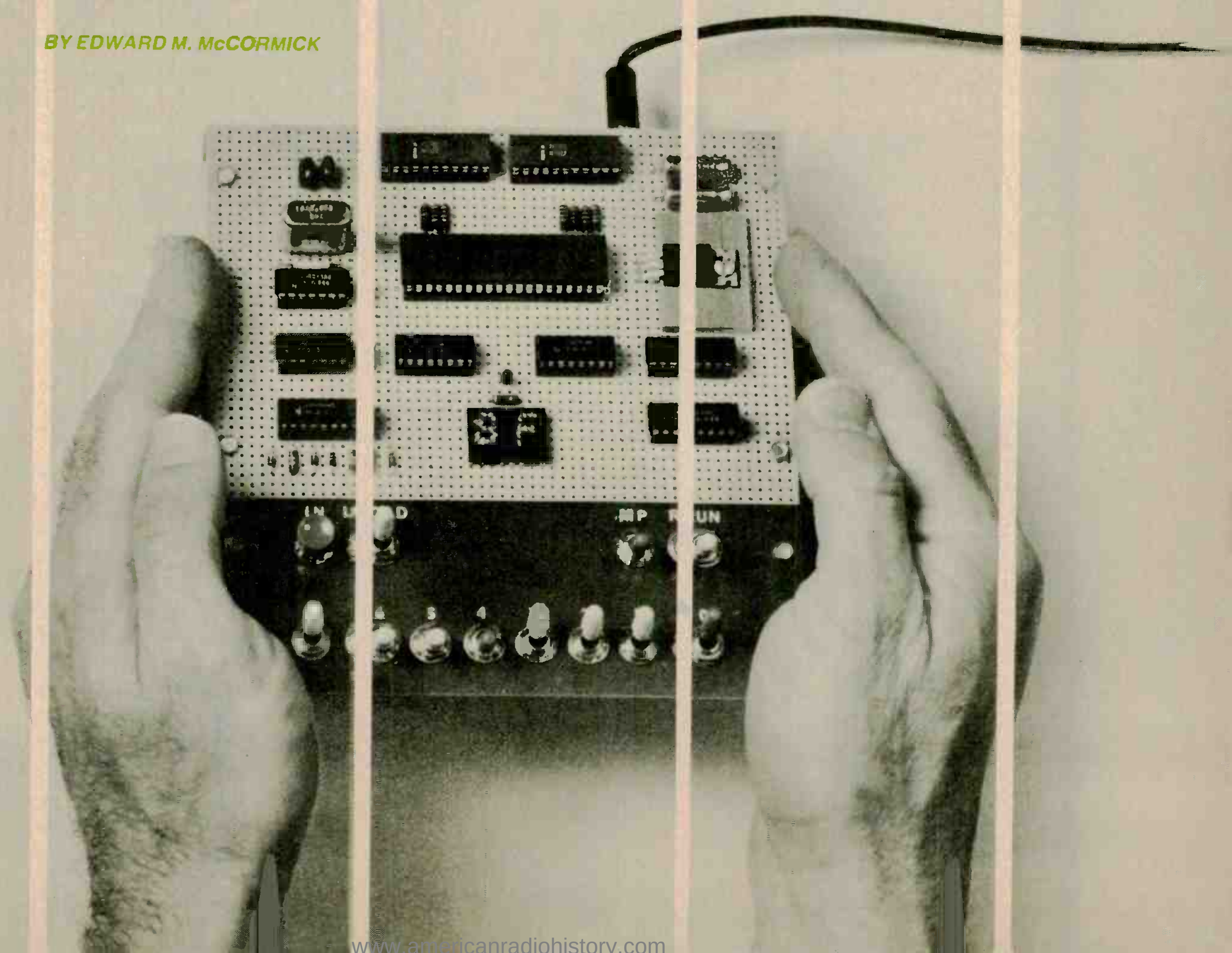


TABLE I. PROGRAM TO READ FROM MEMORY TO CASSETTE.

Loc	Instr	Remark	Loc	Instr	Remark
00	E1	X=1	33	F8 01	* continue mark
01	7A	Turn Q off	35	A6	*
02	F8 68	Set first core	36	F0	Start by getting
04	A1	* address	37	A4	* byte,
05	F8 00	Clear	38	F8 09	* setting shift
07	A6	* reg 6	3A	A5	* count in reg 5,
08	A7	* reg 7, eob sw	3B	30 4B	* going to space
09	F8 10	Generate a mark,	3D	87	Branch if end
0B	A2	* 8 cycles at	3E	3A 5A	* of byte
0C	F8 01	* 2400 hertz	40	85	If not, reduce
0E	A3	*	41	FF 01	* shift count and
0F	30 11	*	43	A5	* branch if end
11	31 16	If Q on, turn	44	32 53	* of byte
13	7B	* it off, if	46	84	Go to mark or
14	30 19	* off, turn it	47	76	* space according
16	7A	* on	48	A4	* to bit of byte
17	30 19	*	49	33 09	*
19	83	Variable delay	4B	F8 08	Generate a space,
1A	FF 01	* to balance	4D	A2	* 4 cycles at
1C	3A 1A	* half cycles	4E	F8 0E	* 1200 hertz
1E	82	Repeat if cycle	50	A3	*
1F	FF 01	* count not	51	30 11	*
21	A2	* zero	53	F8 01	At end of byte,
22	32 2E	*	55	A7	* set eob switch
24	F8 07	Fixed delay	56	F8 20	* and start double
26	FF 01	*	58	30 08	* mark
28	3A 26	*	5A	F8 00	When end of byte,
2A	30 2C	*	5C	A7	* display byte and
2C	30 11	*	5D	64	* if end of core,
2E	86	End of mark	5E	81	* go to mark, if not,
2F	3A 3D	* test	5F	32 01	* get next byte
31	3F 09	If IN up,	61	30 36	* and return

TABLE II. PROGRAM TO READ FROM CASSETTE INTO ELF MEMORY.

Loc	Instr	Remark	Loc	Instr	Remark
00	30 02	Optional branch	32	FC ED	Branch if mark
02	E1	X=1	34	3B 3F	*
03	F8 68	First "load-to"	36	7A	If space, turn
05	A1	* address	37	F0	* Q off,
06	F8 80	Put a one in	38	F6	* shift output
08	A7	* reg 7	39	51	* byte and set
09	F8 08	Put shift count	3A	F8 59	* delay for
0B	A5	* in reg 5	3C	A2	* 2.5 ms
0C	7B	Turn on Q	3D	30 49	*
0D	F8 00	Clear byte to	3F	7B	If mark, turn
0F	51	* be loaded	40	F0	* Q on, add one
10	35 10	Loop on marks	41	F6	* to byte, shift
12	3D 12	* in header of	42	51	* it, restore
14	F8 00	* tape or	43	87	* it and
16	FC 01	* between	44	F4	* set delay
18	35 16	* bytes	45	51	* for 2.9 ms
1A	FC ED	*	46	F8 68	*
1C	3B 10	*	48	A2	*
1E	F8 B3	If space, start	49	85	Continue if not
20	A2	* 5 ms delay	4A	FF 01	* all 8 bits in
21	7A	*	4C	A5	* byte
22	82	Do delay using	4D	3A 22	Continue if not
23	FF 01	* duration in	4F	64	* all core loaded,
25	C4	* reg 2	50	81	* display byte,
26	3A 23	*	51	3A 09	* and return
28	35 28	Determine if	53	7A	If core loaded,
2A	3D 2A	* mark or	54	3F 54	* turn off Q and
2C	F8 00	* space at	56	37 56	* execute program
2E	FC 01	* sampling	58	30 68	* when IN down
30	35 2E	* time			

onto the tape in about six seconds. When the program runs, it first generates a 2400-Hz tone for the leader. After recording the leader for about 10 seconds, depress the IN pushbutton to initiate the data recording. At the conclusion of the data, a trailer tone should also be recorded.

Table II's program will read the bytes from the tape into locations 68 through FF. The RUN switch should be turned on only when the cassette is playing back the 2400-Hz leader. When the data is encountered, it will be displayed. The tape recorder should be stopped while on the trailer.

Depressing the IN pushbutton causes the program starting at 68 to be executed. When the RUN switch is turned off, the Elf is ready to read another program from the cassette. To re-execute the program presently residing at 68, temporarily change the byte at memory location 01 from 02 to 68.

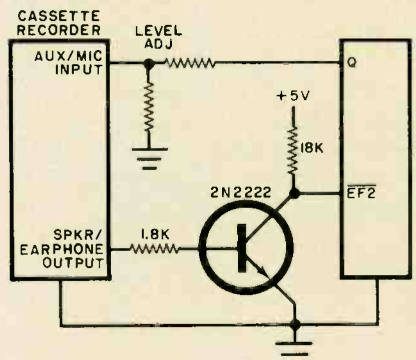


Fig. 1. Simple interface between Elf and cassette recorder.

20-mA Interface. The circuit shown in Fig. 2 provides an interface between the Elf and a 20-mA current-loop device (such as a TTY). The signal from Q drives the current loop, while the signal from the external current-loop device drives the EF3 input of the Elf.

A program to read and write to this interface is shown in Table III. When first executed, the program from 00 through 3E causes characters read from the keyboard or tape reader to be written into successive memory locations starting at 7A. Whenever the memory is filled, or the IN pushbutton is operated, the program reverts to the section between 3F and 6F that reads from memory to the current-loop device. This program illustrates the basic input/output technique and can be adapted for specific needs.

Note that the system will read all eight bits from a byte of memory and will punch all eight bits. Similarly, all eight bits on the tape will be read to memory. However, striking a key on the TTY enters only seven information bits since it is an ASCII device. The printer will ignore the eighth (most significant bit). Thus, Elf programs must be initially entered via the switches or from a hex keypad.

TABLE III. PROGRAM TO READ FROM TELETYPE TO ELF AND VICE VERSA

Loc	Instr	Remark	Loc	Instr	Remark
00	F8 28	Delay subr exit	37	F8 76	Else set delay
02	A6	" in reg 6	39	30 1E	" for 9 ms
03	7B	Turn on Q	3B	64	Display byte
04	E1	X=1	3C	81	"
05	F8 70	First read-to	3D	3A 0B	Read next byte
07	A1	" address	3F	F8 70	First read-from
08	F8 80	Put a one in	41	A1	" address
0A	A7	" reg 7	42	7A	Start space
0B	F8 00	Clear mx	43	F0	Store output
0D	51	"	44	A4	" byte
0E	F8 08	Shift count to	45	F8 09	Shift count to
10	A5	" reg 5	47	A5	" reg 5
11	3E 19	Start if EF3=0	48	F8 4F	Set subr exit
13	3F 11	Loop if IN up	4A	56	"
15	37 15	Loop if IN down	4B	F8 76	Set delay for
17	30 3F	Branch otherwise	4D	30 1E	" 9 ms
19	F8 29	Set subr exit	4F	84	Modify output
1B	56	"	50	76	" according to
1C	F8 B2	Set 13.5 ms delay	51	A4	" bit in byte
1E	C4	Delay loop subr	52	33 57	"
1F	C4	"	54	7A	"
20	C4	"	55	30 58	"
21	C4	"	57	7B	"
22	C4	"	58	85	Return if not
23	FF 01	"	59	FF 01	" all 8 bits
25	3A 1E	"	5B	A5	"
27	30 00	Subr exit	5C	3A 4B	"
29	F0	Form byte	5E	7B	Start mark
2A	F6	" according	5F	F8 66	Set subr exit
2B	51	" to EF3 at	61	56	"
2C	3E 31	" sampling	62	F8 ED	Set delay for
2E	87	" time	64	30 1E	" 18 ms
2F	F4	"	66	64	Display byte
30	51	"	67	81	" just put out
31	85	Branch if all	68	32 05	All core go to read
32	FF 01	" 8 bits read	6A	3F 42	Else start next byte
34	A5	"	6C	37 6C	Loop if IN down
35	32 3B	"	6E	30 05	Return to read

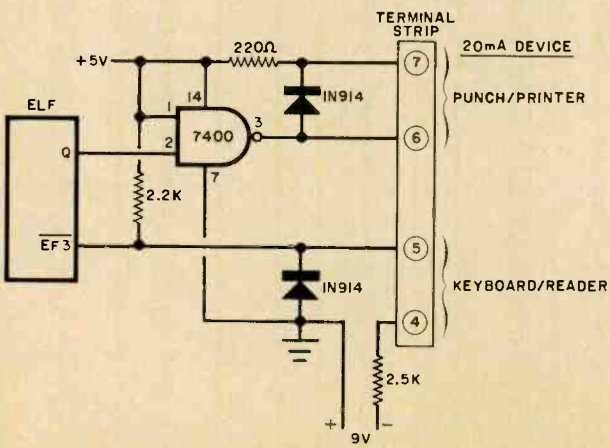


Fig. 2. Interface between Elf and a 20-mA current-loop device such as a TTY.

Memory Prenumbering. As a practical matter, it is often advantageous to "prenumber" all memory before entering data into the Elf. When the program shown in Table IV is entered and run, each memory location's contents is the address of that location. As a result, you can watch the hex display when manually entering programs to see if the next unused location is where it should be, or whether you have entered too many or too few bytes. This approach can be very useful in debugging programs.

TABLE IV. PROGRAM TO PRENUMBER MEMORY.

Loc	Instr
00	E2
01	F8 09
03	A2
04	82
05	52
06	64
07	30 04

Music. It is possible to program the Elf to reproduce the notes of the musical scale by connecting a speaker system to the Q output line and using the program shown in Table V.

The music program requires two data bytes for each note played. The first byte determines the duration of the note, while the second byte determines the pitch. Table VI shows the hexadecimal values for whole-note duration and the pitch of various notes. These byte pairs must immediately follow the music program shown in Table V—that is, it must start at hex AC. To illustrate, data for the first eight bars of Neil Simon's "Feeling Groovy" is listed in Table VII.

The music tempo depends on the hex value stored in memory 77 of Table V. The larger the hex value, the slower the tempo. The usual range is from hex 10 to hex 20.

Incidentally, the music program starts at hex 68; thus it can be recorded on a cassette. However, this leaves space for only 43 notes in a basic Elf. If the program starts at 00, then 91 notes can be stored.

MUSIC PROGRAMMING

TABLE V. PROGRAM TO PLAY MUSIC.

Loc	Instr	Remark	Loc	Instr	Remark
68	E5	X=5	89	3A 87	" indicates
69	F8 AC	Put first data	8B	89	Repeat as often
6B	A5	" in reg 5	8C	FF 01	" as tempo
6C	F0	Stop if data	8E	A9	" indicates
6D	3A 70	" is 00	8F	3A 99	"
6F	00	"	91	88	Repeat as often
70	A8	Store duration	92	FF 01	" as duration
71	15	" in reg 8	94	A8	" indicates
72	64	Display pitch,	95	3A 76	"
73	25	" store it in	97	30 A1	"
74	F0	" reg 7	99	C4	Delay to make
75	A7	"	9A	C4	" alternate
76	F8 10	Store tempo	9B	30 9D	" paths take
78	A9	" in reg 9	9D	30 9F	" same time
79	87	Stop alternating	9F	30 79	"
7A	FC B4	" Q if a rest	A1	7A	When note done,
7C	33 86	"	A2	15	" turn off Q,
7E	31 83	If Q on, turn	A3	F8 0E	" and insert
80	7B	" it off; if	A5	B3	" short quiet
81	30 86	" off, turn it	A6	23	" interval
83	7A	" on	A7	93	" between
84	30 86	"	A8	3A A6	" notes
86	87	Repeat as often	AA	30 6C	Get next note
87	FF 01	" as pitch			

TABLE VI. HEX VALUES FOR WHOLE NOTE DURATION AND PITCH OF MUSICAL NOTES.

Note	Dur	Pitch
D	93	12
C#	8B	14
C	83	15
B	7B	17
A#	75	19
A	6E	1B
G#	68	1D
G	62	1F
F#	5D	22
F	57	24
E	52	27
D#	4E	2A
D	49	2D
C#	45	30
*C	41	33
B	3E	37
A#	3A	3B
A	37	3F
G#	34	43
G	31	47
Rest	2D	4C

*Middle C

TABLE VII. PORTION OF SIMON'S "FEELING GROOVY".

Loc	Data	Loc	Data
AC	31 1F	D6	31 1F
AE	2C 24	D8	29 2A
B0	83 24	DA	83 24
B2	25 2D	DC	25 2D
B4	52 2A	DE	29 2A
B6	2C 24	E0	57 24
B8	25 2D	E2	25 2D
BA	94 2D	E4	94 2D
BC	17 4C	E6	17 4C
BE	1D 3B	E8	31 1F
C0	31 1F	EA	31 1F
C2	29 2A	EC	29 2A
C4	57 24	EE	57 24
C6	25 2D	F0	25 2D
C8	2C 24	F2	2C 24
CA	2C 24	F4	2C 24
CC	57 24	F6	57 24
CE	3A 19	F8	49 12
D0	75 19	FA	49 12
D2	57 24	FC	AF 19
D4	2D 4C	FE	00

TABLE VIII. FREQUENCY COUNT PROGRAM.

Loc	Instr	Remark	Loc	Instr	Remark
00	3F 00	Wait for IN to	25	C4	"
02	37 02	" be operated	26	30 15	"
04	F8 2C	Store values	28	F8 01	Zero side,
06	A2	" for one	2A	A3	" no count
07	F8 32	" second	2B	30 2D	"
09	B2	"	2D	30 15	"
0A	F8 00	Clear freq	2F	14	One side,
0C	A4	" count	30	F8 00	" add to freq
0D	B4	"	32	A3	" count
0E	A3	"	33	30 15	"
0F	3E 13	Wait for 0-1	35	E1	Display high
11	36 11	" transition	36	F8 46	" order
13	3E 13	"	38	A1	" byte of
15	22	Exit if end	39	94	" freq
16	92	" of second	3A	51	" count
17	32 35	"	3B	64	"
19	83	Monitor if on	3C	21	"
1A	32 22	" zero or	3D	3F 3D	Wait for IN to
1C	36 2F	" one side	3F	37 3F	" be operated
1E	C4	One side,	41	84	Display low
1F	C4	" after count	42	51	" order byte
20	30 15	"	43	64	" freq cnt
22	3E 28	One side,	44	30 00	Start over
24	C4	" no count			

Frequency Counter. The input circuit used to read from a cassette (Fig. 1), can also be employed to make the Elf act as a limited range frequency counter when the program shown in Table VIII is entered and run.

When the IN pushbutton is operated, the program counts the number of cycles occuring in a one-second interval and displays the most significant byte of that count. Operating the IN pushbutton switch again displays the least significant byte to be displayed. Operating the IN switch again results in a second frequency count, etc.

The input signal should overdrive the 2N2222 to ensure clean 0's and 1's. The maximum frequency is about 5800 Hz.

TABLE IX. PROGRAM TO MEASURE TIME INTERVALS.

Loc	Instr	Remark	Loc	Instr	Remark
00	3F 00	Wait till IN	16	F8 26	Display high
02	37 02	" sw depressed	18	A1	" hex position
04	F8 00	Clear registers	19	92	" of interval
06	A2	"	1A	51	" count
07	B2	"	1B	64	"
08	A3	"	1C	21	"
09	3E 0D	Wait for first	1D	3F 1D	Wait for IN
0B	36 0B	" 0 to 1	1F	37 1F	" sw depressed
0D	3E 0D	" crossing	21	82	Display low
0F	12	Add when	22	51	" hex position
10	36 0F	" EF3=1	23	64	" of interval
12	12	Add when	24	30 00	Repeat
13	3E 12	" EF3=0	26		Storage
15	E1	Exit at end			

Interval Timer. Using a similar input technique, the program shown in Table IX allows the Elf to be used as a simple interval timer.

When the IN pushbutton is depressed, the Elf waits for the next 0-to-1 crossing, and then measures the time to the next 0-to-1 crossing. The count displayed in the hex readouts is in 16-microsecond units. Accordingly, the maximum count with this program is about one second. The program can be modified for decimal display and longer time intervals. ◇

A future issue will show other alternatives for upgrading an Elf Computer.

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Using Existing House Wiring For Computer Remote Control PART 3

Construction and Software

BY DAN SOKOL, GARY MUHONEN, AND JOEL MILLER

THIS concludes the series of articles on computer remote control.

Data Recovery and Clock Generator. This circuit (Fig. 4) is also similar to its counterpart in the controller except that, in this case, the frequency-adjust potentiometer, *R15*, is a 10-turn potentiometer that is used for accurately synchronizing the frequencies of the controller and the remote.

UART. The data received from the controller is decoded and "unformatted" in this circuit (Fig. 5). Data is also put into the proper format to be sent to the controller. The receiver section of the UART accepts the serial input data from the phase-locked loop (*IC12* in Fig. 4), and converts it to parallel data and status information.

The status information is used by the address and decode logic (Fig. 6) to indicate when data is available and if any errors occurred. Data at the receiver output is looped back to provide the first six bits of the transmit data word. The seventh and eighth bits of the transmit data word are originated by the address and command decode logic. The transmit side of the UART responds with data to the controller when the address and command logic gets a poll command.

The data word sent from the computer through the controller has a specific meaning to the remote. The first five bits (Table I) contain the address of the remote to be controlled while the sixth and seventh bits contain the command information. If the seventh bit is a zero, all remotes (up to 32 in the system) ignore the word. However, if the seventh bit is a one, the word is defined as a command to the remote whose address is contained in the first five bits. The sixth bit contains the actual command; and if it is a one, it toggles the remote channel addressed. If the sixth bit is a zero, the remote responds with poll information that informs the computer of its status (on or off). Bit 6 of the transmitted word contains the on or off information about the remote being polled (1 is on, 0 is off). Bit 7 is always a 0 during a poll.

Address, Command Logic. In the circuit shown in Fig. 6, the incoming data word is compared with that formed by the user-selected address jumpers to determine that it, and no other remote, is being addressed. The circuit then decodes one of the four possible commands and executes the decoded information. In *IC3* and *IC7*, the address is decoded and checked for errors, while *IC4* and *IC5* decode the specific command. Flip-flop *IC6* controls the state of outputs A and B, while portions of *IC8* provide the transmit side of the UART with correct poll information on the status of each side of the remote—circuits A and/or B.

Relay drivers *Q6* and *Q7* convert the outputs of the CMOS circuits to a sufficient power level.

Construction. Due to the complexity of the circuit, it is best to use a double-sided pc board as shown in Fig. 7. Note that, on the component layout guide, diodes are designated "CR" instead of "D" and integrated circuits are "U" in-

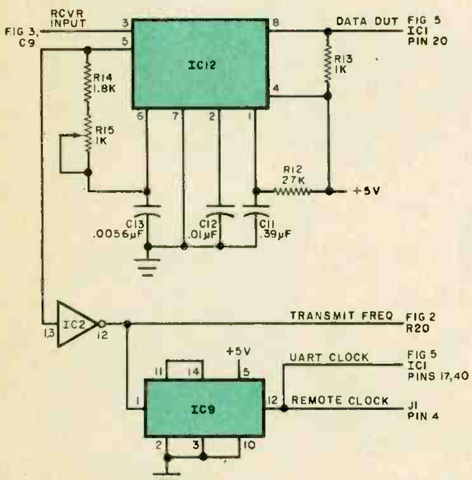


Fig. 4. Data-clock recovery is made by a PLL that delivers data output and a clock signal. The latter is divided by 16 for use in the UART.

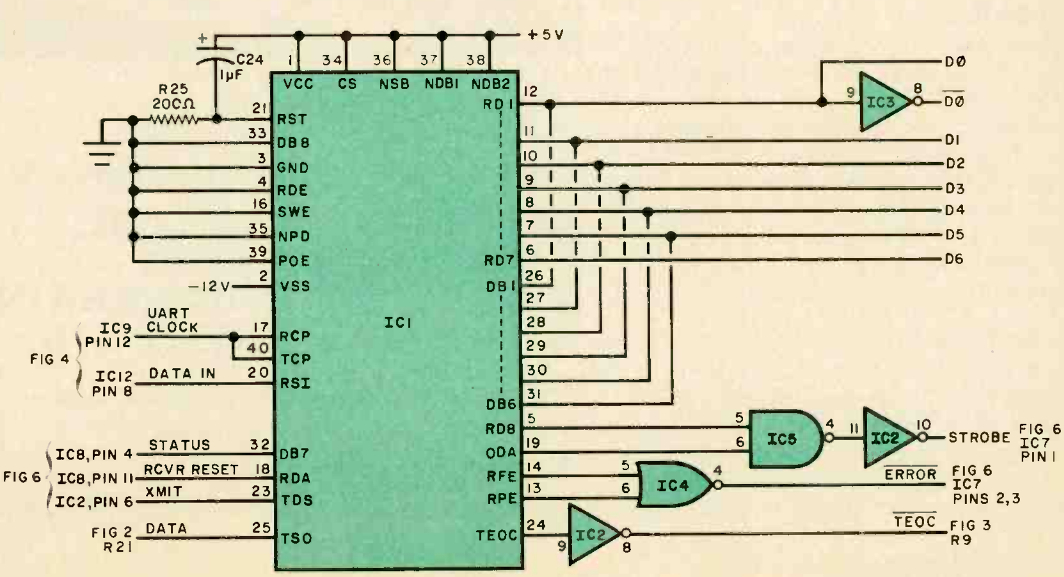


Fig. 5. UART (IC1) decodes data received by remote and formats it to be sent to controller. It also provides interface signals for other parts of circuit.

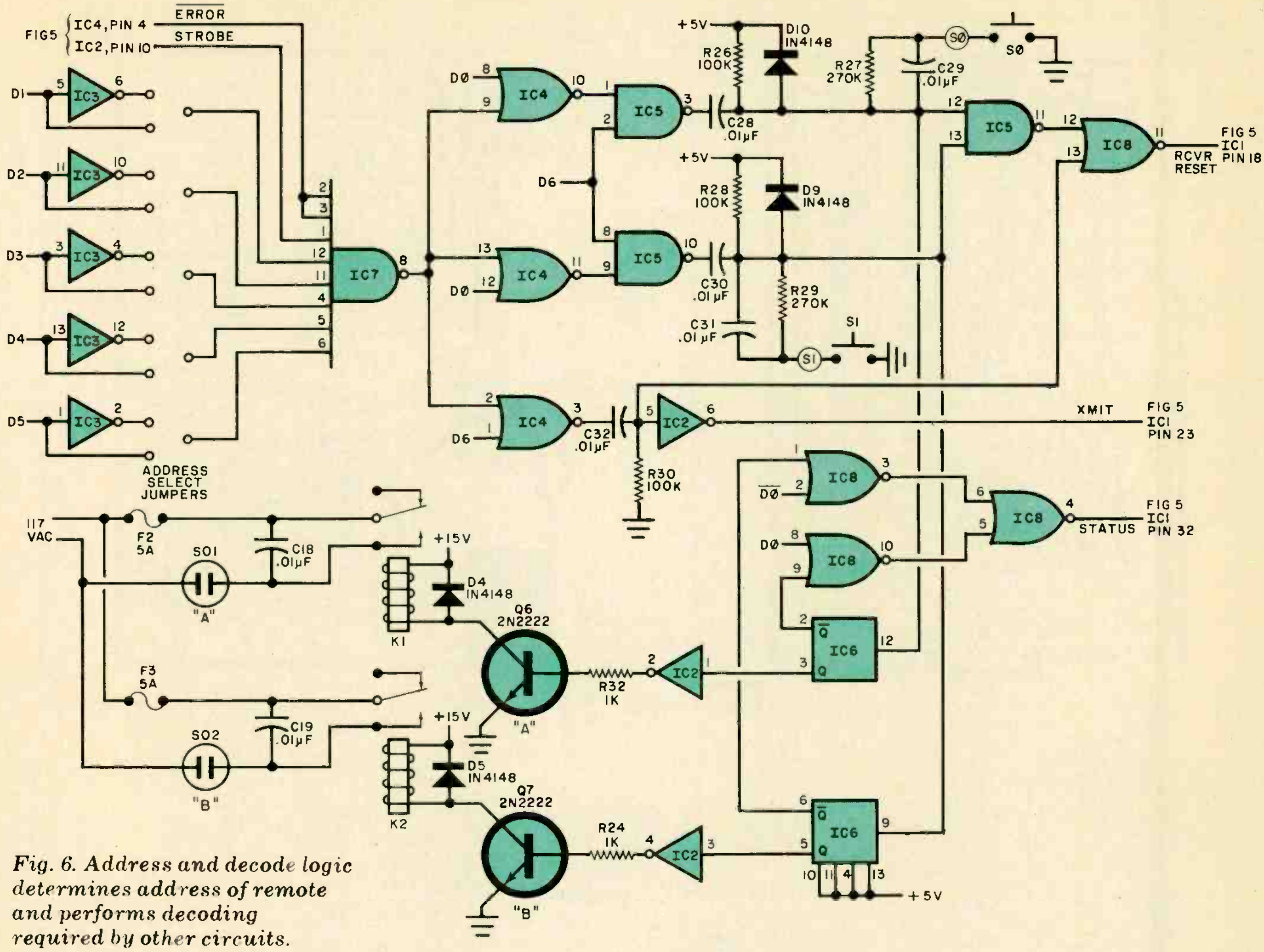


Fig. 6. Address and decode logic determines address of remote and performs decoding required by other circuits.

TABLE I

Information available at status port:

	MSB				LSB
Bit	7 6 5	4	3	2 1	0
Use	not used (always=1)	TBE	ODA	ROR RFE	RPE

	7 6 5	4	3	2	1	0
Decimal	224	16	8	4	2	1
Octal	340	40	10	4	2	1
Hex	E0	10	8	4	2	1

RPE = receive parity error. If this bit is a 1, then the character at the input port was received with a parity error. This bit clears when a word is received without error.

RFE = receive framing error. If this bit is a 1, then the character at the input port did not have the correct number of bits when it was received. This bit clears when a word is received without error.

ROR = receiver overrun error. If this bit is a 1, then the character at the input has overwritten the previous word (that is, the previous word was not read out prior to receiving this word).

ODA = output data available. When this bit is a 1, there is a character waiting to be read at the input data port. This bit clears when the input port is addressed.

TBE = transmitter buffer empty. This bit is a 0 during the time that the output port is busy. When it is a 1, data can be presented to the output port.

MSB							LSB
7	6	5	4	3	2	1	0
POLL	CTRL	address 0-63					

The first six bits contain the address of the remote being contacted. The poll and control bits will determine how the data is interpreted as follows:

Bit	7	6
toggle this remote	1	1
poll this remote	1	0
ignore this data	0	x

(x = don't care)

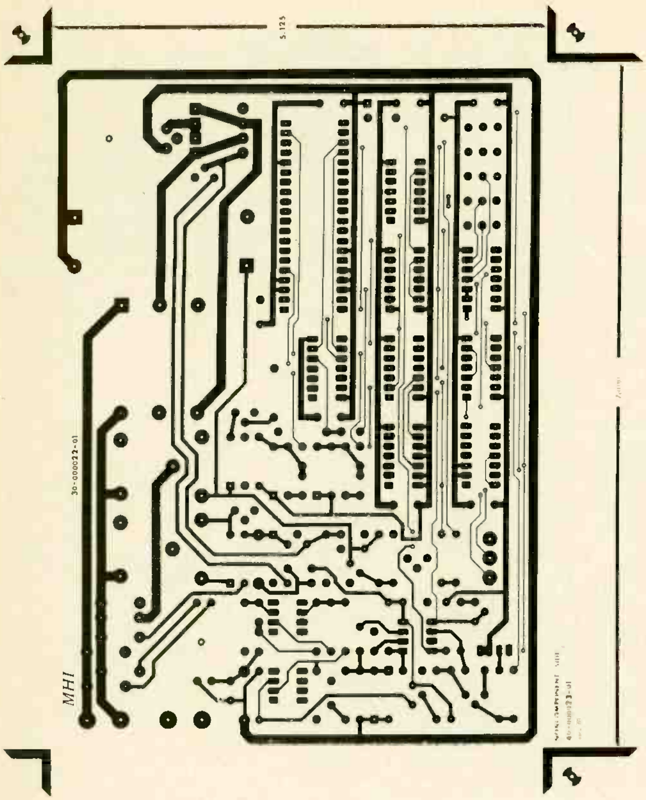
A toggle command will cause the remote to turn on (or off) depending on its previous state. For example, to toggle remote 41 (decimal) output 233 (decimal) to the controller's output port.

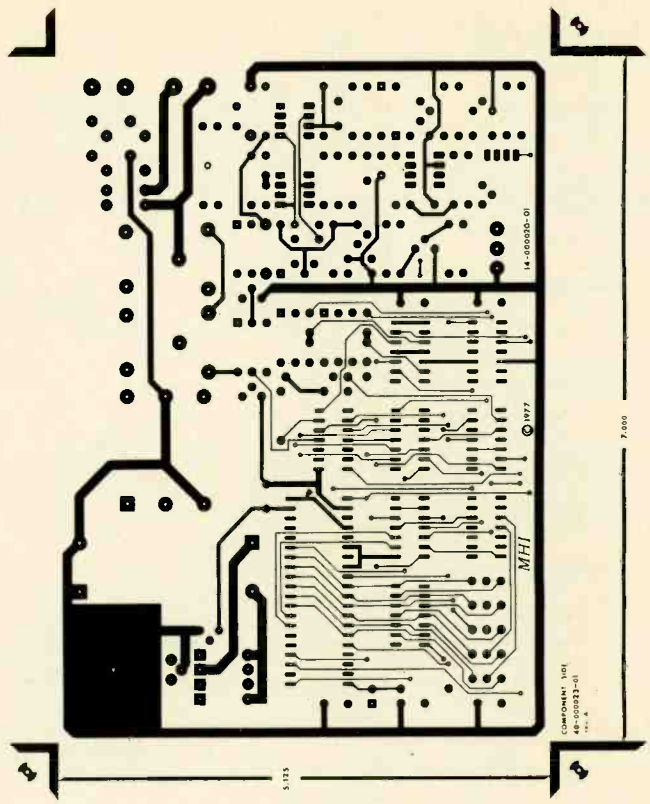
stead of "IC." Sockets may be used for all IC's. Regulator *VR1* is mounted with a conventional heat sink and *VR2* can be mounted directly on the board with the seven transistors. Observe the polarity of the capacitors and diodes and make sure of the orientation of the IC's before installation. Note also that the conductive pot covering transformer *T1* should be electrically isolated from the foil traces beneath it by means of an insulating mica washer.

External wiring is made in accordance with Fig. 8, which shows the connections to be made to the two manual override pushbutton switches and the two sockets to be controlled. These parts are mounted on the rear apron of the selected chassis.

The pc board can be installed in any convenient chassis. If a metal chassis is used, be sure the pc board and other components are well insulated from the metal structure. Keep in mind that there is 117 volts ac on the pc board.

Software. The Intelligent Remote





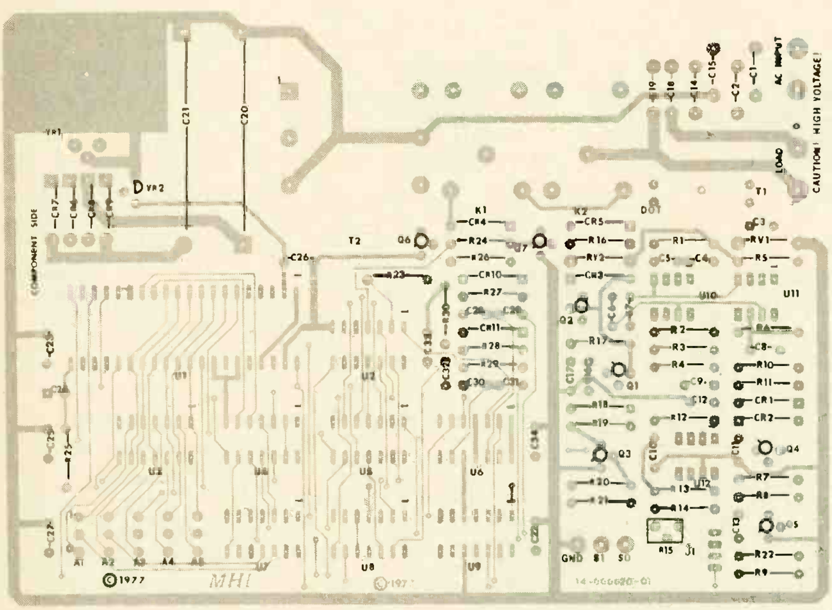


Fig. 7. Etching and drilling guides for the double-sided pc board are shown above half size. Component layout is shown at the left.

Controller is software-oriented to give the user broad flexibility in use. The software set is in two parts: (1) a group of subroutines designed to provide a format for the user to develop software particular to his application, and (2) a program to determine the background error rate and eliminate it. Both programs are written in BASIC for ease of use and are shown in Table II.

Subroutine 1 is a loop that waits for the transmit buffer to clear (TMBT = 1). Several assumptions are made, and the user may have to change these depending on where he has placed his board on the I/O map. These assumptions are: (a) the data input port is jumpered for 5; (b) the data output port is jumpered for 5; (c) the status port is jumpered for 4; (d) the remote is jumpered for addresses 52 and 53.

Subroutine 1 inputs the data at the status port and masks out all but TMBT (which is equal to 16). When TMBT is true, it returns to the main program. If TMBT is false, it remains in the loop to continue the search for a true TMBT.

Subroutine 2 is the polling subroutine that contains a series of conditional loops that wait for a valid response from a specific remote. The following variables in subroutine 2 have these meanings: (a) E is the main error flag and, if this routine returns to the main program with E = 1, then there was an error that could not be corrected within the constraints of this subroutine; (b) P contains the data that is transmitted to the remote plus 128 (bit-7 = 0); (c) X is the data in the status port that is updated during the subroutine; (d) D is the data received from the remote. It is valid when the subroutine returns to the main program, if and only if, E = 0.

Variables C and C1 are the conditional counters that determine how many times the controller is allowed to try for a successful poll of the remote. These variables are absolutely necessary otherwise a failure in the remote (for example, a remote not connected to the power line) would keep the program in the loop and hang up the system.

Subroutine 3, a simple FOR/NEXT loop, is a time waster that keeps data from "bunching up" at the remote.

The main program calls these subroutines to poll each remote and determine its status. It then instructs the remote to change its status and finally checks again to insure that the command was properly executed. The main program keeps track of errors and the number of times the cycle is executed, printing out the error rate every 25 cycles. If the conditional loops in subroutine 2 are set to 1, the user will get a good feel for the number of errors he would experience with no error corrections (line 5030 . . . C>1, line 5100 . . . C1 > 1).

Armed with this knowledge, the user can change the conditional loops until the point of zero errors is reached. Typical error rates with only one pass are 5 to 8%. With this as a background error rate, four passes will make the error rate less than 0.01%.

Errors induced by noise from the ac line are a fact of life. Fortunately, the computer can be taught to recognize and correct errors in transmission. If an error is detected by a remote, it ignores the command. If an error rate exists in response to a poll, it is easily detected.

For example, first test bits 1, 2, and 3 of the status port. If any of these three bits is a 1, then an error has been detected. Read the input port to clear the RDA bit, but ignore the data. If all three bits are 0, then compare bits 0 through 5 with the address polled. They must be the same. If not, re-poll the remote. If the bits are the same, read the poll bit to determine the actual status of the remote.

The actual error rate varies according to operating conditions. The conditions affecting the error rate are as follows: (a) Distance from the transmitter—the farther apart the controller and the remote, the weaker the signal. (b) Many residences are wired with 220-volt, 3-phase power, which means that there are two 117-volt circuits available. The transmitted signal can be detected on the other phase, but greatly attenuated. A 0.01-μF, 600-volt capacitor across the 220-volt line will correct this problem. (c) High-amplitude, wideband noise, generated by older brush-type ac motors, can cause problems. If you can't replace the motors, then you will have to live with the problems. (d) Impulse noise caused by high-current inductive devices (refrigerators, air conditioners, etc.) when they turn on and off is a random factor that can produce single-bit errors. Fortunately, this type of noise is just as rapidly attenuated as the useful digital signal. (e) Triac noise, usually produced by poorly designed light dimmers, can raise the error rate.

The variables in the main program are as follows: (a) A(I) is an array that contains the addresses of all remotes; (b) R(I) is the toggle command for the remote channel and is equal to A(I) plus 128 plus 64; (c) P is the poll command for each remote and is equal to R(I) minus 64; (d) T1 and T2 contain the poll status of the remote before and after it has been toggled; (e) D is the data from the remote; (f) Z is the total number of errors that have been detected. ◇

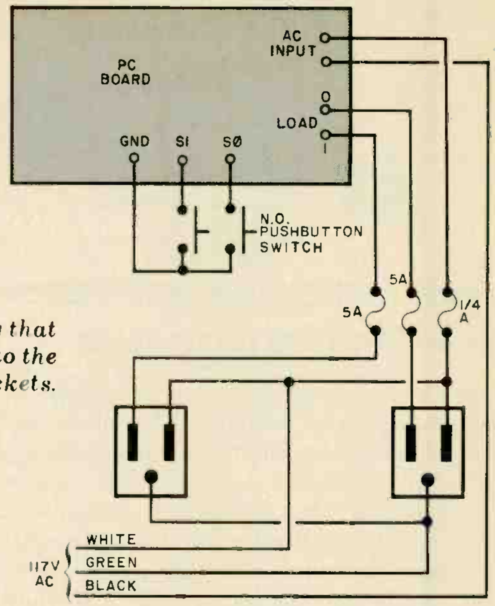


Fig. 8. External wiring that connects the pc board to the ac line and controlled sockets.

TABLE II

Subroutine 1

```
1000 X=INP(4) : IF (X AND 16)=16 THEN
     RETURN
1010 GOTO 1000
```

Subroutine 2

```
5000 C=0 : C1=0 : E=0
5010 OUT 5,P : GOSUB 1000
5015 GOSUB 8000
5020 X=INP(4) : IF (X AND 8)=8 THEN
     GOTO 5200
5030 C=C+1 : IF C > 5 THEN GOTO 5100
5040 GOTO 5020
5100 C1=C1+1 : IF C1 > 5 THEN GOTO
     5150
5110 GOTO 5010
5150 REM you can put an error flagging
     routine here
5160 E=1 : RETURN
5200 D=INP(5)
5210 IF(X AND 7) > 0 THEN GOTO 5100
5230 IF (D AND 63) <> (P AND 63) THEN
     GOTO 5010
5240 RETURN
```

Subroutine 3

```
8000 REM time waster
8010 FOR N=1 TO 15
8020 N1=N1+1
8030 NEXT N : RETURN
```

Main Program

```
10 DIM R(2),A(2)
20 A(1)=52 : A(2)=53
30 FOR I=1 TO 2
40 R(I)=A(I)+128+64
45 P=R(I)-64
50 GOSUB 5000 : REM Call the polling
   routine
55 Z=Z+E
60 T1=(D AND 64)
70 IF E=1 THEN GOTO 50
80 OUT 5,R(I) : GOSUB 1000
90 GOSUB 8000 : REM time waster
100 GOSUB 5000
105 Z=Z+E
106 IF E=1 THEN GOTO 150
110 T2=(D AND 64)
120 IF T2=T1 THEN GOTO 80
130 CO +CO+1 : REM CO counts the num-
    ber of times through the loop
135 IF CO/25 <> INT(CO/25) THEN
    GOTO 150
140 PRINT "CYCLES =";CO;" ERRORS
    =";Z;" % =";(Z/CO)*100
150 NEXT : GOTO 30
```

Solid State

By Lou Garner

THE MICROWAVE CHALLENGE

IT WAS once considered quite a job to design and build a circuit operating at frequencies as high as 500 MHz. Today, however, one can buy off-the-shelf equipment capable of handling the mid-gigahertz range (1 GHz is 1,000 MHz). And it's time electronics hobbyists started investigating the many applications of these solid-state microwave devices.

Loosely defined, the microwave region is considered to be only those frequencies from 1 GHz up, although many engineers feel the term should include all three of the FCC-designated ultrahigh frequency (uhf—300 MHz to 3.0 GHz), superhigh frequency (shf—3.0 to 30.0 GHz), and extremely high frequency (ehf—30.0 to 300.0 GHz) bands. Certainly, the behavior of radiated signals is similar in all of these bands and there is considerable overlap in the techniques used for circuit design and construction. There is little if any difference, for example, in circuits used at 800 MHz and those at 1.1 GHz.

Interestingly, the microwave industry was one of the first to use semiconductor devices commercially—in the form of high-frequency diode detectors—but has not even yet made a complete transition to solid-state designs. There are many commercial all-solid-state microwave test instruments, receivers and other equipment operating above 100 GHz.

From a practical viewpoint, there is virtually no limit to the variety and number of potential solid-state microwave projects for the skilled and determined experimenter, even if these are restricted to low- and medium-power designs. With an appropriate amateur radio license, for example, one can develop and assemble two-way microwave communications systems and model remote control equipment.

Dozens of different and exciting items could be developed for advertising displays, trade shows, school or regional exhibits, Science Fairs, and similar presentations or competitions, including such projects as demonstration radar systems, point-to-point communication links, speed detectors, wireless digital transmission systems, or, with a dash of imagination, perhaps even a working model of a satellite radio relay system. Other possible low-power microwave projects include short-range wireless microphone systems, intrusion and burglar alarms, auto close-approach anti-collision systems, level controls, motion detectors and controls, and vehicle or object identification systems. In addition, as an experimenter becomes more and more involved with microwave designs, chances are he'll want to develop his own test equipment, since commercially manufactured microwave test instruments are quite expensive.

One thing is certain—despite its potential for interesting and exciting projects, the microwave arena is no place for the novice. Offering a genuine challenge to the serious and more advanced hobbyist, it requires much of the knowledge of a trained engineer, and the precise skills of a master machinist, with patience and attention to detail.

If you accept the challenge, you'll have to put forth some extra effort. You'll have to be willing to develop most of your own projects "from scratch," for there are few, if any, "easy-to-build" microwave project kits. You'll have to be willing to dig into such standard reference books as *Microwave Integrated Circuits* by Jeffrey Frey (published by Artech House, Inc., a subsidiary of Horizon House-Microwave, Inc., 610 Washington St., Dedham, MA 02026) and to study manufacturers' data sheets and application notes. You'll also have to pay close attention to detail and be willing to try to perfect your designs.

Fortunately, the rewards are equal to the challenge. Not only will you gain the deep satisfaction that comes from completing really tough projects, but you'll enjoy the excitement of working at the forefront of technology. You'll work with power transistors that have strap-type leads instead of pins, such as *Motorola*'s new MRF838, MRF840 and MRF842. Characterized for operation in the 806-947 MHz uhf FM band, this family of devices can deliver from 1 to 20 watts continuous output when operated on 12.5-V dc supplies, furnishing power gains of 6 to 8 dB. You'll work with other transistors no larger than a match head, with tiny strap-type leads arranged like a "T," as shown in Fig. 1. Typical devices in this group are the members of the MP 1000 family of microwave transistors manufactured by *AND* (770 Airport Boulevard, Burlingame, CA 94010). Of these, the MP 1001, MP 1002 and MP 1004 are npn silicon epitaxial planar transistors, while the MP 1003 is a pnp type. The MP 1001 has a maximum frequency of oscillation of 10.0 GHz, typical, and the MP 1004 has a rated f_T of 7.0 GHz. (The series is moderately priced, incidentally. The MP 1001, for example, sells for only $6.00 each in unit quantities.) But this is only the beginning. Waiting in the wings are some *really* high-frequency devices. Scientists and engineers of the Musashino Division of Nippon Telephone and Telegraph's Electronic and Communications Laboratories in Japan have developed a prototype GaAs FET with a *maximum oscillation frequency of 100 GHz!*

On the discouraging side, most gallium-arsenide (GaAs) mi-

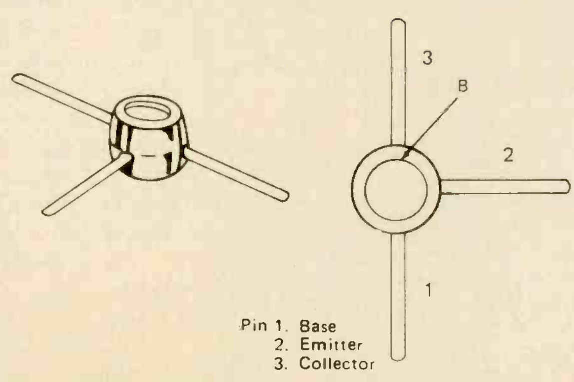


Fig. 1. Sketch of "micropill" transistor.

crowave FET's are somewhat expensive, even though manufactured with a semiconductor material similar to that used in low-priced light emitting diodes (LED's). TI (Texas Instruments, Inc., P.O. Box 5012, Dallas, TX 75222), for example, offers a family of GaAs MESFET's at unit prices ranging from $60.00 each for the MS801 to $250.00 each for the MS803. But the latter device is a real workhorse, capable of delivering a minimum of *1 watt output at 8 GHz*, with at least 4 dB gain. Prices are coming down, however, for the MS803 originally was priced at $1,000.00 each!

Other major semiconductor manufacturers also have made recent cuts in the prices of their microwave transistors. Varian Associates (611 Hansen Way, Palo Alto, CA 94303) has slashed the price of its VSX 93505, a 2-to-26 GHz FET, from $150.00 to $115.00 each. The AFT 2000, a low-noise FET rated past 12 GHz manufactured by Aertech Industries (825 Stewart Drive, Sunnyvale, CA 94086) has been chopped down from $105.00 to $75.00 each. Hewlett-Packard's Microwave Semiconductor Division (1501 Page Mill Road, Palo Alto, CA 94304) has recently reduced the price of the HFET-1000 from $142.00 to $99.00 each. Intriguingly, the new lower prices for microwave transistors closely approximate the prices originally charged for the first commercial transistors.

In addition to new types of transistors, you'll find yourself working with a variety of unusual components. There are diodes that seem to be special-purpose screws and semiconductor devices that look much like small pills or cartridges. You'll learn to install leadless capacitor chips that have to be handled with tweezers and soldered by their edges. You'll encounter and use devices with strange and intriguing names—TRAPATT, IMPATT, pin, nip, Gunn, step recovery, and Schottky barrier diodes, varactors and YIG's. Of these, the TRAPATT, IMPATT and Gunn diodes exhibit the equivalent of a "negative resistance" characteristic and are used extensively in microwave oscillators. Pin and nip diodes are used for switching and in attenuators, modulators and limiters. Schottky barrier diodes are used as switches, mixers and detectors. Varactors are voltage-variable capacitors used for tuning and in frequency multipliers, harmonic generators etc.

The YIG's are perhaps the most fascinating of all the devices you'll meet. Solid state, but *not* semiconductors in the usual sense, they are found in microwave circuits as tiny, highly polished spheres of single yttrium-iron-garnet crystals (hence the acronym, YIG). Exhibiting a property known as ferrimagnetic resonance, they serve in filters, oscillators and amplifiers. In practice, r-f input and output coupling loops are arranged at right angles to each other around the YIG sphere, with a strong magnetic field applied at right angles to both. Normally, there is little or no coupling between the two loops. At a specific frequency, however, determined by the strength of the magnetic field, there is a strong interaction between the loops, with substantial r-f energy transfer possible. The YIG, then, acts as a selective coupling element which can be tuned by varying the strength of its applied magnetic field. They may be used between two amplifiers as a tuned filter or between the input and output of an amplifier or negative resistance device to form an oscillator. If a varying magnetic field is used, one can frequency-modulate the oscillator's output or sweep a band of frequencies. YIG's are effective at frequencies into the mid-GHz range.

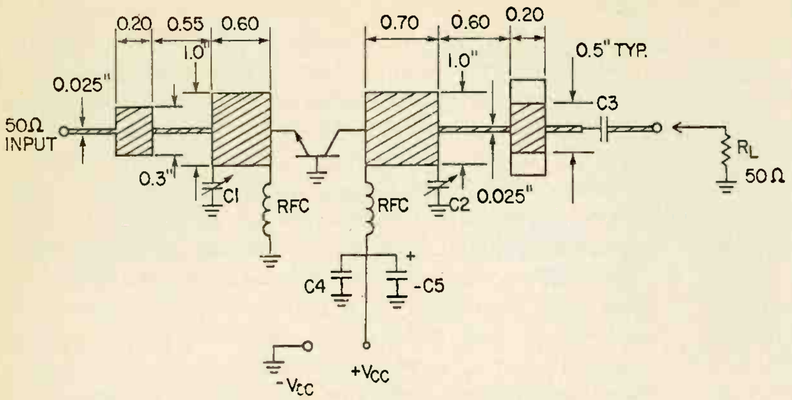


Fig. 2. A microstrip microwave amplifier test circuit.

As you increase your knowledge of microwave technology, you may want to start working with resonant cavities. These are circuit elements which are fabricated using the skills of a precision machinist rather than those of an electronics technician. At the beginning, however, you'll probably confine your projects to those using *stripline* or *microstrip* circuitry. A stripline is essentially a single conductor transmission line supported above a fixed ground plane. In its simplest form, it is a thin conductor etched on one side of a double-clad circuit board, with the unetched side serving as the ground plane. By varying the width of the line at different points, one can create effective circuit elements and match impedances.

A representative stripline microwave amplifier circuit layout is shown in Fig. 2. Suggested as a test amplifier for their DME375 and TSP400 microwave transistors by the Communications Transistor Corporation (301 Industrial Way, San Carlos, CA 94070), the circuit is assembled on a Duroid microstrip line with a 10-mil dielectric, type D-5880. Either the DME375 or the TSP400 may be used in the circuit without modification. Capacitors *C1* and *C2* are 0.6-to-6-pF variable units, *C3* and *C4* are 82-pF chip capacitors, and C5 is a 200-μF, 50-volt electrolytic. The circuit is designed for operation on a 50-volt dc power supply. The nominal operating frequency is 1090 MHz (or 1.09 GHz), although it can be used as low as 1.02 GHz and up to 1.15 GHz with the DME375. If operated as a pulse amplifier (10 μsec at a 1% duty cycle), the circuit can deliver a peak output of nearly 400 watts to a 50-ohm load.

So, if you're bored with computer technology, turned off by the popularity of CB, and have achieved near perfection in your audio designs, try the microwaves for *a real challenge*.

Reader's Circuit. You may have been intrigued by Harold Wright's *Model Railroad Sound Synthesizer* in last December's issue but would rather tackle something a little simpler for a start. If so, you might like to try the inexpensive model train steam whistle circuit shown in Fig. 3. Submitted by reader Ralph O. Bentley (606 Lake View, South Milwaukee, WI 53172), the circuit requires only two active devices, an LM389 IC and a small general-purpose npn transistor, *Q1*. Designed for operation on a standard 12-volt dc source, the circuit can be assembled on perf board. The LM389 was described in our September, 1976 "Solid State" column. Manufactured by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051), the device comprises three uncommitted general-purpose transistors and a ten-transistor low-power audio amplifier in an 18-pin DIP.

Ralph has used two of the IC's uncommitted transistors as RC phase-shift audio oscillators, coupling their outputs to the input of the audio amplifier section at pin 16. The remaining transistor is diode-connected and used as a white-noise generator, with its output applied to external transistor *Q1*, where the noise signal is amplified and applied back to the audio amplifier section through another capacitor. Each phase-shift oscillator can be individually "tuned" with a 50k potentiometer, with a common 100k potentiometer serving to establish tonal balance. The amplifier's gain is controlled by a potentiometer connected between pins 4 and 12. Capable of delivering up to 500 nW to a 16-ohm PM loudspeaker, the amplifier provides ample output for most uses.

Standard components are used in the design. Except for the potentiometers, all resistors can be either one-quarter or one-half watt types, at the builder's option. The electrolytic, which

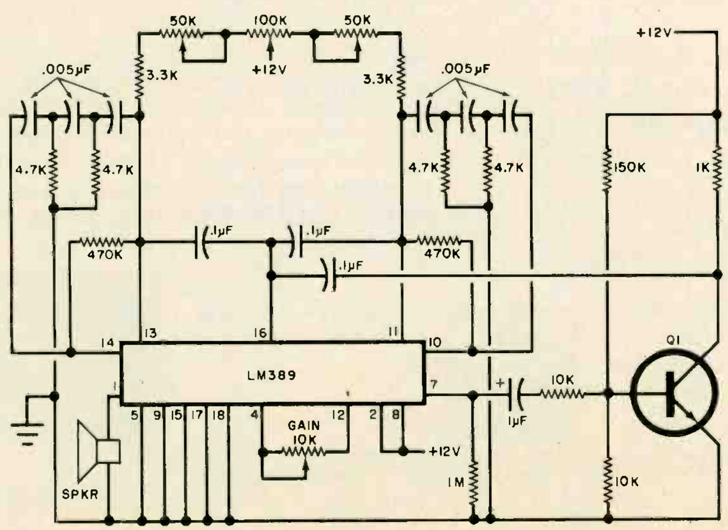


Fig. 3. Inexpensive circuit for a model train steam whistle sent in by a reader.

should be a 15-volt unit, is identified by a polarity sign, while all other capacitors can be either low-voltage ceramics, tubular paper, or plastic-film types. A spst pushbutton control switch should be connected in series with one of the power leads.

After assembly and the customary check for possible wiring errors or accidental shorts, one minor adjustment is required before the unit is ready for use. With the power on, advance the 100k potentiometer until the signals from both oscillators can be heard through the loudspeaker, readjusting the gain control if necessary. Adjust the individual 50k pots until zero beat is achieved or until a single low-frequency tone can be heard. Afterwards, adjust for the desired tonal balance using the 100k pot alone.

Device/Product News. If you're in to high-power projects and price is no object, RCA's Electro-Optics and Devices group (Route 202, Somerville, NJ 08876) has a new family of silicon power devices that should really turn you on. Dubbed *Transcalent* devices, the new units have heat pipes bonded directly to the semiconductor wafers, and feature high current capabilites, high blocking voltages, light weight and small size. The *Transcalent* family currently comprises three series of devices: the P95000EB 250-A rectifiers with blocking voltages to 1200 V, the P95200EE4 100-A npn transistors, and the P95400EB 400-A thyristors (SCR's) with blocking voltages to 1200 V. Potential commercial applications for the devices include welding control, induction heating, electroplating, vehicular drives, heavy-duty power supplies, and motor speed control—wherever high voltages and high currents must be controlled.

Motorola Semiconductor Products, Inc., (P.O. Box 20912, Phoenix, AZ 20912) has introduced a new breed of transistors with improved power handling capabilities. Identified as *Powerbase* devices, the transistors feature a unique "base spreading resistance ring" which produces more uniform current flow through the epitaxial-base region, thus reducing destructive "hot spots." Offered in standard TO-3 packages, the new *Powerbase* units include the 2N3055H, the MJ5015, the 2N3773, and the 2N6609, with the latter two devices an npn/pnp complementary pair.

Motorola also has announced a new quad linear IC which combines two different functions in a single package. Designated type MC3405/3505, the unit comprises two operational amplifiers similar to type MC3403/3503 with a pair of dc comparators similar to type LM339/139. Supplied in 14-pin DIP's, the MC3405 has a specified operating temperature range of 0°C to +70°C, while the identical (electrically) MC3505 is specified for −55°C to +125°C.

National Semiconductor Corporation has developed a series of 2.5-volt reference IC's that perform as if they were zener shunt regulators. The result is a 2.5-volt reference diode that can be used as either a positive or negative reference device and which features an adjustable breakdown voltage and temperature coefficient. Identified as the LM136/236/336 series, the units operate over an input current range of 300 μA to 10mA. When trimmed to operate with a minimum temperature coefficient, the LM336, typically, has a variation of only 2.5 mV over the commercial temperature range, and is guaranteed 6 mV, maximum. The dynamic impedance of the LM136 series is a low 0.6 ohms, maximum. Although basically 2-terminal devices, the series includes an optional third terminal for trimming to precise application requirements. The devices are supplied in 3-lead TO-46 metal packages, with the LM336 also available in a TO-92 plastic package. ◇

Experimenter's Corner

By Forrest M. Mims

THE SCHMITT TRIGGER

THE SCHMITT TRIGGER is a bistable (two-state) circuit with several useful applications, including threshold detection, signal conditioning, and sine-to-square wave conversion. In this column, we'll look at some practical circuits after we've learned the Schmitt trigger's operating principles.

Fig. 1 shows how you can make a Schmitt trigger from two of the inverters in a 7404 IC or half of a 7400 quad NAND gate. The Schmitt trigger consists of the two logic elements and resistors *R2* and *R3*. Voltage divider *R1* provides a variable input voltage to the Schmitt trigger, and the LED indicates when the circuit has triggered.

If we assume *R2* is disconnected from the wiper of *R1*, what happens? The TTL gates we're using interpret an open input as a logic 1. Therefore, the first gate inverts the logic 1 to a logic 0, the second gate inverts the 0 to a 1, and the LED turns on.

Now let's connect the wiper of *R1* to *R2*. When *R1* is adjusted so that *R2* is at or near ground, the logic state at the input to the first gate is logic 0. Therefore, the LED turns off.

As *R1*'s wiper approaches the positive supply, an increasingly positive voltage is applied to the input of gate 1. The output of this gate will switch from 1 to 0 when the input voltage exceeds the logic 1 threshold. However, *R3* provides a negative feedback voltage which requires that the input voltage from *R1* rise somewhat beyond the logic 1 threshold before the output of gate 1 changes states. When this happens, the output of gate 2 immediately switches from 0 to 1 and the LED turns on.

When the wiper of *R1* approaches ground, positive feedback voltage from *R3* requires that the input voltage from *R1* be somewhat lower than that which normally switches the output of gate 1 from logic 0 to 1. When the output of gate 1 goes high, the output of gate 2 immediately switches from 1 to 0 and the LED turns off.

The result of this feedback path is two distinctive switching voltages for the circuit. The LED turns on at one voltage, and then turns off at another, somewhat lower, voltage.

These switching points are called *trip* or *threshold* points. The region between them is called the *hysteresis zone*. Fig. 2 shows how the hysteresis zone looks when the circuit's response is plotted on a graph. The hysteresis of a Schmitt trigger is important because it prevents unwanted oscillation. If the two switching points were identical, the circuit would tend to oscillate when the input was at or near the switching voltage.

You can build the circuit in Fig. 1 on a solderless prototyping breadboard in a minute or two to observe its operation.

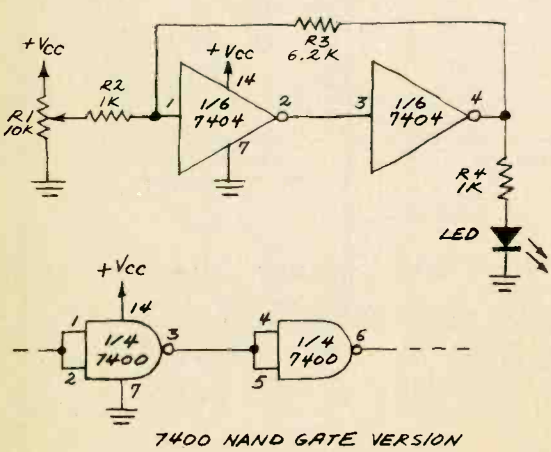


Fig. 1. A basic two-inverter Schmitt trigger.

Connect a voltmeter between the wiper of *R1* and ground so you can measure the trip voltages. Then rotate the potentiometer's shaft so the wiper approaches ground. The LED will go off.

As you slowly rotate *R1* in the opposite direction, the LED will suddenly switch on and the meter will read about 1 volt. When you rotate *R1* back toward ground, the LED will switch off when the meter reads about 0.5 volt.

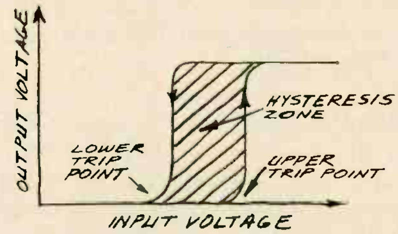


Fig. 2. Hysteresis curve for a Schmitt trigger circuit.

Here are the exact trip voltages I measured using the components shown in Fig. 1 and a 5-volt power supply:

Trip Voltages	7400	7404
ON	1.12	1.08
OFF	.47	.58

The 7413 Dual Schmitt Trigger. Several TTL and CMOS Schmitt triggers are available. One low-cost TTL IC is the 7413 dual Schmitt trigger. You can buy this 14-pin DIP for less than 50 cents (only a quarter per trigger!)

Recently, I used one of these handy chips to perform two completely different operations in a digital controller circuit. One of the Schmitt triggers was connected as a variable frequency oscillator to provide a clock for the controller circuit. The other was used as a threshold buffer for a phototransistor at the input of the controller. Let's look at both these applications.

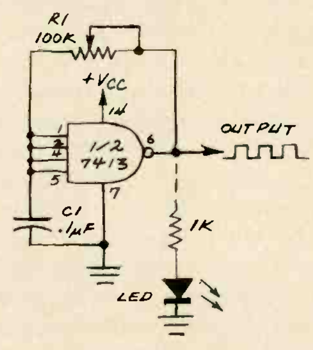
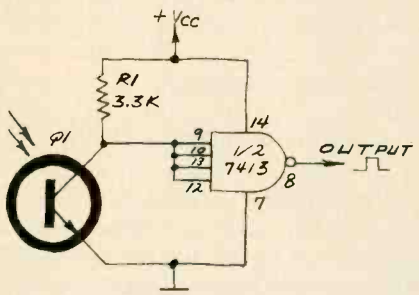


Fig. 3. Connecting one of the two triggers in the 7413 as an oscillator to provide pulses.

Schmitt Trigger Oscillator. Fig. 3 shows how to connect one of the two Schmitt triggers in the 7413 as an oscillator that provides a reasonably stable source of pulses with fast rise and fall times. The frequency of oscillation and the pulse width are determined by *R1* and *C1*. With the values shown, the pulses have an amplitude of 2 volts, a width of 25 microseconds, and a rise time of less than 100 nanoseconds. The oscillation frequency can be varied from a low of 70 Hz to a high of about 300 kHz by adjusting *R1*.

Increasing *C1* to 100 microfarads will reduce the frequency of oscillation to a few Hertz, making the circuit useful as a light flasher or visual logic indicator. For the latter application, remove the connection to pin 1 and replace it with a suitable probe. When the probe is floating or connected to $+V_{CC}$, the LED will flash. When it's connected to ground, the LED will glow continuously.

Schmitt Trigger Threshold Buffer. Using the other half of the 7413 as a threshold buffer for a phototransistor is illustrated in Fig. 4. Assume the light



Q1—ANY NPN PHOTOTRANSISTOR

Fig. 4. Using half of a 7413 as a threshold buffer for a phototransistor.

reaching phototransistor *Q1* varies in intensity or flickers. When the light level at *Q1* is high, the phototransistor turns on and provides a low resistance path from the input of the Schmitt trigger to ground. Thus the trigger switches high. When *Q1* is dark, its resistance is high and the low resistance path to $+V_{CC}$ through *R1* forces the output of the Schmitt trigger low. Incidentally, these switching conditions are reversed from those of the two-gate Schmitt trigger in Fig. 1 because the outputs of the 7413 are inverted.

The net result of all this is that the Schmitt trigger cleans up erratic signals and converts them into more easily processed pulses. Fig. 5 illustrates this graphically.

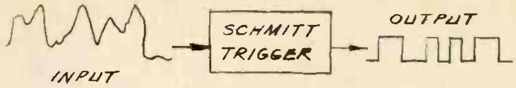


Fig. 5. How a Schmitt trigger cleans up an erratic waveform.

Other Applications. After a little experimentation, you will be able to come up with Schmitt trigger circuits of your own. For starters, try a bounceless pushbutton. Or build a sine-to-square wave converter. You can also try using a Schmitt trigger in some monostable multivibrator applications. Finally, be sure to experiment with Schmitt trigger IC's, such as the 7414 TTL chip with six Schmitt triggers, and the 4093 and 4584 CMOS Schmitt triggers. ◇

Hobby Scene Q&A

By John McVeigh

Have a problem or question on circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

MOTOR SPEED CONTROL

Q. ***Can I vary the speed of a single-speed ac motor by using a variable resistor?—George Crudington, Ellsinore, MD.***

A. I once experimented with slowing down the speed (and noise) of an ac cooling fan motor by inserting various fixed resistors in series with one side of the ac line. I finally selected 450 ohms at 20 watts to obtain an optimum combination of quiet and air moving. Of course, I could have used a rheostat to find this value, and then replaced it with a fixed resistor.

Another way of varying the motor's speed is to use a conventional SCR or triac controller, such as that shown on p. 544 of the *1977 Radio Amateur's Handbook*. This controller can be used with fixed speed drills to get the benefit of variable speed.

However, there is one caveat that must be mentioned. If you slow down the motor too much, you will damage it—unless it is impedance-protected. Unless the motor is turning fast enough, it won't develop a sufficient back emf. This will result in excessive current through the motor windings and reduced motor life.

12-VOLT POWER SUPPLIES

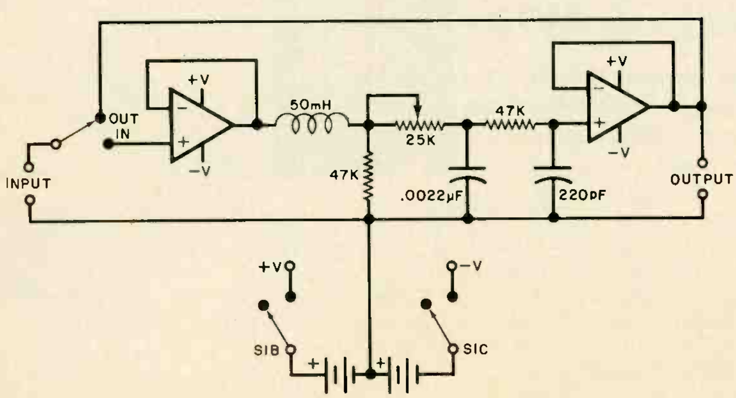
Q. ***Why do most "12-volt" power supplies and battery chargers actually have an output of 14 volts?—David W. Kraeuter, Washington, PA.***

A. These line-powered dc supplies are generally rated at 13.8 volts output so that they can closely simulate the output of an alternator driven by an auto engine. The alternator output (nominally 13.8 volts) is somewhat higher than that of the battery (12 volts) so that the alternator can force current through the battery from positive to negative, thus charging it. If the alternator output were at the same potential as the battery output, no charging action would occur.

SCRATCH FILTER

Q. ***I need a scratch filter to attenuate the surface noise on my old 78-rpm records.—H.A. Dobson, Orangeburg, SC.***

A. Try the circuit shown here. It is a continuously variable passive filter with op amp buffers at the input and output. The filter rolls off at 18 dB/octave and will provide cutoff frequencies between 6000 and 15,000 Hz. The setting of the 25,000-ohm potentiometer determines the exact cutoff frequency. A dual op amp such as a 747 can be used. Two 9-volt batteries can be used as a power source. You can insert the filter between the system's preamp and power amplifier or in the preamp's tape monitor loop.

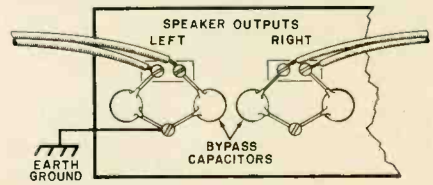


AUDIO RFI

Q. ***My stereo contains no tuner, but the ham who lives up the street comes in loud and clear. The signal is not affected by the volume control. How can I stop this?—David Sluiter, Grand Haven, MI.***

A. You are experiencing audio rectification. That is, the r-f signal is being picked up by a wire (probably the speaker leads) and introduced to the circuitry somewhere past the volume control. It is then detected or demodulated into an audio signal by a diode, transistor junction, or possibly even a poor metal-to-metal connection. Once the signal is demodulated, it is amplified along with the program material you are listening to and delivered to the speakers.

The r-f signal can also enter via the power cable, path cords, or in severe



cases can be picked up directly by wiring within the amplifier or preamp if the components are not completely shielded. Signal leads can be consecutively unplugged to determine the r-f entry path.

In your case, I suspect the speaker leads. Disconnect them, but monitor the amplifier output through headphones. Wrap up the headphone cable to reduce its length. If the RFI has stopped, install 0.001-μF disc ceramic capacitors from each side of the speaker outputs to the chassis and ground the chassis as shown here. If the RFI persists, remove the line cord from the wall socket. If the RFI stops immediately, that's how it's getting in. You can prevent this by installing a 'brute force' line filter. If it fades away as the capacitors discharge, the r-f is entering via another route.

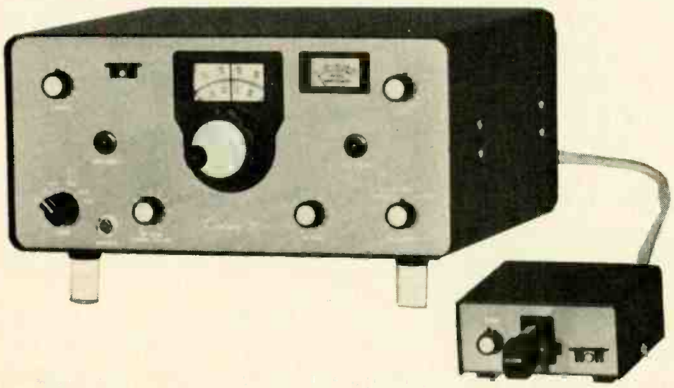
In cases where the volume control affects the interference, the signal is entering at an earlier stage. Remove one input patch cord at a time until the r-f stops to determine the r-f entry point. Shielding the patch cord with a grounded copper braid, or installing small bypass capacitors, ferrite beads, or r-f chokes at the appropriate input jacks.

By all means notify the ham that you are experiencing RFI. Although he is not obligated to help you, he often will cooperate by setting up a series of test transmissions and by giving you some technical advice.

Product Test Reports

TEN-TEC CENTURY/21 HAM CW TRANSCEIVER

Sophisticated, solid-state transceiver for the Novice.



THE Ten-Tec Century/21 solid-state CW transceiver is specifically designed with the Novice in mind. Even so, it has features normally found only in more expensive and sophisticated communication gear. It will not become obsolete as the Novice upgrades. In fact, it can well serve the old timer as a CW transceiver and SSB receiver.

The transceiver features 70 watts of final input power and full coverage of the 80- through 20-meter Amateur bands. Coverage of 15 meters and 1-MHz segment of the 10-meter band is provided by three optional plug-in crystals. It has the same linear tuning rate over each 500-kHz band segment and offers a choice of 2.5-, 1.0-, or 0.5-kHz selectivity. Other features include r-f and audio gain controls; offset receiver tuning; instant QSY with broadband r-f circuits on receive and transmit to eliminate retuning; class-AB power amplifier with individual low-pass filters for each band to minimize harmonics and TVI; full break-in; adjustable-level sidetone; electronic switching; automatic overload protection; transmitter input-power meter; transmitter zerobeating facility; internal, regulated power supply; built-in speaker and phone jack; crystal calibrator accessory socket; and 12-volt dc outlets for other accessories.

The transceiver measures 12⅜"W × 11⅜"D × 5¾"H (31.4 × 29 × 14.6 cm) and weighs 18½ lb (8.4 kg). The Century/21 comes with crystals for the 3.5-, 7-, and 14-MHz bands for $289. Optional crystals for the 21-, 28-, and 28.5-MHz bands are available at $5.00 each.

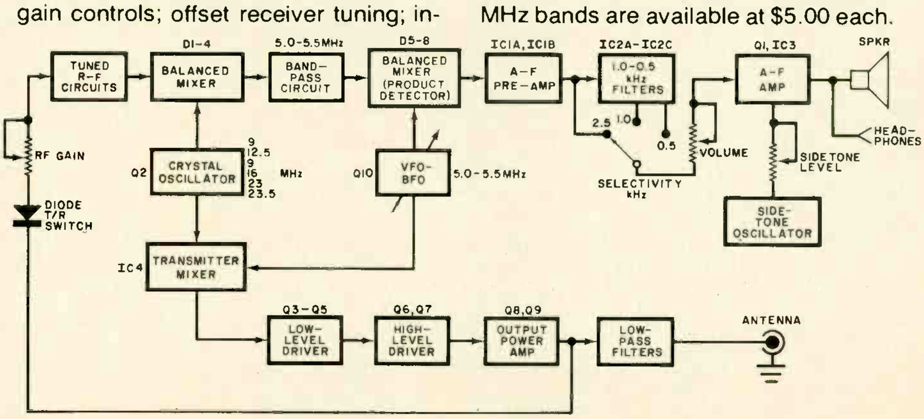


Fig. 1. Block diagram shows "double-direct conversion" design of transceiver.

Technical Details. A block diagram of the transceiver is shown in Fig. 1. Input signals are applied to the receiver mixer via individual double-tuned circuits (using toroid-wound inductors) for each band. At the mixer, the input signals are heterodyned with a crystal-controlled local-oscillator signal of 9, 12.5, 9, 16, 23, or 23.5 MHz to produce an i-f between 5.0 to 5.5 MHz over the respective bands of 3.5 to 4.0 MHz, 7.0 to 7.5 MHz, 14.0 to 14.5 MHz, 21.0 to 21.5 MHz, and 28.5 to 29.0 MHz. The difference frequencies are used for the lower two bands, while the sum mixtures of the frequencies are used for the latter four bands.

The mixer uses a balanced four-diode design that minimizes unwanted outputs from the input signal and the local oscillator. It also has superior signal-handling capabilities. The r-f gain control is a potentiometer that functions as a variable attenuator in the antenna circuit.

The output from the mixer passes through a 5.0-to 5.5-MHz bandpass filter to a second mixer where it is heterodyned with a 5.0- to 5.5-MHz variable-frequency oscillator (vfo) signal, producing an audio-frequency beat note. This mixer operates as a product detector, with the vfo acting as a beat-frequency oscillator (bfo).

Selectivity is obtained by audio filtering that eliminates beat notes beyond a specific range of frequencies. The audio-frequency signal is then amplified to a usable audio level.

Three degrees of selectivity are produced as follows. The 2500-Hz bandwidth is obtained by shaping the response of a two-stage IC preamplifier. The 1000-Hz bandwidth is obtained with an active bandpass filter. And the 500-Hz bandwidth is obtained with two additional cascaded active bandpass filters in the same IC.

Ten-Tec has dubbed the receiver a "double direct-conversion" design. It is similar to a single-conversion superheterodyne but with selectivity obtained in the audio stages rather than at the i-f. Another difference is that the signals are tuned by the bfo at the product detector, as in the conventional direct-conversion receiver, instead of using the local oscillator for this purpose.

The usual direct-conversion receiver eliminates the i-f and applies the signal directly to the product detector. The disadvantage of this approach is that the operating range of the vfo/bfo must be shifted for each band. It therefore must often function at high frequencies, where stability problems are aggravated. Also, it is very difficult to produce a direct conversion receiver with a constant, linear tuning rate on each band.

The vfo/bfo in the Ten-Tec Transceiver is a permeability-tuned oscillator (pto). It is adusted by varying its frequency-determining inductance with a movable powdered-iron core instead of using a tunable capacitor. The use of an inductor yields excellent tuning linearity and enhances stability.

Offset tuning for the receiver shifts the frequency approximately ±5 kHz. It is always active in receive. When transmitting, it is automatically disengaged whenever the key is pressed or the transmitter's zerobeating feature is being used.

The transmitter signal is generated by premixing the output from the vfo with the signal from the crystal oscillator. The sum or difference frequency as required for each band is selected at the output of the IC premixer by individual fixed, double-tuned circuits that are switched in for each band. A low-level r-f driver feeds a push-pull class-AB power-output stage. Fixed bifilar- and trifilar-wound toroid inductors provide broadband operation over the entire frequency range. No retuning is required when going from band to band.

Separate two-section low-pass filters for each band are switched into the signal path to the antenna to provide attenuation of harmonics and other spurious signals. The filters are in the antenna line in both transmit and receive.

Keying is accomplished through direct-coupled transistor stages that remove the cutoff bias from the high-level driver and power-amplifier stages. Simultaneously, the side-tone oscillator is activated, the front end of the receiver is disabled, and the antenna is disconnected from the receiver input by a PIN diode electronic switch.

An r-f drive control permits adjustment of the output level of the transmitter mixer and is used to set the transmitter input power up to the maximum tolerable by the final transistors. Beyond this point, excessive current is drawn from the voltage regulator and a current limiter immediately shuts down the regulator and removes power from the transceiver. The power switch must then be recycled to place the transceiver in operation again after the shutdown.

Laboratory Measurements. Both the overall gain and the sensitivity peak up somewhat near the center of each range. Sensitivity for a given S/N also depends on the selectivity being used, with the best figures obtained at the 500-Hz bandwidth. Using this setting, we measured between 0.4 and 1.1 μV sensitivity for 10dB (S + N)/N, depending on the band and section of band set up. For 1.0-kHz bandwidth, the variation was 0.6 to 1.5 μV, while for the 2.5-kHz setting, it was 0.8 to 3.0 μV.

The 6- and 60-dB bandwidths for the 0.5-kHz position were 450 Hz (550 to 1000 Hz) and 3200 Hz (300 to 3500 Hz). For the 1.0-kHz setting, they were 975 Hz (425 to 1400 Hz) and 7300 Hz (100 to 7400 Hz). For the 2.5-kHz position, they were 2100 Hz (250 to 2350 Hz) and 12,400 Hz (100 to 12,500 Hz). The overall response in each case is indicated in parentheses and plotted on the graph in Fig. 2.

R-f images from signals at frequencies equal to that of the vfo plus that of the local oscillator crystals appeared when the 3.5- and 7-MHz bands were used. The same was true on the higher bands at the vfo minus the local oscillator crystal frequencies. Image rejection on the 3.5-, 7.0-, 14-, 21-, and 28.5-MHz bands averaged 90, 60, 40, 45, and 45 dB, respectively. The 5.0-to-5.5-MHz i-f signal rejection figures averaged nominally 50, 45, 70, 60, and 80 dB.

We located internal tweets at approximately 3596, 14405, and 21,335 kHz that were equivalent to signal inputs of 0.7, 0.7, and 3.2 μV, respectively.

The maximum audio sine-wave output into 8 ohms was 1 watt at 2.5% THD at 1000 Hz. However, with a low-frequency beat from signals greater than 100 μV or at higher audio frequencies with signals greater than 300 μV, heavy clipping and distortion occurred. This is probably due to a lack of agc, which allows overloading at the product detector or the audio preamplifiers, which precede the volume control in the circuit.

Third-order r-f intermodulation (IM) products of 1 μV were produced by two equal-amplitude signals spaced 25 kHz apart at levels 62 dB above 1 μV (−45 dBm or 1300 μV). The 1-dB desensitization of a desired signal occurred with an undesired signal displaced 25 kHz at a level 75 dB above 1 μV (−32 dBm or 5600 μV).

The output power from the transmitter averaged 40 watts in the CW portion of the 3.5-MHz band, 39 watts on 40 meters, 35 watts on 20, and 36 watts on 15 and 10 meters. Maximum input power was 70 watts on the two lower bands and 60 to 65 watts on the three higher bands.

Oscilloscope observations of the keying waveform indicated fairly steep rise and fall times, with a slight rounding off at the crest of the leading edge. No overshoot was noted. Audibly, keying was a bit on the hard side but soft enough to hold down key clicks. By spectrum analyzer measurements, the key clicks were 55 dB down at ± 3 kHz from the carrier frequency and more than 60 dB down at greater than ±5 kHz using both low- and high-speed keying.

The full break-in (QSK) worked excellently. There were no delays, missed first dots, or shortened first dashes

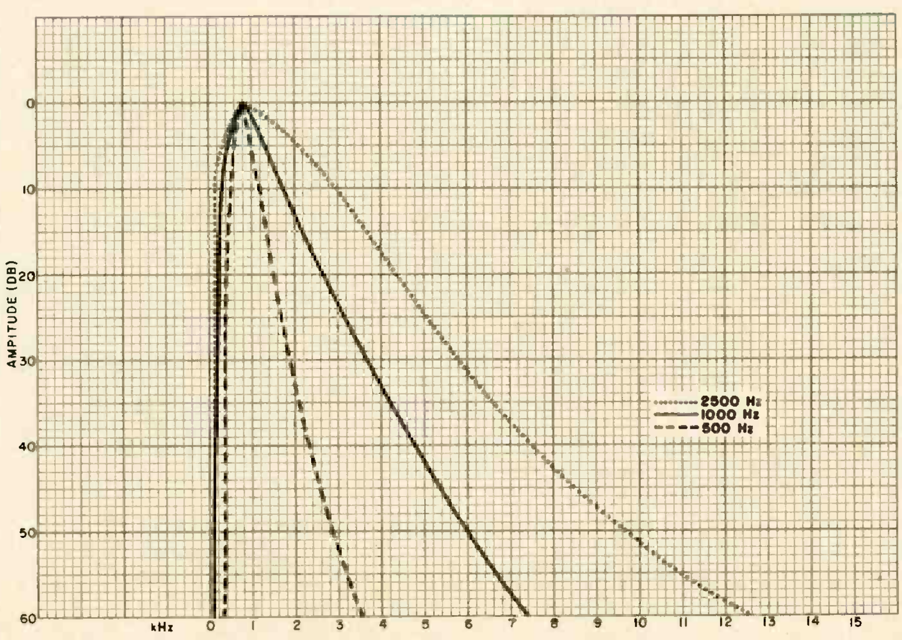


Fig. 2. Response curves of the active audio filters in the Century/21.

which occur with keyed vox (semi-break-in systems). The sidetone, which is not quite pure sine wave (most sidetones aren't) had a nominal frequency of 450 Hz. A unique twist here is that a slight but audibly undetectable delay is built into the sidetone system to eliminate key clicks at the speaker and also at the headphones.

Starting at an ambient temperature of 80° F (27° C), the frequency of the transceiver drifted 100 Hz after the first 30 minutes of operation and averaged 200 Hz/hour thereafter.

User Comment. The Century/21 is housed in a textured, black vinyl-finished, two-piece aluminum cabinet. Snap-up/down wire bales at the front of the enclosure allow the transceiver to be tilted up or placed horizontally. The tuning knob is large and has a fingertip recess for high-speed operation. About 17 revolutions of the tuning knob are required to cover the entire 500-kHz tuning. The operation of the tuning system is very smooth and exhibits no detectable backlash.

The tuning dial is back-lighted, with calibrations in 5-kHz increments that are spaced about ⅛" (3.2 mm) apart on the dial. Because sum- and difference-mixing is employed on different bands, the tuning calibrations go counterclockwise on 3.5 and 7 MHz and clockwise on 14, 21, and 28 MHz. This may be a bit confusing at first, but the confusion rapidly disappears with familiarity. The calibration accuracy was within 2 kHz when set to the nearest 100-kHz point.

Single sideband reception is very easy to obtain with the Century/21, although it is somewhat more difficult to tune in SSB signals with this transceiver than it is with transceivers equipped with sideband filters.

Direct conversion, such as is made at the product detector in the Century/21, can produce an audio image. Therefore, if the receiver is tuned for an audio beat from a desired signal lower than the oscillator frequency, a beat may also appear from an adjacent signal on the upper side of the oscillator frequency. Nevertheless, if this should cause interference, it can usually be eliminated or minimized by tuning for the desired signal on the other side of zerobeat. If the transmitter is set to zerobeat with the desired signal, the above procedure can be performed using the receiver's offset tuning to dodge QRM. We found that this procedure could produce dramatic results.

Since the transceiver has no agc system, when you tune to a very strong signal after listening to moderate-strength signals, your ears will be blasted until you turn down the r-f or audio gain control. Additionally, over-loading with signals greater in strength than 100 to 300 μV can be eliminated by turning down the r-f gain.

Zerobeating the transmitter to the received signal is accomplished by pressing a button on the control panel and simultaneously adjusting the tuning dial for zerobeat with the signal. The receiver can then be shifted for a desirable beat note while using the receiver's offset tuning control without affecting the transmitter frequency. As mentioned earlier, this control can be used to shift the signal to either side of zero beat, depending on which results in the least adjacent-signal interference.

Transmitter tune-up is accomplished by pressing a panel button and trimming the drive control for an indication in the 60-to-70-watt black area on the power-input meter. Advancing the setting beyond this point cuts the power to the transceiver as explained previously. At first this may provide you with a surprise, thinking that you've blown a fuse or damaged the unit.

The transmitter is designed to work into 50-to-75-ohm impedances. If the load is badly mismatched, automatic shutoff may occur below the 60-watt input point. In some cases, particularly where a random-length antenna is used, a matching coupler might be required, tuning it up with a low drive level while using an SWR indicator at the output of the transmitter. Otherwise, no r-f circuit retuning is required for either the transmitter or the receiver when moving from one band to another or when changing frequency within a given band. Only the drive control may have to be reset when you return to transmitting.

The built-in speaker is bottom-facing. Even so, this arrangement appears to present no hindrance to the path of the sound, especially when the transceiver is in its tilted-up position.

The Century/21 has much to offer, making it a good investment for the present and the future with reference to CW operation. Although its power rating of 70 watts input is less than the new Novice regulations permit, it is more than sufficient for plenty of state-side and DX QSO's, as we experienced even with simple antennas.

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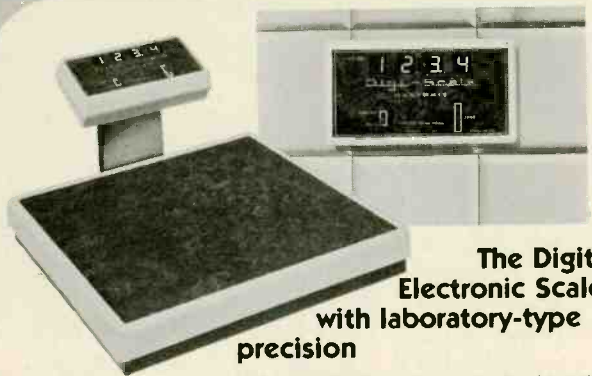

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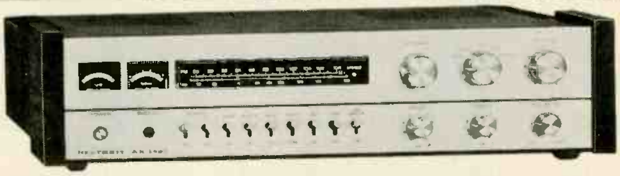

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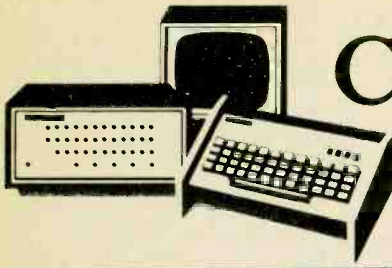


Computer Bits

By Leslie Solomon

MUSIC GENERATORS AND OTHER ITEMS

AS THE hobby computer field keeps growing, many "noncomputer" peripherals are starting to appear. The latest of these is the music generator.

Several music systems are now being offered on the market. We have "played" some of them—the most recent being the $24.50 Music System from Software Technology, Box 5260, San Mateo, CA 94492 (Tel: 415-349-8080). This system has a four-octave range and can produce three notes simultaneously. The hardware is very simple. A small S-100 bus board mounts three resistors and two capacitors; the output drives an audio system. The bulk of the Music System is software, which comes in cassette form with 1200-baud CUTS on one side and 300-baud KC format on the other.

The computer requires 2k of RAM to support the music language and to play any of the six classical pieces (mostly Bach) provided on the cassette. The software includes a multifile editor that supports the standard 8080 source file structure, subroutines required to drive the hardware, and a high-level music language having a one-pass compiler located anywhere in memory.

All standard musical notation is supported, including key signatures, time signatures, clef notation, note values from whole notes to 1/64th notes, rests, dotted notes, triplets, staccato, articulation, and accidentals. There is also a full repeat support with the capability for second endings and refrains and the capability of transposing keys.

Interestingly, you do not have to be a musician to learn how to score music (your own or from sheet music). And, if you are a musician, you do not have to be a computer expert to use the system. It is that easy.

How does the Music System sound? With the original board, about the closest we can get is a reed-organ. However, experimenting with various forms of filters to create different sounds, we've emulated some really strange "synthesizer" sounds.

Remote Control. Not long ago, we discussed a simple tone-system remote control that could be used over existing power lines. This, as you know, was followed by the Intelligent Remote Controller features in our December 1977 and January 1978 issues.

There is still one area of concern, however. What do you do when there is no common ac line between the controller and the remote device to be controlled? We encountered this problem recently. A little investigation led us to the Neil Henson Co., 1 Elmwood Lane, Westport, CT 06880 (Tel: 203-226-4482). This firm sells a small handheld transmitter that's powered by a conventional 9-volt battery and operates in the 300-MHz band. The associated receiver can be located 100 ft away from the transmitter and still have reliable control. As purchased, the system (Model AT-100 Remote Control Switch at $39.95) has only one controlled power socket.

Since the transmitted signal is a tone, and the receiver uses tone demodulation, it is not difficult to install a couple of extra tone generators in the transmitter and some companion tone filters (the 567 works fine here) in the receiver. Each tone detector can then control its own power socket.

Although the transmitter and tone generator are turned on manually in the original circuit, an address decoder or some other form of digital signal can be used to turn on the different tones (and transmitter) from a computer.

Speaking of using the ac line to carry digital remote control information, Energy Technology, Inc., 1601 South Main St., Las Cruces, NM 88001 (Tel: 505-526-3358) has just announced their Coby 1 system. This stand-alone remote control uses an 8085 processor and features solid-state 7-segment readouts to indicate the time, date, and number of the remote unit being programmed. It has 24 keys to provide complete programming, review, and control. Each master control can direct the activity of 100 remotes. Each remote can be turned on or off at any time and date, in cycles as short as a second or as long as 100 hours. Each control contains 2k of RAM, 2k of ROM, the 8085 processor, a power cell and firmware operating system. The power cell backup keeps the clock and memory up during power failures or when moving the system.

Programming requires no knowledge of computers or computer languages. The remotes are available in three basic styles: standard 117 volts for conventional lights and appliances; standard wall-switch replacement; and 220 volts for high-power systems. The controls sell for $399 and each remote (10-A models) is $40 each.

CRT Monitors. Many computer enthusiasts have "real" CRT monitors, but an even larger group uses a conventional TV receiver and some type of r-f modulator to inject a signal into the antenna terminals.

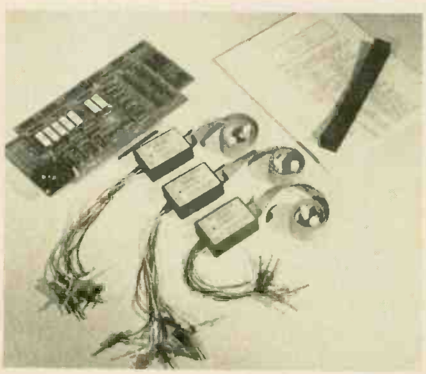
Recently, we had an opportunity to try

The Coby 1 Control has 24 keys to provide remote control information.

out the Super Mod-2 ($29.95 plus $1 postage/handling) from M & R Enterprises, Box 61011, Sunnyvale, CA 94088. The package comes as a built and tested modulator and r-f section tuned to channel 3, a 60-dB antenna isolation switch, and the necessary video and r-f coaxial cables. Power requirements are 6 to 12 volts dc at 2 mA. The r-f output is 800 microvolts into 75 ohms. The modulator is dc coupled and will accept a 0-to-2-volt video signal. Input impedance is 2.2 kilohms. The power and video cables are equipped with ferrite rings to reduce the level of extraneous signals that produce chromatic "worms" on the screen.

We tested Super Mod using the chroma output from our computer driving a conventional color-TV receiver. Despite the fact that we live in a very strong TV signal-strength area, the modulator performed quite well. The viewed image was stable, and the modulation and sync were excellent. Modulation level can be adjusted via an on-board level control. Flipping the 60-dB switch allows the TV receiver to operate in its normal mode. (Note: FCC rules require that modulators and/or isolation switches be approved together with the equipment with which it is to be used.)

New Hardware Things. Databyte Inc., Box 14, 7433 Hubbard Ave., Middleton, WI 53562 (Tel: 608-831-7666) recently introduced their 24-channel logic analyzer for the S-100 bus having 256-by-24 data sets, 10-MHz clock, and TTL logic level inputs. It can be used to disassemble a program exactly as it was executed, with triggering display formatting and operational modes controlled by the user input device. The trigger word is 16 bits; and the readout, on a CRT terminal, is in binary or hex. It has post-trigger, pre-trigger, or any trigger within 256 points. The monitor requires



Databyte analyzer, probe assemblies and tape monitor.

4k of the user's memory. The kit price is $495; assembled, $595. Included are three probe assemblies, system monitor on paper tape, and a comprehensive instruction manual.

If making S-100 prototype boards is part of your hobby, then you should take a look at what E & L Instruments, Inc., 61 First St., Derby, CT 06418 (Tel: 203-735-8774) has to offer. Their latest entry is an S-100 board that mounts three E & L Breadboarding (the solderless variety) and other sockets around the board. There is also a 22-lead edge connector on the top for interfacing. Each board is equipped with a +5-, and ±12-volt regulators as well as pads for obtaining unregulated voltages. Price is $75 per board.

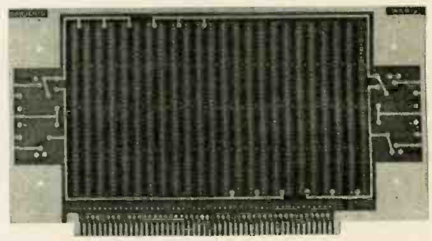
S-100 board for prototyping mounts E & L breadboards.

Another firm making S-100 prototyping boards is Sargents Dist. Co., 4209 Knoxville, Lakewood, CA 90713. This board has space for four regulators and can accommodate 14-, 16-, 18-, 24-, and 40-pin wire-wrap sockets. Maximum density is 48 sockets. Price is $25.

For all you SS50 (SWTP) fans, the Personal Computing Co., 3321 Towarwood, Dallas, TX 75234 (Tel: 214-620-2776) is now making available two sizes of prototype boards for the SS50 bus—I/O or memory sizes. The cards can be used with Wire-Wrap or wiring pencil, and Molex-type edge connectors are used. Memory-size boards are $19.95 and the I/O size is $9.95 (both postpaid). This company also has an ACI-33 Cassette Interface for the SS50 system, or for use with any RS232 output port that also supplies +5 and ±12 volts. Price is $59.95 assembled.

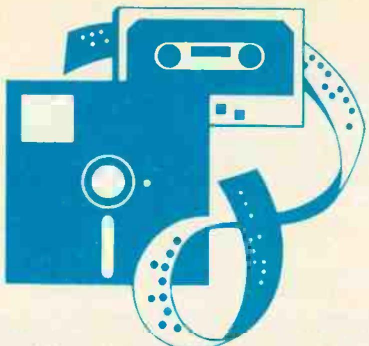
Xitex, Box 20887, Dallas, TX 75220 (Tel: 214-350-5291) has released its Model SCT-100 Video Terminal that plugs into the S-100 bus. The display features 64 characters by 16 lines, 128 character set, ASCII/baudot operation (20- and 60-mA loops), full cursor control, an on-board power supply, and a modified RS232 serial port. It can also be used as a stand-alone terminal. Video output is 1.5 volts into 75 ohms. At this writing, kit price is $135, partial kit (Mostek 3870 processor, character generator, crystal, pc board, and documentation) $79. Assembled and tested, the price is $179.

CQ CPU. Polaris Computer Systems, 3311 Richmond Suite 200, Houston, TX 77006 (Tel: 713-527-0348) offers a Morse code to S-100 bus interface board. The input connects to the communications receiver through the headphone jack and to the computer through a parallel port. Provisions for audio and visual sync are available. The software adjusts for variations in the transmissions between 5 and 60 wpm. Final output is to an SIO port for display on a printer or CRT. Price is $95 for the kit, object program, and documentation. Assembled and tested price is $145.



Sargents' prototype S-100 uses sockets for Wire Wrap.

Software Doings. It looks like a lot of people are jumping on the SWTP SS50 bus these days. Technical Systems Consultants, Box 2574, W. Lafayette, IN 47906 (Tel: 317-742-7509) is now making available its TSC Multi-User System, enabling four terminals to simultaneously use one SWTP 6800-based machine, all running separate programs. The board plugs into a memory slot and no machine modifications are required. When installed, simply load up the BASIC cassette and go! Suggested retail price is $129.95; including the pc board, all parts, IC sockets, diagnostics, and documentation. The BASIC is on cassette. There are two versions of 8k BASIC for the TSC system. One version supports AC-30 Cassette Interfaces—one for each user—while the second version supports the Southwest Technical Mini-Floppy. ◇



Software Sources

8080 FORTRAN. FORTRAN-80 is a compiler for 8080 and Z-80 systems. Includes most features of ANSI standard FORTRAN X3.9-1966, except for double precision and complex data types. Versions now available for MITS DOS, CP/M and ISIS II floppy-disk operating systems. The system also includes some non-ANSI features, such as logical variables, logical DO loops, mixed-mode arithmetic, hex constants, logic operations on integer data, and read/write end-of-file or error conditions. FORTRAN-80 can compile several hundred statements per minute in one pass, and usually needs less than 16k memory. A relocating assembler and loader are included. Manuals available for $15 ($20 with relocating loader); the program itself, with documentation, is $500. Write: Microsoft, 300 San Mateo, N.E., Suite 819, Albuquerque, NM 87108.

6800 BASIC Trainer. Your computer can teach you BASIC with "Learn BASIC" software. There are three packages of 4 lessons each, with lesson plans to coach and prompt you through BASIC commands and programming techniques. Part I, on fundamental commands, requires SWTP BASIC Version 1.02, a copy of which is provided, to run in 12k; Parts II and III run in Version 2.0, available at extra cost. The last 3 of the 12 lessons also cover the MIKBUG operating system. Learn BASIC is available on AC-30 cassette for $14.95 per part and on Smoke-Signal disc for $17.95; all three lessons together, on cassette or disc are $39.95. SWTP BASIC 2.0 can be purchased at the same time for $9.95 on cassette. Write: Computerware Software Systems, 830 First St., Encinitas, CA 92024.

6502 Assembler/Editor. This assembler/text editor for the 6502 processor and others in the family resides in less than 2½k of memory. Assembler is a one-pass type with source file, symbol table and object code resident in memory for greater speed (but with resulting limitations on source file size). Other features include an error message that flags out-of-range branches and a routine that prints the object code and source data on each line during assembly. The program, with source and documentation, is available for $45 on KIM cassette or on paper tape, and as a hard-copy object listing for $35. Write: Micro Software Specialists, Inc., 303 Place, Suite 40, 3301 E. Pioneer Pkwy., Arlington, TX 76010.

Enhancement for PT Software Package #1. Software Package 0.5 adds several features to Processor Technology Software Package #1 (itself available from Processor Technology or Tarbell). New features added include automatic inspection of line numbers, line-number re-ordering, multiple-section assembly from program source code files on tape, octal as well as hex assembly, extensible command table, new pseudo-operands (including ASCII text entry), global symbol table, and Tarbell/Dajen tape driver. The package may also be loaded in 6k PROM. Basic hardware requirements are 8080 or Z-80, with 12k memory. Source code and explanation are $14.95; with object code on paper tape, $19.95; with object code on Tarbell cassette, $24.95. Write: Objective Design, Inc., Box 20325, Tallahassee, FL 32304.

BASIC Games. *Enigmas–1*, a book of computer games from the B. Erickson catalog, is available for $8. Games included are "Gone Fishing," "Concentration" (for two players), "Craps," "Slot-Machine," "Starship," "Sherlock Holmes" and "Tank Attack." The programs have been written to run under Altair 4k or 8k and most other BASIC compilers and interpreters. They range in length from 93 lines and 1397 characters to 241 lines, 3315 characters. The games are also available as separate listings ($3–$4). Write: B. Erickson, Box 11099, Chicago, IL 60611.

SC/MP Assembler. A line-by-line assembler for the SC/MP is available as a 4k firmware package. The SUPAK kit includes assembler, paper-tape line editor, and tape-punch programs. $300. Write: National Semiconductor, 2900 Semiconductor Dr., Santa Clara CA 95051 (Att: Hashmukh Patel).

8080-to-Z-80 Program Converter. Standard Intel 8080 assembly-language statements can be converted to equivalent Z-80 statements with a new FORTRAN program designed to run on any FORTRAN-speaking computer, regardless of word length. All required mnemonics and reserved names are provided for, and all required syntax conversions are performed. Other features include detection and flagging of certain 8080 input-statement errors, control of Z-80 output field formatting and output listing controls. Program is $300 when purchased separately ($50 with Microtec's Z-80 cross assembler) including source program on cards, magnetic tape or paper tape and user's manual. Write: Microtec, Box 69337, Sunnyvale, CA 94088.

Why you should buy a digital multimeter from the leader in digital multimeters.

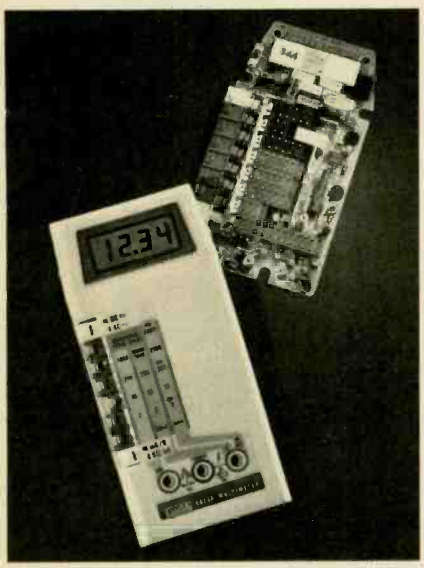
If you're shopping for your first multimeter, or moving up to digital from analog, there are a few things you should know.

First, look at more than price. You'll find, for instance, that the new Fluke 8020A DMM offers features you won't find on other DMMs at *any* price. And it's only $169.*

Second, quality pays. Fluke is recognized as the leading maker of multimeters (among other things) with a 30-year heritage of quality, excellence and value that pays off for you in the 8020A.

Third, don't under-buy. You may think that a precision 3½-digit digital multimeter is too much instrument for you right now. But considering our rapidly changing technology, you're going to need digital *yesterday*.

If you're just beginning, go digital.



Why not analog? Because the 8020A has 0.25% dc accuracy, and that's *ten times better* than most analog meters.

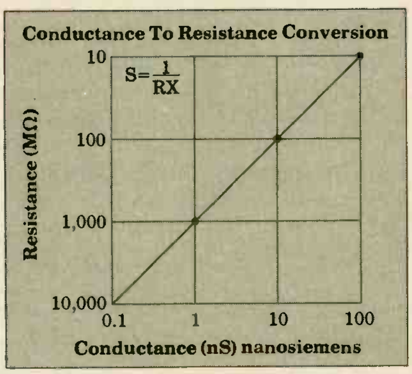
Also, the 8020A's digital performance means things like 26 ranges and seven functions. And the tougher your home projects get, the more you need the 8020A's full-range versatility and accuracy. The 8020A has it; analog meters don't.

If you're a pro.

You already know Fluke. And you probably own a benchtop-model multimeter.

Now consider the 8020A: smaller in size, but just as big in capability. Like 2000-count resolution and high-low power ohms. Autozero and autopolarity. And the 8020A has 3-way protection against overvoltage, overcurrent and transients to 6000V!

Nanosiemens?



Beginner or pro, you'll find the meter you now have can't measure nanosiemens. So what? With the 8020A *conductance* function, you can measure the equivalent of 10,000 megohms in nanosiemens. Like capacitor, circuit board and insulation leakage. And, you can check transistor gain with a simple, homemade adapter. Only with the 8020A, a 13-oz. heavyweight that goes where you go, with confidence.

What price to pay.

$169.*

Of course, you can pay more. Or less. In fact, you could pay almost as much for equally compact but more simplistic meters, and get far less versatility. And, the 8020A gives you the 'plus' of custom CMOS LSI chip design, and a minimum number of parts (47 in all). All parts and service available at more than 100 Fluke service centers, worldwide. Guaranteed, for a full year.

Rugged. Reliable. Inexpensive to own and to operate; a simple 9V battery assures continuous use for up to 200 hours.

Where to buy.

Call (800) 426-0361 toll free. Give us your chargecard number and we'll ship one to you the same day. Or, we'll tell you the location of the closest Fluke office or distributor for a personal hands-on feel for the best DMM value going.

*U.S. price only

Fluke 8020A DMM for Home Electronics Experts: $169

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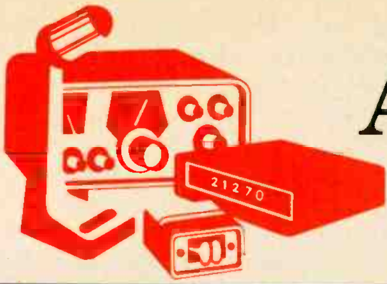

Amateur Radio

THE IDEAL NOVICE HAM SHACK

WHETHER you've earned your Novice license though independent study or an organized training class, you might not know how to get on the air once your ticket arrives. After some on-the-air experience, it's easy to look back and see what *should* have been done in setting up a radio station. But with a little planning beforeheand, you can avoid many commonly made mistakes. Here are some important factors the newly licensed amateur must consider.

Choosing Equipment. There are several routes available to you when it's time to acquire your first rig. You can either buy new, factory-made equipment, buy and assemble kits, build a home-brew station, or purchase used amateur or military surplus gear. Your choice should be influenced by, among other things, your technical knowledge, mechanical ability, and budget.

During the rush of excitement when you first get on the air, what you need most is reliable equipment to ensure many hours of pleasant operating. If you are not an experienced kit builder, you might have problems assembling, troubleshooting, and aligning complex amateur equipment. Used equipment—unless it has been reconditioned—might need tinkering that requires test equipment and technical knowledge. Of course, factory-fresh gear can simply be connected to an antenna and a power source and then used on the air. But new amateur equipment might be beyond your reach financially. In any event, you shouldn't make any equipment decisions without assessing your own resources, both financial and technical. You should also not make any moves without first seeking the advice of an experienced radio amateur.

New Novice Gear. Ten-Tec, Inc. (Sevierville, TN 37862), a well-known manufacturer of ham equipment, has introduced a complete Novice station in one package—the Century/21 transceiver. For $289, you get 70 watts of transmitter input power—enough to project signals to the far reaches of the globe—and a sensitive direct-conversion receiver. The Century/21 offers operation on all frequencies in the 80–, 40–, and 20-Meter bands. Optional plug-in crystals give full coverage of 15 Meters and the 28.0–to–28.5– and 28.5–to–29.0–MHz segments of 10 Meters.

Among the transceiver's features (described fully on page 85) are full break-in keying, broadbanded transmitter circuitry with VSWR and overload protection, receiver offset tuning, built-in speaker and adjustable sidetone, linear crystal-mixed, permeability tuned vfo, and switchable (500, 1000, or 2500 Hz) selectivity. Separate controls are provided for r-f and a-f gain. The use of a Class AB, push-pull final amplifier aids in the suppression of TVI-causing harmonics, as does the insertion of individual low-pass filters in the antenna line by the BAND switch. The optional, plug-in Model 276 Century Calibrator, priced at $29, provides marker signals at either 100– or 25–kHz intervals across the dial.

The transceiver's circuitry is totally solid-state, using transistors, diodes, and integrated circuits. It has no old-fashioned tubes that eat up input power and produce a lot of waste heat. Although the Century/21 can be used to send CW signals only, it receives CW and SSB transmission. Thus, you can listen to the phone bands as an incentive to upgrade.

Many hams prefer separate transmitters and receivers over all-in-one transceivers because "separates" offer more operating flexibility. The new Heathkit twins for Novices form a good beginner's station. The HR–1680 receiver and the HX–1675 transmitter, costing $199 each, are exciting packages, look alike, and offer high levels of performance. The transmitter runs 75 watts input, and the double-conversion superheterodyne receiver can hear the world. They offer full coverage of 80 through 15 Meters, as well as the 28.0–to–28.5– and 28.5–to–29.0–MHz segments of 10 Meters. Ac power supplies are built-in, and external battery operation is also possible. A matching station speaker, Model HS–1661, is available for $19.95 in kit form.

With these radios, all you need are an antenna and a telegraph key to be ready to send and receive Morse code over the airwaves.

Key vs. Keyer. Both the Heath Company (Benton Harbor, MI 49022) and Ten-Tec offer electronic keyers priced at $49.95 and $29.00, respectively, as accessories for their Novice transmitting gear. To use these keyers, you push their built-in paddles from side to side. This causes the electronic circuitry inside to generate Morse dots and dashes of proper durations. Alternatively, you can produce Morse code with a "straight" or manual key as telegraphers have done for a century.

If you first learned to send code with a straight key, you should stay with one during your first on-the-air sessions. Later, when your code speed has increased, you can switch to a mechanical "bug" or an electronic keyer. (Mechanical bugs create dots, but you must make the dashes.) But you should be able to copy perfectly and send with a straight key at a rate of at least 10 wpm before you make the change.

Skywires. With a rig on your shack's operating table and a key at hand, you'll definitely need an antenna. Amateurs use many different antenna designs. A complete discussion of antennas would easily fill a book—and then some. So we can only mention the most common types in passing. For details, refer to the *Radio Amateur's Handbook*, the *ARRL Antenna Book*, or one of the many other publications on this topic.

Most Novices start with the easy-to-build dipole. It's a wire antenna split in the middle and cut to one-half wavelength at the operating frequency. The dipole is fed at the center with coaxial cable (either directly, or for symmetry, through a balun transformer) or balanced transmission line. The dipole, unless it is used with an antenna tuner, can only be easily matched to modern transmitters on the band for which it is cut.

There is one exception to this rule—a fair match is obtained if the dipole is used on odd multiples of the band for which it is cut. This means that a 40-

Meter dipole will also offer a fair match to coax on 15 Meters. If you want to operate on the 80–, 40–, 15– and 10-Meter Novice bands, you'll need three separate dipoles. For economy's sake, you can use one feedline. There will be some interaction between the dipoles, and some trimming might be required.

A dipole can be installed so that the antenna wire and feedline form a "T" by stringing the wire between two trees, poles, etc. Alternatively, you can mount the antenna with one high support at the center so that an "inverted vee' is formed. The inverted vee has two advantages over the flat-top dipole. Because of its shape, the inverted vee requires less real estate for mounting purposes. A full-size 80–Meter Novice dipole is about 126 feet (38.4 m) long—not including the length of end support ropes. In contrast, an 80–Meter Novice inverted vee whose center is 40 feet (12.2 m) high and whose ends are near ground level requires a horizontal run of only 100 feet. Also, the vee generally has a lower angle of radiation than the dipole at a given mounting height, making it more effective in DX work.

If you can't physically put up a dipole (or live in an apartment whose landlord frowns on such installations), consider the end-fed long wire. It's simply a piece of wire as long as possible, fed at one end and worked against ground. A long wire an odd (1,3,5 . . .) multiple of one-quarter wavelength can be connected directly to the "hot" side of the transmitter output jack. A good earth ground is essential to long-wire efficiency. Use a heavy copper wire, and run it from the transmitter chasis to the grounding point as directly as possible. Like any other antenna, the long wire should be as high and as in the clear as possible.

Another antenna popular with Novices is the vertical. It consists of a quarter-wavelength radiator working against earth ground or an artificial ground plane. The vertical is omnidirectional, has a low angle of radiation, and provides a fair to good match for direct coax feed. Multiband verticals made of aluminum tubing are very common. They usually use trap circuits to electrically divorce or connect lengths of tubing so that an electrical quarter wavelength exists on each band. A good ground is necessary if the vertical is to work efficiently. If the antenna is mounted at ground level, the use of radial wires and ground rods improves radiation efficiency. When mounting the antenna above ground, radials are a must.

The most efficient multi-band antenna devised to date is the Zepp. It is similar to dipole in that it is center fed. However, it is made as long as possible and does not have to be cut for any specific wavelength. Balanced transmission line such as TV twinlead or open wire line is used to feed the Zepp. Flat-top or inverted vee configurations are suitable.

In some buildings, "cliff dwellers" are prohibited from putting up any external antennas. That doesn't mean that they can't get on the air. I operate every day with 50 feet (15.2 m) of what was formerly loudspeaker wire run around my apartment. Because the antenna length is not tuned for resonance on any amateur band, an antenna matchbox is used. Alternately called an antenna tuner, matchbox, or transmatch, it is a circuit that allows the transmitter to see the 50-ohm unbalanced (coaxial) output that it is happiest working into.

A transmatch is a very handy device to have, because it performs several useful functions simultaneously. As just mentioned, it allows the transmitter to see a proper load impedance.

Some transmatch designs can substantially attenuate harmonic radiation. A transmatch also prevents strong, out-of-band signals such as those radiated by local AM broadcast stations from reaching the receiver and causing cross-modulation problems. If you are using a Zepp antenna or an indoor or outdoor random-length long wire, a transmatch is a *must*.

Many transmatch designs have been published in amateur radio magazines for home-brewers. Commercial units are also available. MFJ Enterprises (Box 494, Mississippi State, MS 39762) offers two antenna tuners of interest to the Novice. The Model MFJ–16010, priced at $39.95, allows the user to load a random-length, end-fed wire on 160 through 10 Meters at up to 200 watts r-f power output. The Model MFJ–16010ST is a very flexible antenna tuner that covers 160 through 10 Meters, and can be used with coax, end-fed wire, or balanced feeders. It can handle 200 watts of r-f output power and costs $69.95.

To use your antenna tuner effectively or to trim a dipole or end-fed wire for resonance, you should have an SWR meter or directional wattmeter. Either one will give you an indication of how well the antenna is matched to the feedline or if the transmatch is properly adjusted. A directional wattmeter will also tell you how much r-f power your transmitter is producing. SWR meters can only give you a relative indication of r-f output and are less accurate than directional wattmeters, but are much less expensive.

Accessories. There are several items you should have to complete your shack. A 24-hour clock is a must. Hams use what is now called Coordinated Universal Time (UTC), the time broadcast by National Bureau of Standards stations WWV and WWVH. However, many old timers refer to its predecessor, Greenwich Mean Time (GMT or Z). Universal time is on a 24-hour basis, so the day runs from 0000 to 2359.

You should keep your station log in Universal time. Although the Federal Communications Commission (FCC) no longer has strict logging requirements, you'll want to follow the best amateur tradition. Purchase an ARRL logbook (American Radio Relay League, 225 Main St., Newington, CT 06111) for 50 ¢ to keep track of your radio contacts. While you're at it, get a map of the U. S. showing the call areas and a map of the world showing ham call-letter prefixes.

It's also wise to have a telephone nearby. If you have a radio, why do you need a telephone? Well, the landline, as hams call it, will bring quick help from a fellow operator if you're having problems when you first go on the air. Sometimes difficulties crop up and sound advice based on experience is required. Also, traffic handling (carrying messages for nonhams) is a big part of amateur radio. When you get a message for someone in your town who is not a ham, the telephone in your shack will allow you to deliver the radiogram immediately.

To complete your shack, start to assemble a small ham radio library. There will be many occasions when a quick reference is needed. You'll already have the ARRL Manual for studying for ham tickets. Add to that the ARRL Radio Amateur's Handbook, the current edition of the Callbook, and any listings you can find of Q signals, radiogram message codes, and other ham lingo.

If you build your first ham shack around these items, you won't have to add to it for a long time. You'll be on the air with ease and style. When you pass your Technican exam, you can add a transceiver for 2 Meters. And when you get the General ticket, all you'll need is a microphone and an SSB transmitter for voice operation on the low bands. ◇

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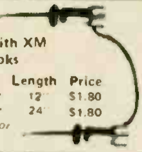

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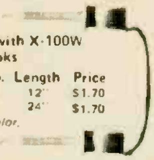

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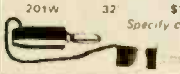

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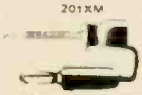

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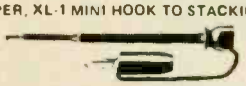

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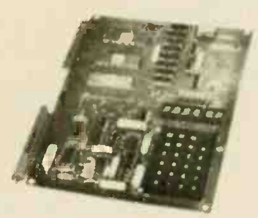

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30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
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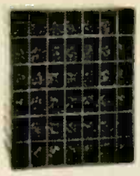

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0015	8/pkg	.01	8/pkg	.056	7/pkg	.33	4/pkg
0018	8/pkg	.012	8/pkg	068	7/pkg	.39	3/pkg
0022	8/pkg	.015	7/pkg	.082	7/pkg	.47	3/pkg
0027	8/pkg	.018	7/pkg	.1	7/pkg	.56	3/pkg
0033	8/pkg	.022	7/pkg	.12	6/pkg	.68	2/pkg
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2N2219	4/1.04	2N3563	6/ .90	2N4124	5/1.00	2N5296	2/1.40	2N6028	2/1.20
2N2219A	3/1.08	2N3565	5/ .90	2N4125	5/1.00	2N5306	3/1.02	2N6034	.92
2N2222A	4/ .96	2N3567	5/ .96	2N4126	5/1.20	2N5322	2/1.40	2N6035	1.00
2N2475	.60	2N3568	4/1.20	2N4228	3/1.20	2N5323	2/1.40	2N6037	.92
2N2484	4/1.20	2N3569	6/1.08	2N4248	5/1.10	2N5366	2/1.00	2N6076	5/1.00
2N2605	2/1.00	2N3638A	5/1.10	2N4249	6/1.08	2N5367	2/1.00	2N6099	.80
2N2647	.95	2N3642	5/1.00	2N4250	5/1.20	2N5369	4/1.04	2N6101	1.06
2N2713	6/ .90	2N3643	5/1.00	2N4258	4/1.28	2N5447	4/1.20	2N6103	1.10
2N2904A	3/1.08	2N3645	5/1.00	2N4400	4/1.00	2N5448	4/1.20	2N6121	2/1.32
2N2905	3/1.02	2N3646	10/1.40	2N4401	4/1.00	2N5449	4/1.00	2N6122	2/1.36
2N2905A	3/1.08	2N3694	5/1.10	2N4416	.90	2N5457	2/1.20	2N6123	.88
2N2906	5/1.00	2N3702	6/1.08	2N4898	1.10	2N5448	2/ .90	2N6124	.80
2N2906A	5/1.05	2N3704	6/1.08	2N4919	2/1.20	2N5484	2/1.20	2N6125	2/1.36
2N2907A	4/1.12	2N3705	6/1.08	2N4923	2/1.40	2N5811	3/1.20	2N6126	.88
2N2924	3/ .90	2N3706	4/1.00	2N5087	4/1.20	2N5817	3/1.20	2N6218	2/1.28
2N2925	5/1.10	2N3707	6/1.08	2N5088	4/1.20	2N5818	3/1.20	2N6219	2/1.20
2N2926	6/ .90	2N3708	5/1.00	2N5089	3/1.20	2N5819	2/ .90	2N6220	2/1.16
2N3053	3/1.08	2N3710	5/1.00	2N5133	6/1.08	2N5822	2/1.16	2N6222	4/1.20
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MS-15	MINISCOPE	$289.00
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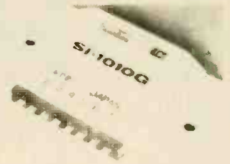
41-141	10 TO 1 PROBE	24.50

Sanken HYBRID AUDIO POWER AMPLIFIERS



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SI-1030G (30W output) . . .	$19.00
SI-1050G (50W output) . . .	$27.80

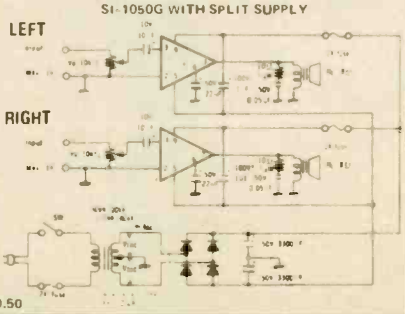
Data Sheet with Application Notes $0.50

TYPICAL CONNECTIONS

SI-1050G WITH SPLIT SUPPLY

LEFT

RIGHT



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16 Pin	.21	.20	.19
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74L$30	.23	74L$139	.70	74L$366	.55
74L$32	.30	74L$151	.65	74L$367	.55
74L$37	.31	74L$153	.66	74L$368	.55
74L$38	.31	74L$154	1.00	74L$386	.39
74L$42	.60	74L$157	$.62	81L$95	.77
74L$47	.75	74L$160	.82	81L$96	.77
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74L$73	.35	74L$162	.82	81L$98	.77
74L$74	.35	74L$163	.82		
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7401	.13	7442	.37	74107	28
7402	.13	7443	.59	74109	.22
7403	.13	7444	.59	74121	29
7404	.15	7445	65	74122	.38
7405	.13	7446	.62	74123	.48
7406	.16	7447	.59	74132	65
7407	23	7448	.60	74141	.70
7408	.17	7450	.13	74145	65
7409	17	7451	13	74150	.88
7410	.13	7453	.13	74151	61
7411	.18	7454	13	74153	61
7412	13	7460	.14	74154	.95
7413	.25	7470	.26	74157	55
7414	61	7472	.21	74161	.55
7416	24	7473	.21	74163	.55
7417	.22	7474	27	74164	85
7420	13	7475	.45	74165	.90
7423	25	7476	.28	74170	1 69
7425	25	7479	5.00	74173	1.10
7426	22	7480	.31	74175	85
7427	17	7481	95	74175	.75
7430	.13	7482	.50	74176	.69
7432	.23	7483	.62	74177	70
7437	21	7485	.75	74180	.65
7438	.21	7486	.26	74181	1.75
7439	25	7489	1.75	74190	.95
7440	.13	7490	40	74191	.95
		7491	.51	74192	.79
		7492	40	74193	.80
		7493	.40	74195	49
		7494	.60	74221	.86
		7495	.60	74251	1 00
		7496	.60	74365	.62
				74366	.62
				74367	.62
				74368	.62

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4008	.79	4030	.22
4009	.37	4035	.98
4010	.37	4040	.99
4011	.16	4049	.34
4012	.16	4050	.34
4013	.29	4051	.89
4014	.74	4052	1.15
4015	.74	4053	.89
4016	.29	4066	.59
4017	.79	4071	.19
4018	.79	4081	.23
4019	.23	4082	.23
4020	.84	4507	.39
4021	.89	4510	1.05
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LM 301AM	.30		
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LM 311N	.85	LM 387N	.69
LM 311H	.90	LM 3900N	.40
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LM 317K	3.70	LM 567M	1.25
LM 318M	1.15	LM 723N	.49
LM 319H	1.25	LM 741H	$ .35
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LM 322H	2.02	LM 747H	.79
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LM 320H-6	1.19	LM 340K-8	1.35
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7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

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74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

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74H00	.33	74H11	.33	74H53	.39
74H01	.33	74H20	.33	74H55	.39
74H04	.33	74H21	.33	74H73	.59
74H05	.35	74H30	.33	74H74	.59
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4002AE	.29	4024AE	1.50
4007AE	.29	4025AE	.35
4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
4019AE	.65	4049AE	.75
4020AE	1.75	4050AE	.75
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75451BP	.39	LM307H	.35	LM747	.90
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LM340K-18	1.95
LM340K-24	1.95
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LM340T0-6	1.75
LM340T0-8	1.75
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10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
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BOSE SPEAKERS

Bose has discontinued their original 301 System. New-Tone purchased the speakers remaining in inventory when the 301 was discontinued, and is offering them at prices that seem impossible. The speakers have been tested with the Bose "Tone Standard" as a reference and have been subjected to the Bose power-handling test which includes both fixed and sweep-frequency testing.
8-Inch Woofer (Bose Part No. 102606) has a free-air resonant frequency of 25-35 Hz., and has a 1.5", 8.5-ounce magnet. The upper tested-frequency is 4000 Hz.
3-Inch Tweeter (Bose Part No. 107376) has a free-air resonant frequency of 1200-1500 Hz., and has an upper tested-frequency of 16.5 kHz. **Supplies are limited.** We urge you to take advantage of these prices and stock up for your future needs.
Sorry, we have no information about the Bose enclosures or the crossover networks, nor do we have more specs. Bose says these data are proprietary information.

8" Woofer NT541 $10.95
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1N4006	1.10	10.00
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2N2160	.65	MU4892	.50
2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
2N4851	.75	2N6027	.55
2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	.35
MU4891	.50	MU20	.40

HARDWARE - SOCKETS

Nylon Screws, Nuts and Rivets - 50 piece assortment		$1.99
MK 20 TO-3 Mounting Kit		5 for $.99
NT-505 Mica and bushing. Specify TO-3, TO-66 or TO-220		10 sets for $.99
IC Socket	14-Pin DIL	$.25 each
IC Socket	16-Pin DIL	$.27 each
Wire Wrap	16-Pin DIL	$.32 each

POPULAR JEDEC TYPES

1N34	.25	2N1540	.90	2N2712	.18	2N3394	.17	2N3856	.20	2N4402	.16
1N60	.25	2N1544	.80	2N2894	.40	2N3414	.17	2N3866	1.25	2N4403	.20
1N270	.25	2N1554	1.25	2N2903	3.30	2N3415	.18	2N3903	.16	2N4409	.20
1N914	.10	2N1560	2.80	2N2904	.25	2N3416	.19	2N3904	.16	2N4410	.16
1N4148	.25	2N1605	1.75	2N2904A	.30	2N3417	.20	2N3905	.16	2N4416	.75
1S1555	.35	2N1613	.50	2N2905	.25	2N3442	1.85	2N3906	.16	2N4441	1.00
		2N1711	.50	2N2905A	.30	2N3553	1.50	2N3954A	3.75	2N4442	1.15
2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35
2N338A	1.05	2N2102	.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.70	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	.60	2N5064	.50
2N508A	.45	2N2218A	.30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20
2N706	.25	2N2219	.25	2N2914	1.20	2N3645	.20	2N4124	.16	2N5133	.15
2N718	.25	2N2219A	.30	2N3019	1.00	2N3646	.14	2N4126	.16	2N5138	.15
2N718A	.30	2N2221	.25	2N3053	.30	2N3731	3.75	2N4141	.20	2N5294	.50
2N918	.60	2N2221A	.30	2N3054	.70	2N3740	1.00	2N4142	.20	2N5296	.50
2N930	.25	2N2222	.25	2N3055	.75	2N3771	1.75	2N4143	.20	2N5306	.20
2N956	.30	2N2222A	.30	2N3227	1.00	2N3772	1.90	2N4220A	.45	2N5400	.40
2N1302	1.25	2N2270	.40	2N3247	3.40	2N3773	3.00	2N4234	.95	2N5401	.50
2N1305	.75	2N2369	.25	2N3250	.50	2N3819	.40	2N4400	.16	2N5457	.35
2N1420	.20	2N2484	.32	2N3393	.20	2N3823	.70	2N4401	.16	2N5458	.30

ALL PARTS GUARANTEED WRITE FOR FREE CATALOG

NEW-TONE ELECTRONICS

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PHONE: (201) 748-6171, 6172, 6173

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COMPU/TIME offers A Real Darn Clever Enhancement to users of IMSAI/ALTAIR Microprocessors

S100 BUS COMPATIBLE

TIME & CALENDAR

COMPU/TIME	CT100	$199 Kit	$245 Assembled
COMPU only	C101	$149 Kit	$189 Assembled
TIME only	T102	$165 Kit	$205 Assembled
COMPU/TIME PC Board only			$ 80

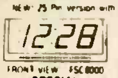
MM16 EPROM

- Utilizing up to 16 2708 EPROMS
- S-100 Bus Computer Systems
- Memory capacity of 8K or 16K bytes by DIP
- 8K boundary addressing by DIP Switch
- 0 to 4 wait cycles by DIP Switch
- Data output, address input lines fully buffered
- Hi-grade glass-epoxy with plated-thru holes
- Epoxy solder masked

$99.00

FCS 8000A — 3½ Digit .8" Display

NEW: 25 Pin version with colon & am pm indicator



FRONT VIEW FSC8000

SPECIAL $3.75 ea.

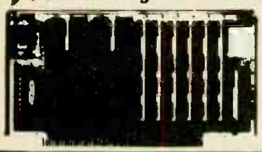
- Connects almost one for one with 3817, 3817A or D ..381? available at $5.00 each
- Typical segment current 8mA except colon 10 hrs b & c and 10 min a & d which are 16 mA
- MAXIMUM FORWARD CURRENT 25 mA
- Forward voltage drop 1.5 volts

Vector SLIT-N-WRAP WIRE WRAP TOOL

- Slits and opens insulation exposing bare wire
- No pre-cutting or pre-stripping
- Comes complete with two 100 ft spools #28 AWG wire

Model P180 $24.50

Vector Plugboards 8800V



Universal Microcomputer/Processor plugboard, use with S-100 bus complete with heat sink & hardware 5.3 x 10 x 1/16"

$19.95

CHANNEL F

Fairchild video entertainment system

$129.95

- Freeze Action • Speed Option
- Automatic time and scorekeeping
- Battery-free AC operation
- Dual controls with 8-way action
- Built-in Pro Hockey and Tennis games
- Easy hook-up on any B/W or Color TV
- Factory warranty

Channel F — additional cartridges — $17.95 ea.

0811 — Tic-Tac-Toe/Shooting Gallery Quadra-doodle/Doodle
0812 — Desert Fox Shooting Gallery
0815 — Spacewar (2 players)
0818 — Magic Numbers (computer logic)
0813 — Blackjack (1 or 2 players)
0814 — Spitfire (1 or 2 players)
0819 — Drag strip (1 or 2 players)
0820 — Maze (2 players)
0822 — Baseball (2 players)

D—SUB CONNECTORS

NO. PINS	PART NO.	PRICE	COVER PRICE
9	DE-9P	1.49	1.25
9	DE-9S	2.15	
15	DA-15P	2.11	1.50
15	DA-15S	3.10	
25	DB-25P	3.00	1.50
25	DB-25S	4.00	
37	DE-37P	4.14	2.00
37	DE-37S	6.00	
50	DD-50P	5.40	2.25
50	DD-50S	8.00	

EDGE CONNECTORS

NO. PINS		TYPE		
20	DUAL	10 PIN	GOLD	$ .50
30	DUAL	15 PIN	GOLD	.75
44	DUAL	22 PIN	GOLD	1.95
44	DUAL	22 PIN	GOLD	2.50
80	DUAL	40 PIN	GOLD	4.95
86	DUAL	43 PIN	GOLD(6800)	5.00
100	DUAL	50 PIN	GOLD(IMSAI/ALTAIR)	4.25
100	DUAL	50 PIN	GOLD(IMSAI/ALTAIR)	4.95
100	DUAL	50 PIN	GOLD(NO EARS-IMSAI	3.50
100	DUAL	50 PIN	TIN (.1" SPACING)	3.25

ALTAIR/IMSAI CARD GUIDES .25¢ EACH

CLOCK CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN	$9.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1 PPS Output	6.95
MM5318-	Video Clock Chip, For Use With (MM5841 - $9.95)	9.95
CT7001	6 Digit, Calendar, Alarm, 12 or 24 Hour	5.85

Wire Wrap

	1-24	25-99	100-999	1K
10	39	36	32	26
14	34	33	31	29
16	36	34	32	30
18	70	60	54	40
20	[illegible]	75	67	55
22	95	[illegible]	72	59
24	95	[illegible]	72	59
28	[illegible]	84	80	71
36	1.40	1.25	1.08	83
40	1.56	1.40	1.20	[illegible]

I C SOCKETS

Lo Profile-Solder Tin

	1-24	25-99	100-999	1K & Up
(8)	15	14	13	12
(14)	25	20	16	14
(16)	25	20	18	16
(18)	28	27	26	20
(20)	34	33	30	239
(22)	36	35	34	28
(24)	36	35	34	289
(28)	44	43	42	367
(40)	60	58	57	493

7400 TTL Series

7400	.18	7443	1.20	74100	1.75	74162	1.90
7401	.20	7445	1.05	74107	.40	74163	1.40
7402	.20	7446	1.05	74109	.45	74164	1.50
7403	.20	7447	.85	74110	.80	74165	1.40
7404	.20	7448	.95	74116	2.00	74166	1.50
7405	.25	7450	.20	74120	1.25	74167	3.00
7406	.35	7451	.20	74121	.55	74170	2.00
7407	.35	7453	.20	74122	.45	74172	9.75
7408	.25	7454	.20	74123	.95	74173	1.60
7409	.25	7460	.20	74125	.55	74174	1.10
7410	.20	7470	.40	74126	.60	74175	1.20
7411	.25	7472	.35	74128	.65	74176	1.50
7412	.40	7473	.40	74132	1.50	74177	.90
7413	.75	7474	.40	74136	1.80	74180	1.00
7414	.70	7475	.70	74141	1.15	74181	2.00
7416	.35	7476	.40	74142	4.00	74182	.90
7417	.40	7479	2.00	74144	4.00	74184	2.00
7420	.20	7480	.69	74145	1.10	74185	2.00
7422	.75	7482	1.50	74147	2.50	74186	12.00
7425	.35	7483	.85	74148	1.75	74190	1.40
7426	.30	7485	1.10	74150	1.00	74191	1.25
7427	.35	7486	.40	74151	1.10	74192	1.10
7428	.40	7489	2.25	74153	1.10	74193	1.10
7429	.40	7490	.55	74154	1.10	74194	1.20
7430	.25	7491	1.10	74155	1.10	74195	1.00
7432	.30	7492	.60	74156	1.10	74196	1.10
7433	.40	7493	.60	74157	1.20	74197	1.30
7437	.30	7494	.85	74158	1.75	74198	1.50
7438	.35	7495	.90	74159	3.80	74199	1.75
7439	.36	7496	.80	74160	1.30		
7440	.20	7497	4.00	74161	1.30		
7441	.75						
7442	.50						

CMOS

34001	.40	4050	.61	4517	8.50	MM74C173N	1.39
4000	.25	4051	1.10	4518	1.65	MM74C174N	1.39
4001	.25	4052	1.10	4519	.90	MM74C175N	1.39
4002	.25	4053	1.10	4520	1.65	MM74C192N	1.71
4004	3.50	4060	3.25	4521	3.25	MM74C193N	1.71
4006	1.40	4061	7.00	4522	1.75	MM74C195N	1.61
4007	.25	4063	2.50	4527	3.00	MM74C200N	10.45
4008	1.25	4066	.85	4528	1.75	MM74C221N	2.93
4009	.48	4067	6.00	4583	1.45	MM74C901N	.84
4010	.48	4068	.35	4584	.75	MM74C902N	.84
4011	.25	4069	.35			MM74C903N	.84
4012	.25	4070	.85			MM74C905N	11.20
4013	.60	4071	.35				
4014	1.25	4072	.35	MM74C00N	.38	MM74C906N	.84
4015	1.25	4073	.35	MM74C02N	.38	MM74C907N	.84
4016	.59	4075	.35	MM74C04N	.38	MM74C908N	3.80
4017	1.25	4076	1.85	MM74C08N	.38	MM74C909N	2.52
4018	1.25	4077	.42	MM74C10N	.38	MM74C910N	10.45
4019	.70	4078	.35	MM74C14N	2.18	MM74C914N	2.18
4020	1.25	4081	.35	MM74C20N	.38		
4021	1.25	4082	.35	MM74C30N	.38	MM74C915N	1.71
4022	1.25	4085	1.35	MM74C32N	.38		
4023	.35	4086	1.45	MM74C42N	1.42	MM74C918N	4.19
4024	1.00	4089	3.00			MM74C922N	5.65
4025	.35	4093	1.75	MM74C48N	2.13	MM74C923N	5.75
4026	2.25	4098	2.50	MM74C73N	.84	MM74C925N	12.00
4027	.60	4160	1.75	MM74C74N	.87		
4028	1.25	4161	1.75	MM74C76N	.84	MM74C926N	12.00
4029	1.50	4162	1.75	MM74C83N	2.00		
4030	.60	4163	1.75	MM74C85N	2.00	MM74C927N	12.00
4032	1.60	4174	1.75	MM74C86N	.99		
4033	2.00	4175	1.60	MM74C89N	6.75	MM74C928N	12.00
4034	3.50	4194	1.80	MM74C90N	1.32		
4035	1.60	4501	.38	MM74C93N	1.32		
4038	1.60	4502	1.75	MM74C95N	1.61	MM80C97N	.84
4040	1.50	4503	1.15	MM74C107N	1.89	MM80C98N	.84
4041	1.45	4506	.70	MM74C150N	5.67		
4042	1.25	4507	1.00	MM74C151N	3.80		
4043	1.20	4508	4.00	MM74C154N	5.67		
4044	1.25	4510	1.75	MM74C157N	3.40		
4045	2.50	4511	2.00	MM74C160N	1.71		
4046	1.95	4512	1.50	MM74C161N	1.71		
4047	2.50	4514	4.75	MM74C162N	2.57		
4048	1.00	4515	4.75	MM74C163N	1.71		
4049	.61	4516	1.75	MM74C164N	1.61		
				MM74C165N	1.61		

74LS00

74LS00	.29	74LS60	.29	74LS151	1.25	74LS196	1.87
74LS01	.29	74LS73	.49	74LS153	1.25	74LS197	1.87
74LS02	.29	74LS74	.49	74LS154	3.65	74LS221	2.00
74LS03	.29	74LS75	.69	74LS155	1.25	74LS240	3.00
74LS04	.29	74LS76	.49	74LS156	1.85	74LS241	3.00
74LS05	.35	74LS78	.65	74LS157	1.50	74LS242	3.00
74LS08	.29	74LS83AN	1.75	74LS158	1.55	74LS243	2.60
74LS09	.50	74LS85	2.25	74LS160	1.95	74LS244	2.60
74LS10	.29	74LS86	.69	74LS161	1.95	74LS247	1.68
74LS11	.40	74LS90	.89	74LS162	1.95	74LS248	1.35
74LS12	.50	74LS92	.89	74LS163	1.95	74LS251	1.91
74LS13	.69	74LS93	.89	74LS164	1.95	74LS253	1.75
74LS14	1.70	74LS95	1.50	74LS165	2.00	74LS257	1.75
74LS15	.40	74LS96	1.89	74LS166	2.00	74LS258	1.95
74LS20	.29	74LS107	.55	74LS168	2.00	74LS259	4.25
74LS21	.40	74LS109	.59	74LS169	2.00	74LS260	.50
74LS22	.40	74LS112	.59	74LS170	4.00	74LS266	.68
74LS26	.39	74LS113	.60	74LS173	2.00	74LS273	2.50
74LS27	.39	74LS114	.60	74LS174	1.87	74LS279	.79
74LS28	.39	74LS122	.60	74LS175	1.95	74LS283	1.85
74LS30	.29	74LS123	1.25	74LS181	3.69	74LS289	6.16
74LS32	.39	74LS124	1.80	74LS189	6.16	74LS290	1.56
74LS37	.48	74LS125	.87	74LS190	2.49	74LS293	1.56
74LS38	.48	74LS126	1.07	74LS191	2.49	74LS295	2.00
74LS40	.39	74LS132	1.25	74LS192	2.25	74LS298	2.00
74LS42	1.20	74LS136	.59	74LS193	2.25	74LS352	1.65
74LS47	1.75	74LS138	1.25	74LS194	1.89	74LS353	1.85
74LS48	1.68	74LS139	1.25	74LS195	1.87	74LS365	.87
74LS51	.29					74LS366	.85
74LS52	.29					74LS367	.87
74LS54	.29					74LS368	.87
74LS55	.29					74LS386	.68
						74LS390	3.00
						74LS395	2.25
						74LS670	3.95

LINEAR

LM300H	1.70	LM702H	.79	LM2111N	1.35
LM301AH	.35	LM703LN	.45	LM2900N	.90
LM301AN	.35	LM703CH	.45	LM2901N	2.95
LM302H	.75	LM709CH	.40	LM2902N	3.00
LM306H	2.50	LM710CH	.60	LM2903N	1.60
LM307H	.55	LM710N	.75	LM2904N	1.60
LM307N	.35	LM711CH	.39	LM2917N	2.00
LM308AH	3.75	LM711CN	.39	LM3046N	1.25
LM308AN	3.00	LM723CH	.55	LM3053N	1.50
LM308H	1.00	LM723CN	.55	LM3064N	1.25
LM308N	1.00	LM725CH	2.50	LM3065N	1.00
LM310H	1.15	LM725CN	3.00	LM3067N	2.60
LM310N	2.00	LM733CH	1.00	LM3075N	1.75
LM311D	2.00	LM733CN	1.00	LM3089N	3.00
LM311H	.90	LM739N	1.19	LM3146N	2.00
LM311N	.80	LM741CH	.35	LM3302N	2.00
LM311N	.80	LM741CN	.35	LM3401N	.80
LM312H	2.70	LM741CJ	.39	LM3900N	.49
LM318H	1.50	LM741CN	.39	LM3905N	.89
LM318N	1.50	LM747CH	.79	LM3909N	.90
LM319N	1.25	LM747CN	.79	LM3911N	1.25
LM321H	3.00	LM748CH	.39	LM4024N	2.75
LM322N	3.00	LM748CN	.39	LM4044N	3.00
LM324N	1.65	LM760CN	3.00	LM4250CH	2.00
LM339AN	3.00	LM1303N	.90	LM4250CN	2.00
LM339N	.99	LM1304N	1.19	LM4558N	.75
LM348N	1.85	LM1305N	1.40	LM5556N	1.75
LM350N	1.00	LM1307N	.85	LM5558N	1.00
LM358N	1.00	LM1310N	2.25		
LM370H	1.15	LM1358N	1.00		
LM370N	2.75	LM1414N	1.75		
LM373N	2.95	LM1458H	1.30		
LM375N	3.00	LM1458N	.59		
LM377N	2.00	LM1468N	2.90		
LM380N	1.05	LM1488N	1.95		
LM380N	1.05	LM1489N	1.95		
LM380N	1.05	LM1496H	.95		
LM381N	1.75	LM1496N	.95		
LM382N	1.75	LM1556N	1.75		
LM386H	.85	LM1596J	2.25		
LM387AN	.75	LM1800N	1.90		
LM387N	.95	LM1808N	2.00		
LM388N	1.25	LM1810N	2.00		
LM389N	1.25	LM1812N	4.00		
NE531T/V	2.00	LM1820N	1.25		
NE550A	1.30	LM1830N	2.00		
NE555V	.39	LM1845N	1.75		
NE556B	1.25				
NE560B	5.00				
NE562B	5.00				
NE565B	1.50				
NE566B	2.00				
NE566T/V	1.75				
NE567V	1.59				

RCA LINEAR SERIES

CA3013	2.15
CA3023	2.56
CA3035	2.48
CA3039	1.35
CA3046	1.30
CA3059	3.25
CA3060	3.25
CA3080	.85
CA3081	2.00
CA3082	2.00
CA3083	1.60
CA3086	.85
CA3089	3.75
CA3130	1.39
CA3140	1.75
CA3401	.49
CA3600	3.50

MICROPROCESSOR CRYSTALS

FREQUENCY	price
1.0 MHz	5.95
1.8432 MHz	9.80
2.0 MHz	5.95
2.097152 MHz	8.50
2.4576 MHz	8.50
2.667 MHz	8.50
3.00 MHz	8.50
3.20 MHz	8.50
3.2768 MHz	8.50
3.579545 MHz	1.25
4.0 MHz	4.95
4.0 MHz	4.95
4.194304 MHz	4.95
4.91520 MHz	4.95

FREQUENCY	price
5.0 MHz	4.95
5.0688 MHz	4.95
5.185 MHz	4.95
5.7143 MHz	4.95
6.00 MHz	4.95
6.144 MHz	4.95
6.40 MHz	4.95
6.5536 MHz	4.95
8.0 MHz	4.95
10.0 MHz	4.95
18.00 MHz	4.95
18.432 MHz	4.95
20.0 MHz	4.95
22.1184 MHz	4.95
27.0 MHz	4.95
36.0 MHz	4.95
48.0 MHz	4.95

FOR PROCESSOR TECH

14.318 $4.95

DIP SWITCHES

4 POSITION	$1.50	7 POSITION	1.80
5 POSITION	1.60	8 POSITION	2.00
6 POSITION	1.70	9 POSITION	2.25
		10 POSITION	2.50

WIRE WRAP CENTER

HOBBY-WRAP TOOL-BW-630

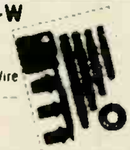
$34.95 (batteries not included)

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)
- Complete with built-in bit and sleeve

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire



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WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

50 ft $1.95 1000 ft $15.00

SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

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- Strips 1" of insulation Specify — Blue-Yellow-White-Red

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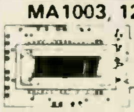

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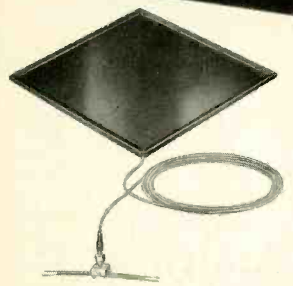

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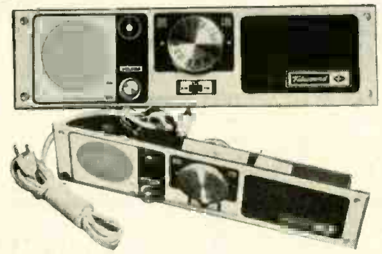

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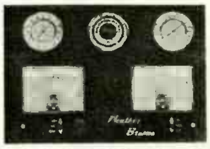

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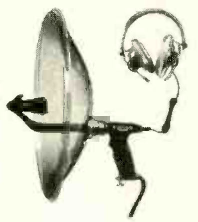

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