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48784

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AK, Puerto Rico — 218-681-6674 FAX — 218-681-3380 TWX — 9103508982 DIGI KEY CORP

INTEGRATED CIRCUITS

7400 TTL

Part	Price
7400N	.35
7401N	.35
7402N	.35
7403N	.35
7404N	.35
7405N	.43
7406N	.48
7407N	.48
7408N	.43
7409N	.43
7410N	.43
7414N	.50
7416N	.35
7417N	.35
7420N	.33
7426N	.35
7427N	.43
7430N	.30
7432N	.35
7437N	.40
7438N	.40
7440N	.48
7442N	.55
7445N	.98
7446AN	.98
7447AN	1.20
7450N	.42
7451N	.48
7453N	.34
7459N	.30
7460N	.34
7473N	.48
7474N	.48
7475N	.50
7476N	.48
7485N	.70
7486N	.48
7489N	7.50
7490N	.55
7493AN	.55
7495N	.63
74107N	.53
74109N	.53
74121N	.60
74123N	.58
74125N	.60
74132N	.75
74145N	1.03
74148N	1.10
74150N	1.58
74151AN	.63
74153N	.63
74154N	1.58
74155N	.60
74157N	.60
74161AN	.75
74164N	.75
74166N	.90
74173N	1.00
74174N	.63
74175N	.63
74180N	.90
74181N	2.50
74182N	1.15
74184N	3.45
74185AN	3.37
74191N	.90
74193N	.90
74194N	.90
74197N	1.05
74251N	1.17
74365N	.65
74367N	.70
74368N	.70
75450N	.70
75451N	.50
75452N	.50
75453N	.50
75454N	.50
75491N	1.00
75492N	1.12
75493N	1.38
75494N	1.38

74LS00 TTL

Part	Price
74LS00N	.32
74LS02N	.32
74LS03N	.32
74LS04N	.31
74LS05N	.32
74LS08N	.32
74LS09N	.32
74LS10N	.32
74LS11N	.32
74LS12N	.32
74LS14N	.45
74LS15N	.36
74LS20N	.32
74LS21N	.32
74LS26N	.32
74LS27N	.32
74LS30N	.32
74LS32N	.32
74LS37N	.33
74LS38N	.33
74LS42N	.60
74LS51N	.45
74LS55N	.38
74LS73AN	.42
74LS74AN	.42
74LS75N	.42
74LS78N	.52
74LS83AN	.66
74LS85N	.66
74LS86N	.39
74LS90N	.51
74LS93N	.51
74LS107AN	.48
74LS109AN	.45
74LS112AN	.45
74LS122N	.68
74LS123N	.63
74LS125AN	.48
74LS126AN	.60
74LS132N	.63
74LS136N	.54
74LS138N	.54
74LS139N	.60
74LS151N	.51
74LS153N	.57
74LS154N	1.44
74LS155N	.60
74LS156N	.57
74LS157N	.54
74LS158N	.54
74LS161AN	.69
74LS163N	.69
74LS164N	.69
74LS169N	1.23
74LS174N	.57
74LS175N	.57
74LS190N	.81
74LS191N	.81
74LS193N	.91
74LS195AN	.78
74LS221N	.93
74LS240N	.66
74LS241N	.66
74LS243N	.66
74LS244N	.66
74LS245	.68
74LS249N	1.24
74LS251N	.60
74LS253N	.60
74LS257BN	.60
74LS258N	.60
74LS279N	.54
74LS283N	.78
74LS290N	.90
74LS293N	.40
74LS352N	1.17
74LS365AN	.54
74LS366AN	.54
74LS367N	.54
74LS368AN	.60
74LS373N	.66
74LS374N	.66
74LS670N	1.44
81LS95N	1.91
81LS96AN	1.89
81LS97AN	1.89
81LS98N	1.89

74S00 TTL

Part	Price
74S00N	.35
74S02N	.35
74S03N	.35
74S04N	.35
74S05N	.35
74S08N	.35
74S09N	.38
74S10N	.38
74S11N	.35
74S15N	.35
74S20N	.38
74S22N	.54
74S30N	.45
74S32N	.46
74S40N	.46
74S51N	.45
74S64N	.45
74S65N	.55
74S74N	.43
74S86N	.45
74S112N	.50
74S113N	.50
74S114N	.82
74S133N	.45
74S134N	.71
74S135N	1.12
74S138N	.88
74S139N	.85
74S140N	.58
74S151N	.85
74S153N	.85
74S157N	.85
74S158N	.85
74S161N	2.38
74S163N	2.38
74S174N	.63
74S175N	.63
74S181N	2.48
74S182N	1.75
74S188N	1.70
74S194N	1.43
74S195N	1.43
74S240N	1.63
74S241N	1.63
74S243N	3.50
74S244N	1.63
74S251N	1.05
74S253N	.90
74S257N	1.30
74S258N	.90
74S280N	1.68
74S283N	1.63
74S287N	2.00
74S288N	1.70
74S373N	1.75
74S374N	1.75
74S387N	1.95
74S472N	4.80
74S473N	4.80
74S474N	4.80
74S475N	4.80
74S570N	3.75
74S571N	3.75
74S572N	4.50
74S573N	5.00
74S940N	3.50
74S941N	3.50

74C00 CMOS

Part	Price
74C00N	.45
74C02N	.45
74C04N	.28
74C08N	.45
74C10N	.45
74C14N	.33
74C20N	.45
74C30N	.45
74C32N	.48
74C42N	1.05
74C48N	1.33
74C73N	.65
74C74N	.63
74C76N	.65
74C83N	1.60
74C85N	1.60
74C86N	.28
74C89N	5.00
74C90N	1.23
74C93N	1.23
74C95N	1.50
74C107N	.65
74C150N	3.98
74C151N	2.60
74C154N	3.98
74C157N	2.60
74C160N	.83
74C161N	.83
74C162N	.83
74C163N	.83
74C164N	1.23
74C165N	1.23
74C173N	.80
74C174N	.55
74C175N	.55
74C192N	1.10
74C193N	1.10
74C195N	.78
74C221N	1.50
74C240N	1.98
74C244N	1.98
74C373N	2.23
74C374N	2.23
74C901N	.55
74C902N	.55
74C903N	.55
74C904N	.55
74C905N	8.25
74C906N	.55
74C907N	.55
74C908N	1.33
74C909N	2.45
74C910N	6.88
74C911N	10.45
74C912N	10.45
74C914N	.95
74C915N	1.63
74C917N	10.45
74C918N	1.60
74C922N	4.23
74C923N	4.23
74C925N	6.38
74C926N	6.38
74C927N	6.38
74C928N	6.38
74C932N	1.23
74C941N	1.98
74C945N	11.25
74C947N	11.25
80C95N	.55
80C96N	.55
80C98N	.55
82C19N	3.98

74HC00 CMOS

Part	Price
74HC00N	.28
74HC02N	.28
74HC04N	.28
74HC08N	.28
74HC10N	.28
74HC11N	.28
74HC14N	.39
74HC20N	.28
74HC27N	.28
74HC30N	.28
74HC32N	.28
74HC42N	.72
74HC51N	.28
74HC73N	.39
74HC74N	.36
74HC75N	.39
74HC76N	.50
74HC85N	.85
74HC86N	.45
74HC107N	.53
74HC112N	.53
74HC113N	.53
74HC125N	.48
74HC126N	.53
74HC132N	.38
74HC133N	.38
74HC138N	.45
74HC139N	.45
74HC147N	.73
74HC151N	.55
74HC153N	.55
74HC154N	1.13
74HC157N	.63
74HC158N	.63
74HC160N	.68
74HC161N	.63
74HC162N	.63
74HC163N	.63
74HC164N	.63
74HC165N	.63
74HC174N	.58
74HC175N	.58
74HC193N	.78
74HC194N	.78
74HC195N	.78
74HC221N	1.10
74HC240N	.75
74HC241N	.75
74HC242N	.78
74HC243N	.78
74HC244N	.75
74HC245N	.82
74HC251N	.80
74HC253N	.65
74HC257N	.63
74HC259N	.75
74HC266AN	.38
74HC280N	.90
74HC299N	1.35
74HC354N	1.10
74HC356N	1.10
74HC365N	.78
74HC366N	.78
74HC367N	.78
74HC368N	.78
74HC373N	.75
74HC374N	.75
74HC390N	.70
74HC393N	.70
74HC533N	.98
74HC534N	.98
74HC564N	1.53
74HC574N	1.10
74HC640N	1.75
74HC643N	1.75
74HC688N	.88
74HC4002N	.28
74HC4020N	.93
74HC4040N	.93
74HC4049N	.70
74HC4050N	.70
74HC4060N	1.10
74HC4075N	.28
74HC4078N	.30
74HC4306	1.64
74HC4514N	1.50
74HC4538N	1.05
74HC4543N	1.37

4000 CMOS

Part	Price
4001BCN	.27
4002BCN	.40
4006BCN	.63
4007CN	.28
4008CN	.65
4009CN	.35
4010CN	.38
4011BCN	.28
4012BCN	.28
4013BCN	.30
4014BCN	.70
4015BCN	.55
4016BCN	.30
4017BCN	.70
4018BCN	.70
4019BCN	.35
4020BCN	.60
4021BCN	.60
4022BCN	.55
4023BCN	.28
4024BCN	.45
4025BCN	.28
4027BCN	.33
4028BCN	.55
4029BCN	.75
4030CN	.30
4031B	.83
4034BCN	1.13
4035BCN	.75
4040BCN	.60
4041CN	.63
4042BCN	.63
4043BCN	.63
4044BCN	.63
4046BCN	.65
4047BCN	.75
4048BCN	.35
4049CN	.33
4050BCN	.33
4051BCN	.55
4052BCN	.55
4053BCN	.55
4060BCN	.58
4066BCN	.33
4071BCN	.28
4072BCN	.50
4073BCN	.28
4075BCN	.28
4081BCN	.28
4082B	.28
4089BCN	1.00
4093BCN	.30
4099BCN	.78
4503BCN	.33
4510BCN	.80
4511BCN	.80
4512BCN	.80
4514BCN	1.08
4515BCN	1.08
4516BCN	.83
4518BCN	.83
4519BCN	.90
4520BCN	.73
4522BCN	.90
4526BCN	1.03
4527BCN	.88
4528BCN	.83
4529BCN	.83
4541BCN	.78
4543BCN	.80
4723BCN	.95
4724BCN	.95

Linear

Part	Price
LF347N	1.20
LF351N	.60
LF353N	1.05
LF355N	1.20
LF356N	1.20
LF357N	1.50
LF398N	2.38
LF411CN	1.05
LF412CN	1.74
LF441CN	.78
LF442CN	1.80
LF13741N	.78
LM10CLN	2.70
LM11CLN	2.55
LM34CZ	6.00
LM35CZ	6.00
LM301AN	.57
LM307N	.75
LM308N	.60
LM311N	.54
LM317K	4.95
LM317LZ	.92
LM317MP	.86
LM317T	.99
LM318N	1.65
LM319N	1.50
LM320LZ 5.0	.72
LM320LZ 12	.60
LM320LZ 15	.72
LM320MP 5	2.25
LM320MP 12	1.90
LM320MP 15	1.95
LM322N	2.40
LM323K	8.25
LM324N	.54
LM325N	5.12
LM326N	6.00
LM327N	3.38
LM329DZ	.81
LM331N	5.25
LM334Z	1.65
LM335Z	2.10
LM336Z 2.5	1.20
LM336Z 5.0	1.20
LM337K	7.65
LM337MP	1.80
LM337T	1.95
LM338K	10.20
LM339N	.51
LM340KC 5	2.10
LM340KC 12	2.10
LM340KC 15	2.10
LM340T 5	.87
LM340T 12	.87
LM340T 15	.79
LM341P 5	.90
LM341P 12	1.00
LM341P 15	.90
LM346N	1.65
LM348N	.90
LM349N	1.35
LM350K	7.50
LM350T	4.95
LM358N	.51
LM359N	2.40
LM380N	1.50
LM380N 8	1.50
LM381N	2.61
LM382N	1.86
LM383AT	4.05
LM384N	2.55
LM386N-1	.81
LM387N	1.65
LM389N	1.38
LM390N	1.32
LM391N 60	2.00
LM391N 100	2.40
LM392N	.75
LM393N	.51
LM395P	2.40
LM395T	3.00
LM395K	10.50
LM396K	21.00
LM555CN	.75
LM556CN	.90
LM565CN	1.95
LM566CN	1.56
LM567CN	1.11
LM709CN	.75
LM723CN	.75
LM725CN	2.70
LM733CN	.84
LM741CN	.51
LM747CN	.72
LM748CN	.72
LM1458N	.54
LM1496N	1.50
LM1800N	1.95
LM1801N	1.35
LM1812N	12.30
LM1830N	2.55
LM1870N	3.00
LM1871N	2.40
LM1872N	2.55
LM1875T	5.25
LM1889N	2.16
LM2900N	1.50
LM2901N	.60
LM2902N	.60
LM2903N	.57
LM2904N	.57
LM2905N	3.90
LM2907N	1.80
LM2907N-8	2.70
LM2917N	2.25
LM2917N-8	2.25
LM2924N	2.61
LM2931Z 5.0	.66
LM2931T 5.0	.95
LM2931CT	1.65
LM3046N	1.35
LM3080N	1.26
LM3086N	.84
LM3089N	2.55
LM3301N	.99
LM3302N	.99
LM3401N	1.02
LM3524N	3.75
LM3900N	.69
LM3905N	1.80
LM3909N	1.50
LM3911N	2.25
LM3914N	2.85
LM3915N	2.85
LM3916N	2.85
LM78L05ACZ	.48
LM78L12ACZ	.54
LM78L15ACZ	.54
LM7905CT	.93
LM7912CT	.96
LM7915CT	.96
LM13080N	1.80
LM13600	1.44
MF10CCN	4.20
AN7805	.75
AN7806	.75
AN7807	.75
AN7808	.75
AN7809	.75
AN7810	.75
AN7812	.75
AN7815	.75
AN7818	.75
AN7820	.75
AN78L04	.43
AN78L05	.43
AN78L06	.43
AN78L07	.43
AN78L08	.43
AN78L09	.43
AN78L10	.43
AN78L12	.43
AN78L15	.43
AN78L18	.43
AN78L20	.43
AN78L24	.43
AN78M05	.63
AN78M06	.63
AN78M07	.63
AN78M08	.63
AN78M09	.63
AN78M10	.63
AN78M12	.63
AN78M15	.63
AN78M18	.63
AN78M20	.63
AN78M24	.63
AN7905	.75
AN7906	.75
AN7907	.75
AN7908	.75
AN7909	.75
AN7910	.75
AN7912	.75
AN7915	.75
AN7918	.75
AN7920	.75
AN7924	.75
AN79L04	.43
AN79L05	.43
AN79L06	.43
AN79L07	.43
AN79L08	.43
AN79L09	.43
AN79L10	.43
AN79L12	.43
AN79L15	.43
AN79L18	.43
AN79L20	.43
AN79L24	.43
AN79M05	.63
AN79M06	.63
AN79M07	.63
AN79M08	.63
AN79M09	.63
AN79M10	.63
AN79M12	.63
AN79M15	.63
AN79M18	.63
AN79M20	.63
AN79M24	.63

Memory

Part	Price
MM2147N	17.50
MM5257N	2.40
74C200N	8.37
74C910N	6.87
74S188N	1.70
74S189N	2.10
74S287N	2.00
74S288N	1.70
74S289N	2.10
74S387N	1.95
74S472AN	4.80
74S473AN	4.80
74S474AN	4.80
74S475AN	4.80
74S570N	3.75
74S571N	3.75
74S572N	4.50
74S573N	4.50

Micro.

Part	Price
COP402N	7.75
COP470N	4.13
COP498N	5.38
COP499N	5.38
DP8212N	3.38
DP8216N	2.75
DP8224N	3.75
DP8226N	2.25
DP8228N	6.88
DP8238N	6.88
DP8300N	6.87
DP8303AN	2.13
DP8304BN	1.88
DP8307AN	3.25
DP8308N	2.74
DP8310N	5.88
DP8311N	5.88
INS8035LN 6	3.50
INS8035N 11	3.38
INS8039N 6	3.25
INS8039N 11	5.63
INS8154N	17.50
ISP 8H352	25.00
MM58167AN	10.63
MM58174AN	10.25
NSC800N	18.25
NSC800 1	9.25
DM8334N	2.25

A/D & D/A

Part	Price
ADC0803LCN	7.38
ADC0804LCN	4.50
ADC0805LCN	5.00
ADC0808CCN	8.13
ADC0809CCN	4.75
ADC0816CCN	18.00
ADC0817CCN	11.25
ADC0833CCN	5.00
ADC1001CCJ	32.00
ADC3511CCN	8.25
ADC3711CCN	8.25
ADD3501CCN	8.88
ADD3701CCN	8.88
DAC0800LCN	1.85
DAC0807LCN	1.58
DAC0808LCN	1.65
DAC0830LCN	6.90
DAC0832LCN	3.88
DAC1020LCN	7.50
DAC1022LCN	5.75
MM5369AAN	1.63
MM5369EST	1.63

Interface

Part	Price
DS1488N	.85
DS1489AN	1.20
DS1489N	.85
75450N	.87
75451N	.70
75452N	.70
75453N	.70
75454N	.70
75491N	1.00
75492N	1.12
75493N	1.37
75494N	1.37

SILICON TRANSISTORS

Digi-Key Part No.	Pac Price
2N3117	1.37
2N3055	1.47
2N3439	1.75
2N3440	1.40
2N3700	1.00
2N3724	1.06
2N3903	.23
2N3904	.23
2N3905	.14
2N3906	.23
2N3962	1.16
2N4030	1.12
2N4032	1.12
2N4033	1.24
2N4036	1.40
2N4037	1.40
2N4123	.23
2N3124	.23
2N4125	.23
2N4126	.23
2N4208	1.25
2N4209	2.10
2N4234	2.10
2N4235	2.30
2N4236	2.30
2N4237	2.30
2N4238	2.30
2N4239	2.30
2N4400	.23
2N4401	.23
2N4402	.23
2N4403	.23
2N4410	.36
2N4896	2.90
2N5086	.28
2N5087	.28
2N5088	.28
2N5089	.28
2N5210	.29
2N5224	.24
2N5225	.23
2N5226	.23
2N5227	.23
2N5320	2.30
2N5321	2.60
2N5322	2.30
2N5323	1.84
2N5400	.31
2N5401	.31
2N5415	1.80
2N5416	2.00
2N5457	.60
2N5550	.30
2N5679	2.55
2N5680	2.50
2N5681	2.60
2N5682	2.60
2N5769	.32
2N5771	1.25
2N5772	.31
2N5830	.65
2N5831	.70
2N5833	.75
2N5961	.51
2N6715	.35
2N6725	.49
2N6727	.35
2N697	1.30
2N718A	1.15
2N1132A	2.04
2N1613	.92
2N1893	1.14
2N2218	.95
2N2218A	.95
2N2219	.76
2N2219A	.76
2N2221	.80
2N2221A	.80
2N2222	.60
2N2222A	.60
2N2369	.60
2N2369A	.60
2N2405	1.45
2N2484	.84
2N2904	.95
2N2904A	.95
2N2905	.76
2N2905A	.76
2N2906	.80
2N2906A	.60
2N2907	.60
2N2907A	.60
2N3013	.90
2N3014	1.10
2N3019	1.04
2N3020	1.04
2N3053	1.04
2N3107	1.30
2N3108	1.30
MPS2907A	.23
MPS2924	.36
MPS3392	.21
MPS3393	.27
MPS3565	.23
MPS3638A	.23
MPS3641	.30
MPS3646	.52
MPS3704	.27
MPS5172	.23
MPS5551	.65
MPS6514	.24
MPS6515	.28
MPS6520	.24
MPS6560	.41
MPS6561	.45
MPS918	.45
MPSA10	.27
MPSA12	.52
MPSA13	.52
MPSA14	.30
MPSA42	.45
MPSA43	.45
MPSA92	.45
MPSA93	.45
MPSL01	.36
PN2222	.24
MPSL51	.36
PN2222A	.23
PN2369	.25
PN2369A	.25
PN2484	.30
PN2907	.23
PN2907A	.23
PN3251	.39
PN3565	.28
PN3566	.31
PN3567	.28
PN3569	.24
PN3639	.30
PN3640	.30
PN3641	.30
PN3643	.23
PN3644	.32
PN3645	.32
PN4121	.35
PN4122	.32
PN4248	.34
PN4249	.34
PN4250	.34
PN4250A	.40
PN4258	.30
PN4274	.29
PN4275	.29
PN4355	.36
PN4356	.37
PN4888	.56
PN4889	.70
PN4916	.36
PN4917	.36
PN5128	.26
PN5133	.27
PN5134	.26
PN5135	.35
PN5136	.27
PN5138	.24
PN5139	.35
PN5142	.27

1 AMP SILICON RECTIFIERS

Part No.	Description	Pkg.	10	100	1,000
1N4001	50 PIV	DO-41	.70	5.60	49.00
1N4002	100 PIV	DO-41	.75	6.00	52.50
1N4003	200 PIV	DO-41	.80	6.40	56.00
1N4004	400 PIV	DO-41	.85	6.80	59.50
1N4005	600 PIV	DO-41	.88	7.00	61.25
1N4006	800 PIV	DO-41	.98	7.80	68.25
1N4007	1000 PIV	DO-41	1.08	8.60	75.25

5% CARBON FILM RESISTORS

Available in 1/8, 1/4 & 1/2 Watt

How To Order: Take any standard resistor value (i.e. 3.2) and add an "E" for 1/8 watt or a "Q" for 1/4 watt or an "H" for 1/2 watt (i.e. 3.2Q for 3.2Ω 1/4 watt), this is the Digi-Key part number.

Pricing	5	200	1,000
1/8 Watt	.25	6.40	25.00
1/4 Watt	.25	3.40	13.00
1/2 Watt	.25	3.50	16.00

1/8 Watt Resistor Assortments

RS112 Set of 5 each of the 73 standard 5% 1/8 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pieces) $9.90

RS212 Set of 5 each of the 72 standard 5% 1/8 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pieces). $9.90

1/4 Watt Resistor Assortments

RS125 Set of 5 each of the 73 standard 5% 1/4 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pieces). $9.90

RS225 Set of 5 each of the 72 standard 5% 1/4 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pieces) $9.90

1/2 Watt Resistor Assortments

RS150 Set of 5 each of the 73 standard 5% 1/2 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohms (365 total pieces). $9.90

RS250 Set of 5 each of the 72 standard 5% 1/2 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pieces). $9.90

5% WIREWOUND REC. RESISTORS

Available in 5 & 10 Watt

How To Order: Take any standard resistor value (i.e. 7.5) and add "W5" for 5 watt, or add a "W10" for 10 watt (i.e. 7.5W5 for 7.5Ω 5 watt), this is the Digi-Key part number.

Pricing	1	10	100	500	1,000
5 Watt	.36	3.25	26.90	100.80	162.00
10 Watt	.41	3.78	31.90	118.00	212.00

5 Watt Metal Resistor Assortments

RS105 5 each of values 0.30Ω to 0.91Ω (300 total pieces) $20.10

RS205 4 each of values 1.0Ω to 9.1Ω (384 total pieces) $31.30

RS305 4 each of values 10Ω to 91Ω (384 total pieces) $31.30

RS405 4 each of values 100Ω to 2.0KΩ (288 total pieces) $31.30

10 Watt Resistor Assortments

R110 2 each of all 10 watt standard resistor values listed in the Digi-Key catalog (168 total pieces) $58.95

5% METAL OXIDE FILM RESISTORS

Available in 1 & 2 Watt

How To Order: Take any standard resistor value (i.e. 1.5K) and add a "W1" for 1 watt, or add a "W2" for 2 watt (i.e. 1.5KW1 for 1.5KΩ 1 watt), this is the Digi-Key part number.

Pricing	1	5	100	500	1,000
1 Watt (0.47-0.91Ω)	.21	[illegible]	12.60	56.00	101.50
1 Watt (1.0-1.0MΩ)	.15	.70	9.00	40.00	72.50
2 Watt (0.47-0.91Ω)	.23	1.06	13.15	59.40	109.40
2 Watt (1.0-1.0MΩ)	.18	.85	10.50	47.50	87.50

1 Watt Metal Resistor Assortments

RS101 5 each of values 0.47Ω to 56Ω (255 total pieces) $26.95

RS201 5 each of values 62Ω to 7.5KΩ (255 total pieces) $26.95

RS301 5 each of values 8.2KΩ to 1.0M (255 total pieces) $26.95

2 Watt Resistor Assortments

RS102 5 each of values 0.47Ω to 56Ω (255 total pieces) $29.95

RS202 5 each of values 62Ω to 7.5KΩ (255 total pieces) $29.95

RS302 5 each of values 8.2KΩ to 1.0M (255 total pieces) $29.95

1% METAL OXIDE FILM RESISTORS

Available in 1/4 Watt

How To Order: Take any standard resistor value (i.e. 1.69K) and add an "X" (i.e. 1.69KX), this is the Digi-Key part number.

Pricing	5	200	1,000
1/4 Watt	.50	7.80	30.00

1/4 Watt Metal Film Resistor Assortments

RS1X 5 each of values 10Ω to 97.6Ω (480 total pieces) $29.95

RS2X 5 each of values 100Ω to 976Ω (480 total pieces) $29.95

RS3X 5 each of values 1.00KΩ to 9.76KΩ (480 total pieces) $29.95

RS4X 5 each of values 10.0KΩ to 97.6KΩ (480 total pieces) $29.95

RS5X 5 each of values 100KΩ to 1.00MΩ (480 total pieces) $29.95

PANASONIC® SU SERIES

Miniature Aluminum Electrolytic Capacitors

WV/Cap. (VDC)/(µF)	Axial Lead Digi-Key Part No.	Price 1	Radial Lead Digi-Key Part No.	Price 1
6.3/47	P6301	.25		
6.3/100	P6302	.26	P6201	.16
6.3/220	P6303	.35	P6202	.21
6.3/330	P6304	.42	P6203	.22
6.3/470	P6305	.46	P6204	.23
6.3/1,000	P6306	.64	P6205	.38
6.3/2,200	P6307	.81	P6206	.62
6.3/3,300	P6308	.95	P6207	.81
6.3/4,700	P6309	1.13	P6208	1.01
6.3/6,800	P6310	1.48	P6209	1.22
6.3/10,000	P6311	1.97	P6210	1.62
6.3/15,000	P6312	2.67	P6211	2.64
6.3/22,000	P6313	3.82		
10/22	P6314	.21		
10/33	P6315	.27	P6212	.14
10/47	P6316	.28	P6213	.16
10/100	P6317	.33	P6214	.16
10/220	P6318	.41	P6215	.22
10/330	P6319	.49	P6216	.24
10/470	P6320	.53	P6217	.33
10/1,000	P6321	.73	P6218	.42
10/2,200	P6322	.99	P6219	.75
10/3,300	P6323	1.16	P6220	.87
10/4,700	P6324	1.49	P6221	1.19
10/6,800	P6325	1.86	P6222	1.62
10/10,000	P6326	2.65	P6223	2.31
10/15,000	P6327	3.79		
10/22,000	P6328	5.10		
16/22	P6329	.27	P6224	.14
16/33	P6330	.28	P6225	.15
16/47	P6331	.33	P6226	.16
16/100	P6332	.29	P6227	.21
16/220	P6333	.47	P6228	.24
16/330	P6334	.53	P6229	.31
16/470	P6335	.63	P6230	.39
16/1,000	P6336	.82	P6231	.50
16/2,200	P6337	1.13	P6232	.95
16/3,300	P6338	1.49	P6233	1.24
16/4,700	P6339	1.75	P6234	1.62
16/6,800	P6340	2.14	P6235	2.31
16/10,000	P6341	4.04		
16/15,000	P6342	5.15		
25/10	P6343	.21		
25/22	P6344	.26	P6236	.15
25/33	P6345	.29	P6237	.16
25/47	P6346	.34	P6238	.20
25/100	P6347	.42	P6239	.22
25/220	P6348	.49	P6240	.33
25/330	P6349	.57	P6241	.42
25/470	P6350	.66	P6242	.50
25/1,000	P6351	.89	P6243	.82
25/2,200	P6352	1.35	P6244	1.24
25/3,300	P6353	1.71	P6245	1.74
25/4,700	P6354	2.55	P6246	2.48
25/6,800	P6355	3.79	—	—
25/10,000	P6356	4.95	—	—
35/4.7	P6357	.21	P6247	.14
35/10	P6358	.26	P6248	.14
35/22	P6359	.29	P6249	.20
35/33	P6360	.35	P6250	.21
35/47	P6361	.42	P6251	.23
35/100	P6362	.46	P6252	.26
35/220	P6363	.56	P6253	.42
35/330	P6364	.66	P6254	.53
35/470	P6365	.72	P6255	.65
35/1,000	P6366	1.03	P6256	.97
35/2,200	P6367	1.71	P6257	1.74
35/3,300	P6368	2.24	P6258	2.48
35/4,700	P6369	3.47	—	—
35/6,800	P6370	4.88	—	—
50/0.47	—	—	P6259*	.13
50/1.0	—	—	P6260*	.13
50/2.2	—	—	P6261*	.13
50/3.3	P6371	.21	P6262*	.14
50/4.7	P6372	.26	P6263*	.14
50/10	P6373	.29	P6264*	.16
50/22	P6374	.35	P6265*	.22
50/33	P6375	.41	P6266*	.23
50/47	P6376	.45	P6267*	.24
50/100	P6377	.49	P6268*	.38
50/220	P6378	.70	P6269*	.53
50/330	P6379	.79	P6270*	.77
50/470	P6380	.95	P6271*	.90
50/1,000	P6381	1.38	P6272*	1.34
50/2,200	P6382	2.52	P6273*	2.38
50/3,300	P6383	3.63	—	—
50/4,700	P6384	4.79	—	—
63/0.47	P6385	.21	P6274	.14
63/1.0	P6386	.21	P6275	.14
63/2.2	P6387	.21	P6276	.15
63/3.3	P6388	.26	P6277	.16
63/4.7	P6389	.29	P6278	.16
63/10	P6390	.34	P6279	.18
63/22	P6391	.42	P6280	.24
63/33	P6392	.47	P6281	.27
63/47	P6393	.47	P6282	.40
63/100	P6394	.59	P6283	.53
63/220	P6395	.78	P6284	.77
63/330	P6396	.92	P6285	.97
63/470	P6397	1.12	P6286	1.14
63/1,000	P6398	1.75	P6287	1.74
63/2,200	P6399	3.53	—	—
63/3,300	P6400	4.83	—	—
100/0.47	P6401	.21	P6288	.21
100/1.0	P6402	.21	P6289	.22
100/2.2	P6403	.26	P6290	.23
100/3.3	P6404	.29	P6291	.24
100/4.7	P6405	.34	P6292	.26
100/10	P6406	.42	P6293	.31
100/22	P6407	.48	P6294	.40
100/33	P6408	.54	P6295	.46
100/47	P6409	.57	P6296	.52
100/100	P6410	.82	P6297	.81
100/220	P6411	1.22	P6298	1.09
100/330	P6412	1.54	P6299	1.32
100/470	P6413	2.02	P6300	1.89
100/1,000	P6414	3.94		
160/0.47	—	—	P6415	.23
160/1.0	—	—	P6416	.24
160/2.2	—	—	P6417	.27
160/3.3	—	—	P6418	.36
160/4.7	—	—	P6419	.37
160/10	—	—	P6178	.46
160/22	—	—	P6179	.65
160/33	—	—	P6180	.85
160/47	—	—	P6181	1.13
160/100	—	—	P6182	1.25
160/220	—	—	P6183	2.15
250/1.0	—	—	P6184	.40
250/2.2	—	—	P6185	.42
250/3.3	—	—	P6186	.43
250/4.7	—	—	P6187	.43
250/10	—	—	P6188	.61
250/22	—	—	P6189	.87
250/33	—	—	P6190	.98
250/47	—	—	P6191	1.28
250/100	—	—	P6192	2.19
450/1.0	—	—	P6193	.47
450/2.2	—	—	P6194	.55
450/3.3	—	—	P6195	.73
450/4.7	—	—	P6196	.79
450/10	—	—	P6197	.98
450/22	—	—	P6198	1.57
450/33	—	—	P6199	2.04

DISC CAPACITORS

Part No.	Cap./Volt. (pf)/(V)	Price 10
P4000	10/500	.71
P4002	15/500	.64
P4003	18/500	.64
P4004	22/500	.64
P4005	27/500	.64
P4006	33/500	.64
P4007	39/500	.64
P4008	47/500	.64
P4009	56/500	.64
P4010	68/500	.71
P4011	82/500	.71
P4141	1000/25	.98
P4142	1500/25	.98
P4143	2200/25	.98
P4144	3300/25	.98
P4145	4700/25	1.09
P4146	6800/25	1.09
P4147	10000/25	1.13
P4148	15000/25	1.20
P4149	22000/25	1.20
P4150	33000/25	1.76
P4152	1000/50	1.09
P4153	1500/50	1.09
P4154	2200/50	1.09
P4155	3300/50	1.09
P4156	4700/50	1.20
P4157	6800/50	1.24
P4158	10000/50	1.24
P4159	15000/50	1.35
P4160	22000/50	1.95
P4100	100/500	.68
P4102	150/500	.68
P4103	180/500	.68
P4104	220/500	.68
P4105	270/500	.68
P4106	330/500	.68
P4107	390/500	.68
P4108	470/500	.79
P4109	560/500	.79
P4110	680/500	.79
P4111	820/500	.79
P4112	1000/500	.94
P4114	1500/500	.94
P4116	100/1K	1.28
P4117	120/1K	1.28
P4118	150/1K	1.28
P4119	180/1K	1.28
P4120	220/1K	1.28
P4121	270/1K	1.28
P4122	330/1K	1.99
P4123	390/1K	1.99
P4124	470/1K	1.99
P4125	560/1K	1.99
P4126	680/1K	1.99
P4127	820/1K	2.25
P4128	1000/1K	2.25
P4129	1200/1K	2.25
P4130	1500/1K	2.25
P4131	1800/1K	2.25
P4132	2200/1K	2.93
P4133	2700/1K	2.93
P4134	3300/1K	2.93
P4135	3900/1K	4.46
P4136	4700/1K	5.36
P4137	5600/1K	5.36
P4138	6800/1K	8.44
P4139	8200/1K	8.44
P4140	10000/1K	8.44
P4161	10000/50	.86
P4162	22000/50	.94
P4163	47000/50	1.01
P4164	100000/50	1.13
DH682	6800/50	.90
P4200	1000/100	.68
P4202	1500/100	.68
P4203	2200/100	.79
P4205	3300/100	.79
P4206	4700/100	1.09
P4209	6800/100	.71
P4300	.01µF/25	.56
P4303	.022µF/25	.64
P4305	.033µF/25	.64
P4307	.047µF/25	.79
P4311	.1µF/25	1.61
P4418	1000/25	.75
P4419	1500/25	.75
P4420	2200/25	.75
P4421	3300/25	.75
P4422	4700/25	.75
P4423	6800/25	.83
P4424	10000/25	.83
P4425	15000/25	.90
P4426	22000/25	.94
P4427	33000/25	.94
P4428	47000/25	1.55
P4429	68000/25	1.73
P4430	100000/25	1.91
P4431	1000/50	.86
P4432	1500/50	.86
P4433	2200/50	.86
P4434	3300/50	.86
P4435	4700/50	.86
P4436	6800/50	.94
P4437	10000/50	1.01
P4438	15000/50	1.01
P4439	22000/50	1.09
P4440	33000/50	1.73
P4441	47000/50	1.73

NPO

Part No.	Cap./Volt.	Price
P4400	10/500	.68
P4402	15/500	.79
P4403	18/500	.79
P4404	22/500	.79
P4405	27/500	.79
P4406	33/500	.98
P4407	39/500	.98
P4408	47/500	1.13
P4409	56/500	1.13
P4410	68/500	1.28
P4411	82/500	1.91
P4412	100/500	1.91
P4413	120/500	1.91
P4414	150/500	2.03
P4415	180/500	2.70
P4416	220/500	2.70

TANTALUM CAPACITORS

Part No.	Cap./Volt. (µF)/DC	Price 1
P2011	4.7/6.3	.31
P2012	6.8/6.3	.34
P2013	10/6.3	.42
P2014	15/6.3	.50
P2015	22/6.3	.60
P2016	33/6.3	.72
P2017	47/6.3	.85
P2018	68/6.3	1.18
P2019	100/6.3	1.82
P2020	150/6.3	3.60
P2094	220/6.3	7.85
P2095	330/6.3	11.65
P2022	2.2/10	.28
P2023	3.3/10	.31
P2024	4.7/10	.34
P2025	6.8/10	.42
P2026	10/10	.50
P2027	15/10	.60
P2028	22/10	.72
P2029	33/10	.85
P2030	47/10	1.18
P2031	68/10	1.82
P2032	100/10	3.60
P2083	150/10	6.98
P2084	220/10	9.63
P2033	1.5/16	.23
P2034	2.2/16	.31
P2035	3.3/16	.33
P2036	4.7/16	.42
P2037	6.8/16	.50
P2038	10/16	.60
P2039	15/16	.74
P2040	22/16	.88
P2041	33/16	1.18
P2042	47/16	1.82
P2043	68/16	3.60
P2086	150/16	9.08
P2096	100/16	6.98
P2044	1.5/25	.31
P2045	2.2/25	.34
P2046	3.3/25	.42
P2047	4.7/25	.54
P2048	6.8/25	.65
P2049	10/25	1.06
P2050	15/25	1.19
P2051	22/25	1.68
P2052	33/25	2.36
P2053	0.1/35	.27
P2054	0.15/35	.27
P2055	0.22/35	.27
P2056	0.33/35	.27
P2057	0.47/35	.27
P2058	0.68/35	.28
P2059	1.0/35	.31
P2060	1.5/35	.34
P2061	2.2/35	.42
P2062	3.3/35	.51
P2063	4.7/35	.65
P2064	6.8/35	.90
P2065	10/35	1.19
P2066	15/35	1.88
P2099	.047/35	.43
P2100	.068/35	.43
P2101	22/35	2.56
P2102	33/35	4.46
P2103	47/35	13.36
P2067	0.1/50	.28
P2068	0.15/50	.30
P2069	0.22/50	.30
P2070	0.33/50	.30
P2071	0.47/50	.33
P2072	0.68/50	.37
P2073	1.0/50	.50
P2074	1.5/50	.84
P2075	2.2/50	.90
P2076	3.3/50	1.48
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P2104	10/50	5.40
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P4518	0.027/50	1.38
P4519	0.033/50	1.41
P4520	0.039/50	1.44
P4521	0.047/50	1.47
P4522	0.056/50	1.54
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P4537	1.0/50	6.62
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P4714	0.012/100	1.38
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P4720	0.039/100	1.96
P4721	0.047/100	2.03
P4722	0.056/100	2.10
P4723	0.068/100	2.23
P4724	0.082/100	2.25
P4725	0.1/100	2.30
P4726	0.12/100	2.57
P4727	0.15/100	2.65
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P4733	0.47/100	4.71

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P4556	.0027/50	1.05
P4557	.0033/50	1.05
P4558	.0039/50	1.05
P4559	.0047/50	1.05
P4560	.0056/50	1.05
P4561	.0068/50	1.05
P4562	.0082/50	1.05

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Freq. MHz	Digi-Key Part No.	Case	Pricing 1	Pricing 10
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2.000	X001	HC-33	3.78	31.50
2.0000	X068	HC-18	3.24	27.00
2.4576	X047	HC-33	3.78	31.50
2.4576	X069	HC-18	3.06	25.50
2.5000	X070	HC-18	3.42	28.50
3.000	X048	HC-33	3.78	31.50
3.2768	X022	HC-18	1.73	14.40
3.579545	X005	HC-33	2.34	19.50
3.579545	X049	HC-18	1.62	13.50
3.6864	X071	HC-18	1.62	13.50
3.700	X012	HC-6/U	2.60	22.00
4.000	X006	HC-18	1.62	13.50
4.0320	X072	HC-18	1.62	13.50
4.194304	X007	HC-18	1.62	13.50
4.91520	X050	HC-18	1.62	13.50
5.000	X051	HC-18	1.62	13.50
5.0688	X052	HC-18	1.62	13.50
5.1850	X053	HC-18	1.62	13.50
5.9904	X073	HC-18	1.62	13.50
6.000	X026	HC-18	1.62	13.50
6.144	X054	HC-18	1.62	13.50
7.3728	X074	HC-18	1.62	13.50
8.000	X056	HC-18	1.62	13.50
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16.000	X077	HC-18	1.62	13.40
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Editorial

A JOB WELL DONE

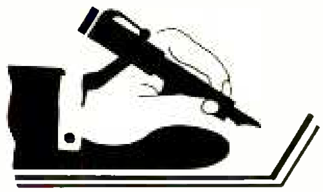
It was shortly after 5 p.m. in San Francisco (8 p.m. here on the East Coast) on October 17, 1989, and the nation was settling back in their easy chairs and sofas waiting for Game 3 of baseball's showcase—the World Series. Suddenly, all the fun and games turned deadly serious as the Bay area was hit with a killer earthquake.

And, as always happens when disaster strikes, radio hobbyists were on the scene lending aid and comfort, and providing vital communication links. REACT (Radio Emergency Associated Communications Teams), an organization of amateur radio operators, CB'ers, and GMRS (business) radio users who have volunteered their expertise in emergencies, and for the general public good, was already active in the area, assisting travelers on the way to the World Series when the earthquake struck.

Almost immediately, calls reporting accidents, injuries, major damage, downed lines, and fires began to pour in to REACT monitors, who relayed the information to the appropriate emergency services. Other requests included directions around blocked roads, locations of Red Cross centers, and where to go to volunteer. At the police's request, and to help them concentrate their efforts on disaster relief, REACT members patrolled areas left without power, watching for looters and other problems.

Disasters like the San Francisco Bay area earthquake and Hurricane Hugo, which had devastated the Southeast coast and the Caribbean region just weeks before, try the courage and dedication of every man, woman, and child involved. And time after time, radio hobbyists have performed above and beyond what could be reasonably expected of anyone. Job well done—again!

Carl Laron
Managing Editor



Letters

DE-MYSTIFIED STATION

Regarding the letter from G.R. in the November 1989 issue of **Popular Electronics:** The station he asks about, W6QIE, is the station of Don Johnson, located in South San Francisco. Since the mid-1960's that station has been transmitting code practice on 3590 kHz every Tuesday through Saturday, commencing at 8 PM local Pacific Time. Don's dedication to code-practice transmissions may well represent the longest running such service in the country, besides the ARRL's W1AW.

F.S.B., W6OWP
Paradise, CA

IN THE DARK

I built the "Electronic Darkroom Timer" (**Popular Electronics,** November 1989), and before I even got started on the circuit I noticed an error in the timing capacitors. Capacitors C2 and C4 must be reversed so that the 2.2-μF is in series with the 22-μF capacitor. To get the exact 15-second and 30-second intervals I used my digital capacitance meter to select the 2.2-and 22-μF capacitors.

Other than that, I really enjoyed the project—keep 'em coming!

D.S.
Kansas City, MO

ADDRESS CORRECTION

HSC Electronic Supply appreciates being included in the article "Supplying the Electronic Workshop" in the November 1989 issue. However, please inform your readers that the Zip Code in the mail-order address in the article's sidebar is incorrect. The correct address for mail orders is HSC Electronic Supply of Santa Clara, 3500 Ryder Street, Santa Clara, CA *95051-0717*. Recent requests for catalogs have depleted our supply, but additional catalogs are currently being prepared.

Bob Ogburn, WA6LXK
National Marketing Manager
HSC Electronic Supply

BOOSTER AMP WARNING

As I was looking over the schematic of the "Booster Amp for Your Car Stereo" (**Popular Electronics,** November 1989) I noticed something that could cause heartburn for some stereo owners who try to use the circuit.

Not all stereo outputs are referenced directly to ground; in some units, including late-model Delco stereos in GM cars, the outputs are balanced. If the booster-amp circuit was connected to one of those output-balanced stereos, at minimum the final output would probably be degraded. It's likely that the stereo would sustain damage from smoke!

P.W.
Virginia Beach, VA

You are, of course, correct. While most current production stereo amplifiers do reference their outputs to ground, a few do not. If you are not sure about your amplifier's output configuration, consult the manual or contact the manufacturer. Under no circumstances should the Booster Amp be connected to an output that is not referenced to ground.—Editor

SECRET AGENT'S ADDRESS REVEALED!

We could pretend that the publisher and address of Golgo 13 Comics *(GIZMO, December 1989) were withheld to protect the security of "Duke Togo" secret agent for hire in the popular Nintendo game on which the comic is based—but the truth of the matter is we simply forgot to include it. The comic is published in a joint venture by Vic Tokai Inc., Saito Productions, and Lead Publishing Company Ltd., and those interested can contact Vic Tokai Inc., 370 Amapola Avenue, Torrance Tech Park, Suite 104, Torrance, CA 90501. Sorry for any inconvenience caused by the omission.—Editor*

SORRY, WRONG NUMBER

*The phone number listed for Jameco Electronics Inc. in the "Sources" box accompanying the article "Upgrading Your PC" (***Popular Electronics,** *December 1989) is actually that company's* fax *number. The correct telephone number is: 415-592-8097.*

—Editor

CELLULAR CONNIPTION

Politely, I'll listen to crank phone calls,
even when they're collect and pre-recorded.
And junk mail over my fax doesn't annoy me,
or "Urgent & Personal" letters, pre-sorted.

I offer coffee to all door-to-door salesmen
and refills before bidding them "Good day."
I've always given very thoughtful responses
to each and every obnoxious opinion survey.

I've made a few interesting friends because
to wrong numbers I just can't say "good bye."
I also leave messages on answering machines
even though I'd only called up to say "hi."

But I went totally berserk stuck in traffic
when I answered a call on my cellular phone
and heard the computer's solicitation begin
"Dear Friend . . ." in a hollow aluminum tone.

I ranted, I raved at that digital disk-head,
while watching for the light to turn green.
My fellow drivers must surely have wondered
to whom I could have been speaking so mean.

Naomi Hardy

SOURCE FOR MANUALS

I'd like to let other **Popular Electronics** readers in on the advice I sent to John Daniels in response to his "Haves & Needs" letter in the November 1989 issue. There is a company called Hi-Manuals that supplies hard-to-find manuals. Even if they don't have the manual, they may be able to provide a circuit diagram. Enclose $1.00 and ask for "Catalog J." Their address is P.O. Box J-802, Council Bluffs, IA 51502.

P.R.F.
Cincinnati, OH

BAR NONE

I spotted an error in Fig. 3 of *The Digital Electronics Course* (**Popular Electronics,** November 1989). It should read $Y = \bar{A}$ (Y is equal to *not* A) instead of $Y = A$.

K.F.
Sauk City, WI

HAVES & NEEDS

I have a Convergence Technology *AWS 231* workstation that I purchased at a flea market for what I thought was a bargain price. I was told that software *and* an operating system was available. The only place that has even been willing to answer my letters concerning software was charging a hefty price of $400.00 each for the operating system and word-processing software.

I also was told at the time of purchase that the system, which has 256K of RAM, can use MS-DOS software. I haven't been able to get the system up and running. It's been a year since I bought it, and I have since bought an IBM-compatible computer, but I would still like to use the Convergence Technology computer, if possible. Can any **Popular Electronics** readers help me find out if it's possible to use MS-DOS with the system, or to find a reasonably priced operating system and software?

D. Rutledge
3110 Mt. Vernon Avenue #190
Alexandria, VA 22305

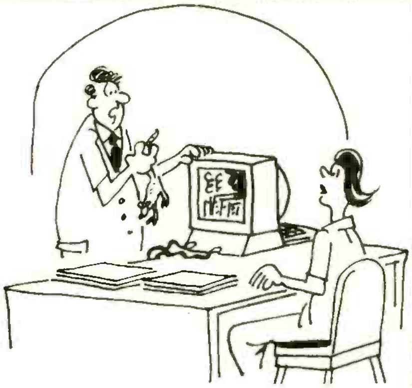
I need service notes or a schematic for a Philco 7-transistor radio (model *T7-126*), and I'm also looking for service notes, schematics, or owner's manuals for an RCA model *WO-91B* oscilloscope and an EICO model *377* audio generator. I'm willing to pay copying costs and postage for any of those manuals and schematics. Thanks.

Robin Evans
622 Stevenson Street
Jacksonville, AR 72076 ■

A peek inside the Computer Revolution

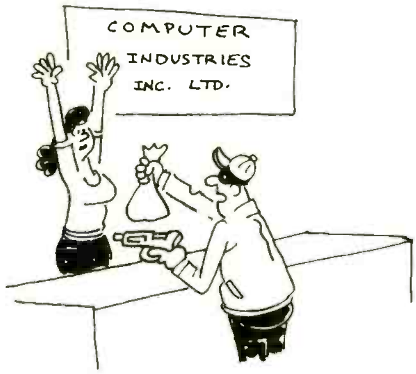
By Harry Nelson

"Sure it's a great improvement, but who'll retrain Quasimotto?"



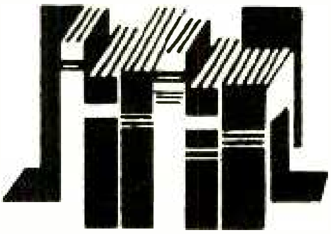
"You've got a bad power supply, but the tread mill looks okay."

"Melvin can't spell and he is completely lacking in logic. He's perfect for devising access codes."



"Forget about the money! Just fill this bag with memory chips!"

"Don't worry, Melbley, we'll have your computer on line and you can be back at work before lunch!"



Electronics Library

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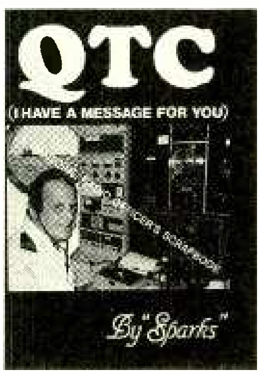
QTC (I HAVE A MESSAGE FOR YOU)

by "Sparks"

Author Ray "Sparks" Redwood—a wireless operator in the RAF during World War II who later served as the radio officer on a British merchant ship and now works for 3 to 6 months at a stretch on freighters or tankers—wrote this book under the pseudonym "Sparks" because it represents the experiences of all sea-going radio officers —also known as "Sparks." With their radios and Morse code, those officers (the "ears and voice" of their ships) provide a vital communications link .

The book brings the history of radio to



life by mixing personal anecdotes with background material and true stories of rescues and mysteries of the sea. The contributions of five radio pioneers—Maxwell, Hertz, Marconi, Fleming, and De Forest—are described. Well-known sea stories, such as the sinking of the Titanic, are presented from the unique viewpoint of a radio operator. Those tales are interspersed with accounts of lesser-known historic events and personal at-sea and port-of-call stories of adventure, friendship, and love. With communications satellites and high-tech computer and electronics systems threatening to replace the Morse-code operators, a certain nostalgic spirit surrounds the tales told.

QTC (I Have A Message For You) is available in hardcover in a limited edition, numbered and signed by the author, for $15.00, or in paperback for $8.95, from Sequoia Press, 2502 Cockburn Drive, Austin, TX 78745.

CIRCLE 90 ON FREE INFORMATION CARD

COMMUNICATIONS NETWORKS

by Michael F. Hordeski

With today's business world becoming increasingly dependent on networking among PC's, mainframes, and minicomputers, managers at all levels need to stay abreast of the latest developments in order to set up networks and keep them operating smoothly. This book provides an in-depth examination of the technical, managerial, and economic issues surrounding communications networks.

It shows readers how to evaluate their current and future networking needs so that they can select appropriate systems and add-ons, and how to avoid making costly mistakes. It explains the differences between available modes, to ensure compatibility between systems and components. Using practical examples throughout, the book provides a comprehensive analysis of available hardware and software, including how to buy it.

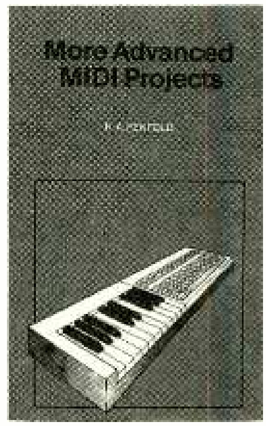
Communications Networks is available in hardcover from TAB Professional and Reference Books, Division of TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

MORE ADVANCED MIDI PROJECTS

by R.A. Penfold

The projects presented in this book are designed to overcome a deficiency in a piece of MIDI equipment, to enhance the performance of an electronic-music system, or to make the system easier to use. For the most part, the projects are more complex than those presented in the author's previous book (*MIDI Projects*) and are not suitable for beginners. However, a few simple ones have been included, and all of the projects should be well within the capabilities of electronics hobbyists with some experience. Included are circuits for a MIDI indicator, a THRU box, a merge unit, a code generator, a pedal, a programmer, a "channelizer," and an analyzer. The circuit descriptions are also intended to provide some useful building blocks for use in the reader's own designs.



More Advanced MIDI Projects (No. BP247) is available for $7.95, including shipping and handling, from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

ELECTRICAL TEST EQUIPMENT

by Harry Mileaf

Written for anyone who needs to understand the electrical test equipment used by electricians—expecially trade-school students, apprentices, journeyman electricians, and do-it-yourselfers—this book provides a detailed look at its construction, operation, and practical applications. As a complete source of practical instruction on how to use electrician's instruments to test and measure various kinds of circuits, the book strives to make learning easy. Each page covers one concept or topic, with an illustration to clarify it. All technical terms are defined as soon as they are introduced, key points are high-lighted (and often reiterated in later sections), and summary sections with review questions are included, making quick refresher studies simple.

The book provides a solid foundation in electrical measurements and complete information on the basic meter movement, including its construction and how it's used to measure current, voltage, continuity, and resistance. The book covers analog and digital meters, as well as special-purpose meters such as oscilloscopes, component testers, and wattmeters.

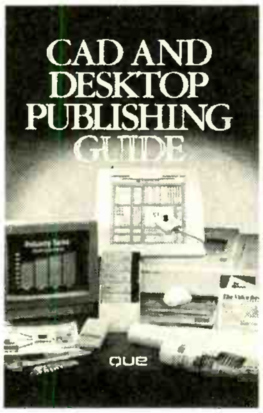
Electrical Test Equipment is available for $19.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

CAD AND DESKTOP PUBLISHING GUIDE

developed by Que Corporation

This comprehensive sourcebook of software, hardware, accessories, and services covers the three fastest growing personal-computer technologies: computer-aided design (CAD), desktop publishing, and presentation graphics. It includes thousands of listings, each of which contains complete product and company information—the systems the product runs on; pricing information; product description;



and vendor name, address, and phone number.

The book's easy-to-follow layout lets the reader access information about 2,600 products, saving time and simplifying purchasing decisions. The guide is divided into four main sections: CAD systems and software, system software and programming languages, desktop-publishing systems and software, and hardware and peripherals. Each section is further divided into more specific categories, and within those entries are arranged alphabetically.

CAD and Desktop Publishing Guide is available for $24.95 from Que Corporation, 11711 N. College Ave., Carmel, IN 46032.

CIRCLE 94 ON FREE INFORMATION CARD

MODERN ELECTRONIC AND ELECTRICAL DRAFTING WITH COMPUTERS

by James D. Bethune

Taking a generic approach rather than depending on a single CAD system, this book explains how to use computer-aided design to prepare electronic and electrical drawings and schematics. Introductory material is included on computers as well as on the basic mathematical concepts needed to set up and prepare drawings using CAD. The book explains two-dimensional construction and how those techniques are applied to a variety of electronic and electrical drawings. Extensive illustrations and photographs accompany the text.

Chapters on electronic symbols, schematic diagrams, and printed-circuit development include design layouts, film mas-

(Continued on page 12)

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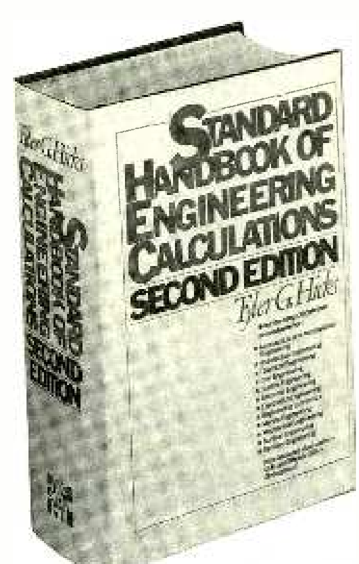

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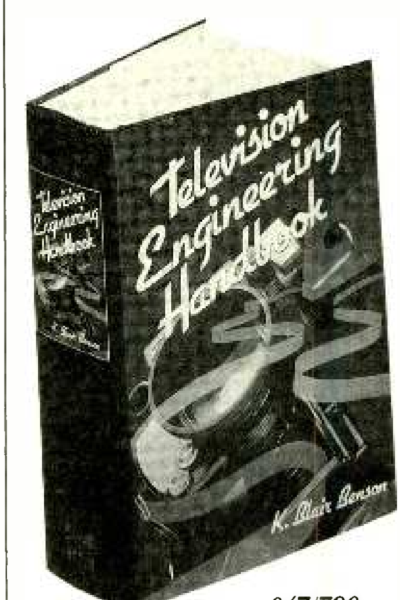

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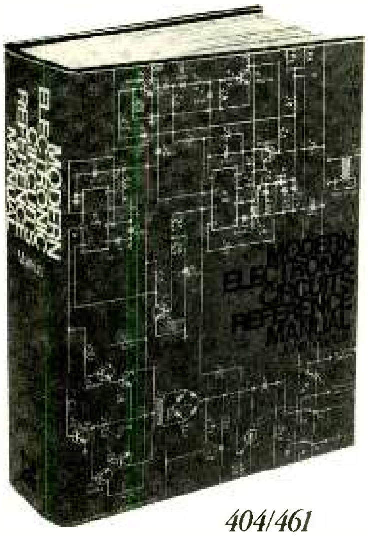

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- ranges from basic circuits and measurements to advanced topics, such as power distribution and telecommunications
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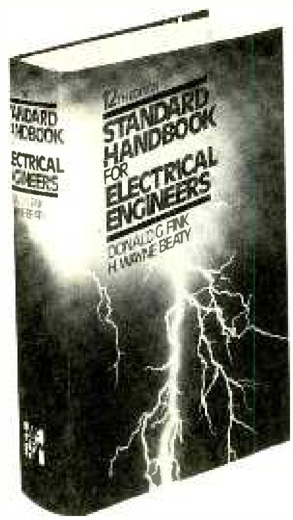

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Electronics Library
(Continued from page 7)

ters, soldering, and drill drawings. The section on integrated circuits features sample problems that illustrate how to draw the various masks required for IC manufacturing. Other topics covered include orthographic views, sheet-metal bending, dimensioning of multiple-hole patterns, residential and industrial wiring, and charts and graphs. Each chapter ends with exercises designed to apply the material presented.

Modern Electronic and Electrical Drafting with Computers is available for $40.00 from Prentice-Hall, Inc., Englewood Cliffs, NJ 07632.

CIRCLE 99 FOR FREE INFORMATION CARD

MILITARY STANDARDS LISTING

from Seastrom Manufacturing Co., Inc.

In this brochure, more than 130 listings of AN, NAS, M, MS, and USAF Standards are identified for immediate shipment from stock. Most variations and dash numbers are also available for prompt pricing and shipping.

The MIL Standards listing is available at no charge from Seastrom Manufacturing Co., Inc. 701 Sonora Avenue, Glendale, CA 91201-2495.

CIRCLE 91 ON FREE INFORMATION CARD

THE COMPUTER NETWORKING BOOK

by Peter O'Dell

The personal computer has changed the business world by providing even the smallest companies with the power to manipulate and share information (in other words, to network) in various ways. Unfortunately, the information that generally *isn't* being shared involves how to implement a networking system. Nontechnical managers must trust key decisions to consultants and vendors, who might have a vested interest in a particular system.

This book aims to put the decision-making process back into the hands of management, by providing impartial, plain-English explanations concerning how and when to link up their computers. It helps business owners decide whether they need to network and, if so, what type of network would work best for their office environment. For clearer communications with consultants and computer dealers, the book provides the right questions to ask the experts. It shows how to create a network without disrupting business—by "phasing" it in step by step, business can proceed as normal and large capital outlays can be avoided. With an emphasis on cost control, the book explains how to manage a network without a full-time MIS director, and includes a special chapter on low-cost alternatives to expensive networks.

The Computer Networking Book is available for $19.95 from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515.

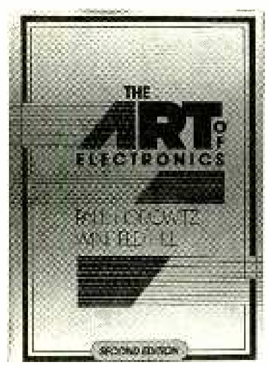
CIRCLE 92 ON FREE INFORMATION CARD

THE ART OF ELECTRONICS: Second Edition

by Paul Horowitz and Winfield Hill

This update of the book that was widely accepted as the single authoritative text and reference for the study of electronics retains the informality and easy access that made the original so popular. The emphasis is on the methods actually used by circuit designers—a combination of some basic laws, rules of thumb, and a large bag of tricks. The result is a primarily non-mathematical treatment that encourages circuit intuition, brain-storming, and simplified calculation of circuit values and performance.

Extensive changes have been made in this edition. The chapters on microcompu-



ters and microprocessors have been completely rewritten, every table has been revised and many new ones have been added, and a new chapter on micropower design was added. Chapters on many subjects—digital electronics, op-amps, FET's, precision design, construction techniques—have been substantially revised. New sections have been added on active-filter designs, switched-capacitor filters, optoelectronics, isolation amplifiers, RS-232 interfacing, low-dropout regulators, sensor linearization, and dozens of other topics of current interest. The 1100-plus-page book is well-indexed and fully illustrated.

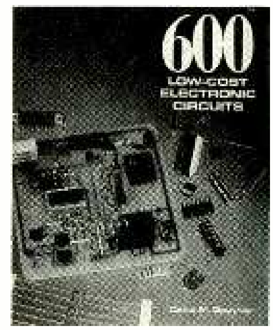
The Art of Electronics: Second Edition is available in hardcover for $49.50 from Cambridge University Press, 32 East 57th Street, New York, NY 10022.

CIRCLE 101 ON FREE INFORMATION CARD

600 LOW-COST ELECTRONICS CIRCUITS

by David M. Gauthier

When you need a circuit for a specific application right away, this book is sure to come in handy. Its 350 pages contain up-to-the-minute, practical circuit designs assembled from a broad cross section of major manufacturers. The circuits—which can be used "as is" or adapted for your own purposes—are presented with all necessary diagrams and complete specifications. All of them use between one and ten hobby-



type, readily available IC's—and most of them can be built for less than $25.

The book is logically organized and extensively indexed so that you can quickly find the correct circuit from the array offered. Included are power-regulators, amplifier-based circuitry, A/D and D/A converters, waveform-oscillator circuits, array circuitry, and voltage-to-frequency converters. Also included are high-speed, proprietary high-voltage switches and multiplexers, and special-purpose circuits.

600 Low-Cost Electronic Circuits is available in paperback for $18.60, or in hardcover for $27.95, from TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

TUNE IN THE WORLD WITH HAM RADIO: 8th Edition

edited by Larry Wolfgang, WA3VIL

The latest edition of this classic from the American Radio Relay League (ARRL) includes the question pools that will be used on FCC Novice-level exams beginning in November 1989. Available as a separate text or as a kit including two 90-minute audio cassettes, *Tune in the World With Ham Radio* provides a comprehensive study guide. The book has been updated to be easier to read, and the code-teaching and code-practice cassettes have also been revised.

Tune in the World With Ham Radio is available for $14.00 for the book alone, or

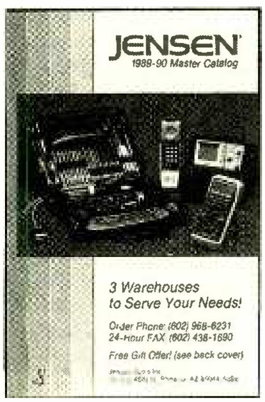
$19.00 for the book and cassettes (plus $2.50 shipping or $3.50 for U.P.S.) from ARRL, 225 Main Street, Newington, CT 06111.

CIRCLE 102 ON FREE INFORMATION CARD

MASTER CATALOG

from Jensen Tools

Along with their full line of products, this 168-page booklet features new tools and test equipment for the repair and maintenance of radios, televisions, VCR's, computers, and other electronic and electromechanical devices. The catalog also presents complete lines of specialized field-service kits, test equipment, hand and



power tools in inches and metric measurements, lighting and optical aids, tool boxes and cases, soldering supplies and equipment, and static-control devices. All items are fully illustrated and described in detail.

The 1989–90 Master Catalog is free upon request from Jensen Tools, Inc., 7815 South 46th Street, Phoenix, AZ 85044, Tel. 602-968-6241.

CIRCLE 103 ON FREE INFORMATION CARD

GREAT RADIO READS

from Tiare Publications

This brochure contains an assortment of books that will appeal to radio enthusiasts of all types and levels of experience. Featured are books on shortwave-radio listening, ham radio, and scanner monitoring, as well as pirate radio, clandestine broadcasters, and AM and FM station directories. The booklet also announces the first annual celebration of "Shortwave Radio Week."

Great Radio Reads: Fall & Winter 89–90 is available for $1.00 from Tiare Publications, P.O. Box 493, Lake Geneva, WI 53147.

CIRCLE 104 ON FREE INFORMATION CARD

THE CUCKOO'S EGG: Tracking a Spy Through the Maze of Computer Espionage

by Clifford Stoll

Proving that not all spy-catchers are James Bond clones, self-professed "ex-hippie" and astrophysicist-turned-systems-analyst Clifford Stoll broke up an international computer spy ring almost single-handedly. On his second day of work at Lawrence Berkeley Laboratory, Stoll found a 75-cent accounting error that alerted him to the presence of an unauthorized user on the computer system. That discovery triggered the hunt for an elusive hacker. With a little help from "friends" (including the FBI, the CIA, and his girlfriend), Stoll tracked down the hacker who was prowling through the nation's computer networks.

Reading more like a techno-thriller than a true story, Stoll's book describes the plan he devised to follow every move the intruder made, and the dawning realization that the hacker's focus on nuclear weapons, intelligence satellites, and the Strategic Air Command had the potential to compromise U.S. security. The trail led Stoll on

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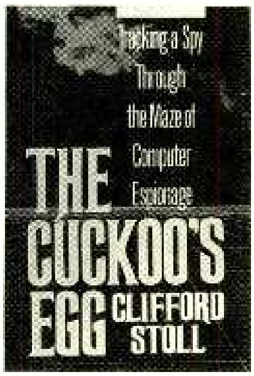
a chase around the world, finally resulting in a "sting" operation that exposed a computer spy ring that sold the data it collected to the Soviets. This unlikely hero weaves



his tale with wry humor and suspense, creating an absorbing read.

The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage is available for $19.95 from Doubleday, 666 Fifth Avenue, New York, NY 10103.

CIRCLE 105 ON FREE INFORMATION CARD

ELECTRONICS KITS CATALOG

from Mark V Electronics

A full line of projects for hobbyists at all levels of expertise is included in this 32-page brochure. More than a dozen different amplifier kits are offered, along with an array of light controllers, regulators, and digital meters and counters. Other items include electronic Lotto and roulette, touch switches, level meters, a digital clock, a wireless microphone, and an infrared control unit. The level of difficulty of each kit is clearly indicated in the catalog's index and in each fully illustrated item description. Besides the kits, LCD thermometer/clocks and "talking clocks" are offered fully assembled.

Catalog C-3 is free upon request from Mark V Electronic, Inc., 8019 East Slauson Avenue, Montebello, CA 90640.

CIRCLE 106 ON FREE INFORMATION CARD

MASTERING NINTENDO VIDEO GAMES: Tips, Tricks, Strategies

by Joshua Robbins and Judd Robbins

Written by a father-son team, this book is aimed at "kids of all ages" who want to improve their video-game scores. It is divided into three sections. The first provides in-depth reviews of 25 popular Nintendo games, including summaries of each game's plot and main characters, as well as specific game-playing tips, techniques, and codes. The "Turbo Tips" section reveals "the hottest passwords and secret features" for dozens of games from Nintendo and other manufacturers, and the final section includes game summaries as well as "mini tips" for still more games. Over 100 different games are covered in the book.

Mastering Nintendo Video Games: Tips, Tricks, Strategies is available for $7.95 from Hayden Books, Division of Macmillan, Inc., 4300 West 62nd Street, Indianapolis, IN 46268.

CIRCLE 107 ON FREE INFORMATION CARD

CONSUMERS SHOULD KNOW . . .

from Electronics Industries Association/ Consumer Electronics Group

Three "Consumers Should Know..." booklets from the EIA/CEG provide important information for anyone buying and using a variety of popular consumer-electronic items. *How to Save Money and Take Care of TV's, VCR's, Camcorders, Audio Products, Computers, and other Electronic Products* covers preventative maintenance, including special-care products such as voltage surge suppressors, tape-deck demagnetizers, and protective covers. It explains how to care for floppy and compact discs and audio and video tapes. *How to Install, Connect, and Expand TV's, VCR's, Telephones, Audio Systems, and other Consumer-Electronic Products* begins by explaining what types of installations and expansions you can do yourself, and which require professional assistance. It covers how to shop for and use cables, wires, connectors, and antennas; and how to hook up virtually every popular audio and video accessory. *How to Choose and Use Accessories to Improve Your Enjoyment of Consumer-Electronic Products* points the reader toward accessories that enhance, adapt, and protect their audio, video, and communications products. Included are remote controls, headphones, microphones, stereo and surround-sound converters, portable power supplies, audio and video tapes, video lights, tripods, modems, and more. Each brochure includes a glossary of terms and a description of related pamphlets that are also available.

Each "Consumer Should Know..." pamphlet is available by sending a self-addressed, stamped (25 cents for How to Save Money and Take Care of..., 45 cents for How to Choose and Use Accessories..., and 65 cents for How to Install, Connect, and Expand...) No. 10 envelope to Electronic Industries Association, P.O. Box 19100, Washington, DC 20036.

CIRCLE 108 ON FREE INFORMATION CARD

IBM PS/2: User's Reference Manual

by Gilbert Held

Although the newest generation of IBM PC's—the PS/2's—support DOS and can run more than 99% of the software developed for use on the original PC's, there are major differences between the two computer families. PS/2's use different data-storage media, support different expansion slots, and use new video standards. This book was written for people who have switched to the PS/2 system, and want to take full advantage of its increased capabilities.

The book provides an in-depth guide to the PS/2 computers, the DOS 3.3 and 4.0 and OS/2 operating systems, and data communications. Beginning with an overview of the hardware involved, it progresses in a clearly written style to explain proper fixed-disk organization for efficient use of data-storage space. It describes how to create and implement configuration and batch files—including installation, hardware requirements, and commands. Detailed instructions are provided for using both OS/2 and DOS, including a comparison of the two operating systems. Advanced DOS commands are explored, as is the OS/2 Presentation Manager. The book's coverage of data communications includes methods of transmission, protocols, LAN's, and networking techniques.

With an emphasis on practicality, the book provides solutions to compatibility problems and explains how to integrate PS/2 with other computers. Third-party products that increase the performance of PS/2 systems are also described. All procedural steps and instructions are accompanied by illustrations to make learning easier.

IBM PS/2: User's Reference Manual is available for $24.95 from John Wiley & Sons, Business/Law/General Books Division, 605 Third Avenue, New York, NY 10158-0012. ■

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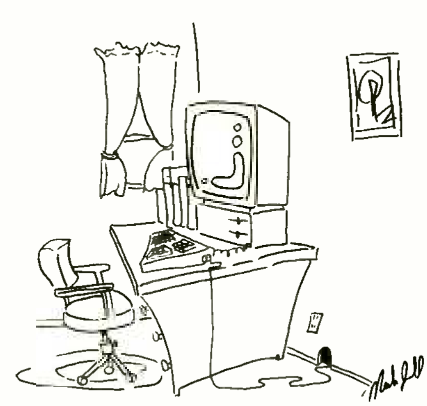
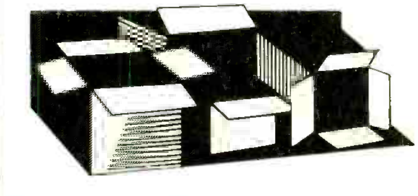




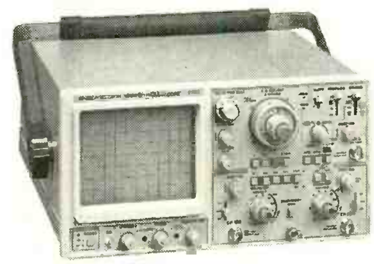
New Products

To obtain additional information on new products covered in this section from the manufacturer, please circle the item's code number on the Free Information Card

100-MHz OSCILLOSCOPE

B&K-PRECISION's model *2190* oscilloscope offers a wide range of high-end features, including triple input and six-trace operation, which allows three different signals to be observed at two timebase settings. The instrument provides excellent high-frequency triggering; it will trigger on signals well beyond its rated bandwidth. That extra margin ensures stable performance over the full rated bandwidth.

Other features include 1-mV-per-division vertical sensitivity, V-mode for viewing two signals unrelated in frequency, dual time base, alternate sweep function, a 20-MHz bandwidth limiter, and video-sync separators. The user can choose from 23 calibrated sweep-time ranges on the main time base, and 20 calibrated ranges on the delayed-sweep time base. Each sweep-time range is fully adjustable between calibrated ranges. A ×10 magnifier is also provided to allow closer examination of waveforms. In delayed-sweep operation, the delayed signal can be viewed as a second trace, or superimposed on the non-delayed signal. For special applications, the 2190 also offers front-panel x-y operation, TTL-compatible z-axis input, channel 1 output on the rear panel, signal delay line, and single-sweep operation.



The model 2190 oscilloscope, complete with two probes, a manual, and a schematic diagram, has a suggested user price of $1645.00. For additional information, contact B&K-PRECISION, Maxtec International Corp., 6470 West Cortland St., Chicago, IL 60635.

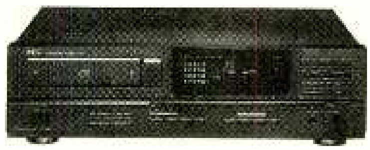
CIRCLE 74 ON FREE INFORMATION CARD

COMPACT-DISC PLAYER

Improved digital filter oversampling and multiple digital-to-analog converters in *NEC's CD-730* CD-player provide substantially reduced audio distortion. Professional-quality features include a 16-times transversal filtering circuit; four dedicated D/A converters (two for each audio channel) to minimize crosstalk and phase shift; electrical and optical digital outputs to transmit audio data in unaltered digital form to compatible amplifying systems; and an optical decoupling mechanism to reduce digital noise and RFI.

The unit's convenience features include auto edit, which lets the user select specific songs; auto space, which provides a 5-second pause between tracks, helpful when recording from a CD; and "cue and

CIRCLE 9 ON FREE INFORMATION CARD



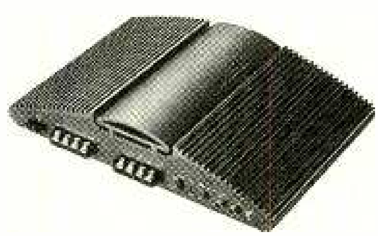
review," which plays five seconds from each track to help the listener find the desired song. "Delete programming" tells the player which songs not to play, and "time search" tracks the length of recordings. The player also has digital audio fade, auto and manual edit modes, and 24-track random memory.

The CD-730 compact-disc player has a suggested retail price of $399.00. For additional information, contact NEC Home Electronics (U.S.A.), Inc., 1255 Michael Drive, Wood Dale, IL 60191.

CIRCLE 75 ON FREE INFORMATION CARD

CAR-AUDIO AMPLIFIER

Styled in black, with a distinctive pyramid-like shape, *Sansui's SM-A807* power amplifier delivers a maximum 100 watts per channel for stereo operation, and can be bridged to provide 200 watts of mono power. The car-audio power amplifier has a frequency response of 10 Hz–100 kHz ±3 dB. THD is less than 0.04% and the signal-



to-noise ratio is 90 dB. The 6.6-pound amp measures $11\frac{13}{16}$-inches wide by $2\frac{9}{16}$-inches high by $8\frac{5}{16}$-inches deep. With adjustable-level RCA inputs, the SM-A807 is easy to install.

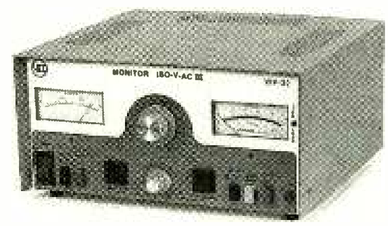
The SM-A807 car-audio power amplifier has a suggested list price of $399.95. For further information, contact Sansui Electronics Corp., 1250 Valley Brook Avenue, Lyndhurst, NJ 07071.

CIRCLE 76 ON FREE INFORMATION CARD

ISOLATED AC-POWER SOURCES

KAPPA/VIZ's Iso-V-AC II WP-30 and *Iso-V-AC III WP-32* (pictured) provide isolated-output AC voltage, adjustable from 0 to 150 volts. The WP-30 can supply a continuous 5-amp output current to a maximum of 650 VAC, and the WP-32 can supply a continuous 10-amp output current to a maximum of 1300 VAC. The output current can be set to the maximum output desired, at which point a latching relay will open the circuit and reduce output volts and amps to zero. Two parallel three-prong AC sockets are provided, allowing the unit to be used for more than one load.

Both models include a leakage tester that can measure AC-current in electronic equipment to determine if the leakage is within UL and CSA limits. An audible alarm warns of "hot" chassis or shorts to exposed metal on the equipment under test. Each unit



comes with two $3\frac{1}{2}$-inch meters. One meter monitors line or output voltage and the other can be used to display output current or leakage. For safety, the units' metal cases are connected to the power-line ground through the three-conductor AC-power cord. The AC input is separately fused.

The Iso-V-AC II WP-30 and Iso-V-AC III WP-32 have suggested user prices of $420.00 and $570.00, respectively. For further information, contact KAPPA/VIZ Test Equipment, 175 Commerce Drive, Fort Washington, PA 19034.

CIRCLE 77 ON FREE INFORMATION CARD

LAPTOP COMPUTER

Aimed at portable-computer users who require PC compatibility but don't want the tradeoff in terms of increased weight, size, and cost, *Tandy* has introduced the ultralight *1100 FD* laptop computer. It features the MS-DOS 3.3 operating system and DeskMate's Desktop, TEXT application, and 90,000-word spell checker in ROM. With those features, its one $3\frac{1}{2}$-inch 720K drive provides plenty of disk space for most purposes. In addition, the standard array of DeskMate applications, accessories and utilities—Worksheet, Filer, Telecom, Calendar, Address Book, PC-Link, etc.—are included on floppy disks.

The 1100 FD measures 12.1 × 2.4 × 9.8 inches and weighs less than $6\frac{1}{2}$ pounds. It runs for more than five hours on a removable, rechargeable battery. An AC adapter/recharger is included. The laptop has a low-battery indicator and a battery-saving stand-by mode.

Other features include an NEC V-29 microprocessor with 8-MHz clock speed, 640K of available memory, a built-in real-time clock, and a full-size 84-key keypad with enhanced keypad emulation. The 80 × 20, high-contrast LCD has 640 × 200 resolution. The fold-over display measures approximately 9 inches diagonally, and closely resembles the aspect ratio of conventional video monitors. The laptop also

has a parallel printer port, a serial communications port, and one dedicated internal modem slot.

The 1100 FD laptop computer (catalog No. 25-3530) has a retail price of $999.00. A 2400-bps internal modem (catalog No. 25-3538) and a replacement battery (catalog No. 25-3536) are available optionally for $199.95 and $29.95, respectively. For more information, visit or call your local Radio Shack Computer Center or Radio Shack store.

CIRCLE 78 ON FREE INFORMATION CARD

VHS CAMCORDER

Digital special effects including picture wipe, image mix, and strobe set *Philips'* top-of-the-line *Sylvania VKC242A* apart from the camcorder crowd. When using picture wipe, the last shot recorded is stored in the digital memory and used as a transition into the next recorded segment. The photographer can choose between left-to-right wipes, center wipes, and a "dissolve wipe" effect. Six different image mixes are available: The stored and live pictures can be viewed simultaneously on a full screen, viewed side by side, viewed with either of those pic-

tures in the center of the screen and the other surrounding it, or the stored picture can appear in the upper-left or lower-right corner with the live picture filling the rest of the screen. The strobe feature lets the user record a series of progressive still images onto the tape.

The VKC242A also offers a 10-watt integrated DC video light, a flying erase head, and a built-in monitor speaker with volume control. Other advanced features include VHS index search, audio/video dubbing, automatic date with battery backup, wind-noise defeat, and review/edit search. The camcorder has an 8:1 $f/1.2$ two-speed zoom lens with Macro, and a two position high-speed shutter.

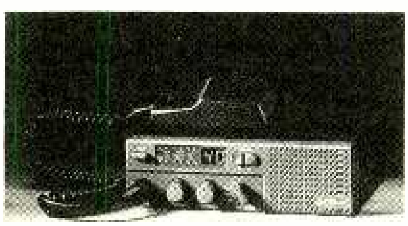
The model VKC242A VHS camcorder, including a 3-year limited video-head warranty—has a suggested retail price of $1,849.00. For more information, contact Philips Consumer Electronics Company, One Philips Drive, P.O. Box 14810, Knoxville, TN 37914-1810.

CIRCLE 79 ON FREE INFORMATION CARD

WEATHER RADIO CB

By combining a National Weather Service receiver with a CB, *Cobra's 18RV* offers a complete travel-information center in one unit. The model 18RV, designed with truckers, RV owners, and off-road enthusiasts in mind, is also the industry's first mobile CB with a front-firing speaker. That makes it easy to install under a seat, in the dashboard, or in an overhead instrument panel—without needing to cut extra openings for speakers.

The radio's integrated National Weather Service receiver allows selection of the three most active weather frequencies by a front-panel switch. The 24-hour broadcasts provide regional and local forecasts and



weather summaries, as well as weather-related highway and waterway information and emergency announcements about travel conditions. The weather bands are received with the CB's standard antenna.

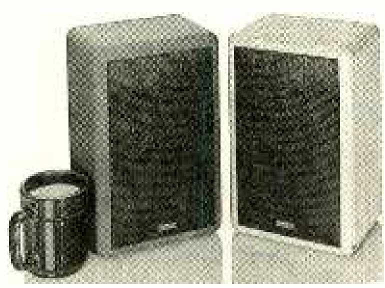
Other features of the 18RV include electronic tuning, a front-panel microphone connector, squelch control, and an automatic noise limiter to reduce background noise. Its "channel saver" feature retains the last channel used when the CB is turned off. The large LED readout includes separate transmit and receive indicators and a signal-strength meter.

The 18RV CB radio has a suggested retail price of $129.00. For more information, contact Cobra Electronics Group, Dynascan Corporation, 6500 West Cortland Street, Chicago, IL 60635.

CIRCLE 80 ON FREE INFORMATION CARD

COMPACT SPEAKER

Ideal for situations where space is at a premium, *Cambridge SoundWorks' Ambiance* speaker system measures just $7^{1}/_{16} \times 10^{7}/_{8} \times 5^{1}/_{2}$ inches. The compact two-way system was designed by Henry Kloss according to classic acoustic suspension principles. It uses a $6^{1}/_{2}$-inch long-throw woofer



and a 1-inch dome tweeter. While a minimum of 15-watts-per-channel is recommended, unusually high power-handling capabilities assure safe operation with virtually any amplifier or receiver designed for home use. The Ambiance can also be used as an extension speaker, and in surround-sound systems in the rear or in the "front center-fill" position.

Ambiance speakers are available for $109.00 each in gunmetal-gray Nextel or primed but unpainted; in a solid-oak cabinet, they cost $129.00 each. (Prices do not include shipping.) For additional information, contact Cambridge SoundWorks, Inc., 154 California Street, Newton, MA 02158; 1-800-252-4434 (in Canada, 1-800-525-4434).

CIRCLE 81 ON FREE INFORMATION CARD

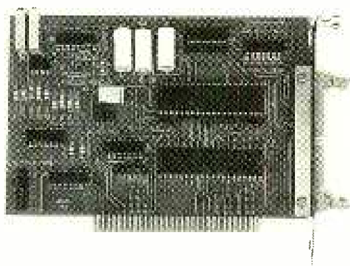
DATA-ACQUISITION CARD

A turnkey 8-channel data-acquisition system from *Global Specialties*, dubbed the *PROTO-KEY AD-128*, offers an accurate means of real-time data collection from IBM and compatible PC's. It comes complete with menu-driven software, no programming skill is required. The software uses a pop-up menu format, and users can

New Products

save and recall experiment setups, log data, or obtain on-line help with a single key stroke. Data can be stored in a disk file for later use with popular spreadsheet and analysis program.

The board plugs directly into the PC's I/O expansion slot. It includes 8 A/D input channels with 12-bit resolution, selectable conversion times of 7 Hz or 30 Hz, three input ranges from ±5 volts to 50 mV, 100-



uv resolution, software-programmable gain, and built-in thermocouple linearization. The AD-128 easily interfaces to a variety of transducers, and with the optional *WORKBOX* accessory it is possible to construct specialized signal-conditioning circuits. Accessory pods for interfacing type-K thermocouples are available in single-channel or eight-channel versions.

The PROTO-KEY AD-128 data-acquisition system costs $395.00. For further information, contact Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Tel. 1-800-572-1028.

CIRCLE 82 ON FREE INFORMATION CARD

AM/FM HEADPHONE RADIOS

Two AM/FM stereo headphone radios from *Emerson*, models *AR2200* and *AR2203* feature FM-mono/FM-stereo slide switching, a built-in four-section telescoping FM antenna, an AM ferrite antenna, direct station rotary tuning, and rotary volume control. The AR2203 (pictured) also offers a three-band graphic equalizer for bass, mid-range, and treble. Both compact, lightweight

models have soft earpads and an adjustable headband for comfortable listening.

The AR2200 and AR2203 AM/FM stereo headphone radios have suggested retail prices of $19.95 and $24.95, respectively. For further information, contact Emerson Radio Corp., One Emerson Lane, North Bergen, NJ 07047.

CIRCLE 83 ON FREE INFORMATION CARD

SURGE SUPPRESSORS

Specially designed for protecting *d*ata *l*ines (*DL*) in computer and communications systems against transient voltages, *Verite's Veri/Protektor* line of surge suppressors safeguard signal lines and equipment against electrical overstress caused by lightning, electrical motors, heavy machinery, or generators in the area. The devices are qualified with 6000-amp 8 × 20 microsecond pulses and attenuate transients that exceed EIA limits with a peak current up to 25 amps.

The DL series includes three standard models of 2, 6, or 8 lines rated for the desired clamping voltage. The standard clamping voltages offered are 5, 12, 24, and 48; special voltages are available on request.

Custom units for up to 1024 lines are also available, and multiple banks can be added in parallel for larger systems. The 2-, 6-, and 8-line units are configured in individual modules using screw terminal connectors. Larger systems use plug-in circuit cards of 16 lines each that plug into a custom integrated rack-mount system. Each cabinet features an interconnecting backplane, power supplies, and a distribution network.

The Veri/Protektors DL surge suppressors cost $59.90 for the 2-line model, $89.90 for the 6-line, and $129.00 for the 8-line. For additional information, contact Verité, P.O. Box 697, Harbor City, CA 90710-0697.

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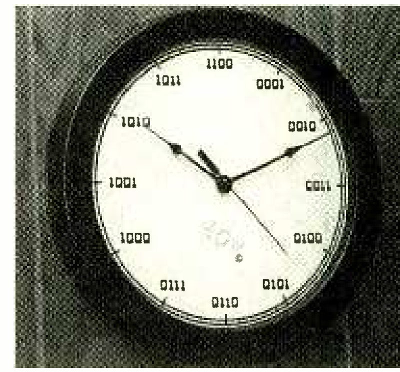
BINARY-DIGIT CLOCK

Adding a high-tech touch to home or office, the *Binary Digit Wall Clock* from *Sunrise Computer Products* is a conversation piece



as well as a time-keeping device. The 13-inch diameter clock has numbers in binary digits, especially appealing to computer lovers who are accustomed to working in the binary system. The timepiece has battery-operated precision quartz movement, so it can be hung anywhere; an AA battery is included.

The Binary-Digit Wall Clock costs $49.95 plus $3.00 for shipping and handling. For more information, contact Sunrise Computer Products, P.O. Box 709, Kenilworth, NJ 07033.

CIRCLE 85 ON FREE INFORMATION CARD

DIGITAL HF TRANSCEIVER

Designed for serious contesting and DX'ing, *Kenwood's TS-950SD* is the first amateur radio transceiver to use digital signal-processing (DSP) techniques, a 50-volt final amplifier, dual fluorescent-tube digital display, and a digital bar meter with a peak-hold function. The transceiver is fully equipped with CW, SSB, and AM IF filters.

The unit's digital signal processor improves spurious response and unwanted sideband suppression, and delivers flat and clean sound with a wide frequency response. The user can choose from any of

four possible audio levels on the DSP. For CW, digital filtering results in a waveform that is free of key clicks; the waveform's rise time is adjustable. A digital AF filter, synchronized with SSB IF-slope tuning, provides optimum filter response.

The TS-950SD can receive two frequencies simultaneously. Its built-in microprocessor has been factory programmed to quickly tune for minimum SWR, and the tuner settings can be stored in memory.

(Continued on page 22)

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New Products

(Continued from page 18)

The transceiver includes all of Kenwood's well-known interference-reducing controls—SSB IF slope tuning, CW variable-bandwidth tuning, CW AF tune, IF notch filter, dual-mode noise blanker with level control, a 4-step RF attenuator, and all-mode squelch circuit.

Microprocessor-managed frequency control is easy to operate using the transceiver's built-in keyer, direct BAND ACCESS key, and illuminated keyboard frequency selection. It offers 100-channel memory that stores independent transmit and receive frequencies, mode, filter data, auto-tuner data, and tone frequency. Ten channels are used to establish the upper and lower limits for the programmable band marker.

The TS-950SD transceiver has a suggested retail price of $4399.95. For additional information, contact Kenwood U.S.A. Corporation, Communications & Test Equipment Division, 2201 East Dominguez Street, Long Beach, CA 90810.

CIRCLE 86 ON FREE INFORMATION CARD

POWER SUPPLY

Elenco's 3-output power supply, model *XP-620*, is regulated to better than 0.2-volts when going from no load to a full load. It provides one fixed voltage—5 volts DC at 3 amps—and two variable supplies—1.5 volts DC to 15 volts DC and ±1.5 volts DC to ±15 volts DC at 1 amp.

The XP-620 is small enough to fit on any workbench, measuring just 8¼ × 7 × 4 inches. It is available fully assembled with a two-year warranty, or in kit form with easy-to-follow instructions and circuit descriptions.

The XP-620 3-output power supply costs $89.95 fully assembled or $59.95 in kit form. For more information, contact Elenco Electronics, 150 West Carpenter Avenue, Wheeling, IL 60090.

CIRCLE 87 ON FREE INFORMATION CARD

SWR/WATTMETER

A peak-reading function, offered along with the standard average-reading function, distinguishes the *MFJ-815B* lighted cross-needle SWR/Wattmeter. It lets users

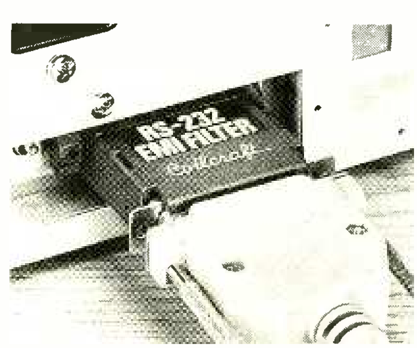
monitor SWR, forward and reflected power at a single glance. There are two power ranges available for forward and reflected power: 2000 watts forward and 500 watts reflected, or 200 watts forward and 50 watts reflected. The instrument displays SWR from 1:1 to 8:1, and covers 1.8 to 30 MHz with 10% accuracy.

The MFJ-815B cross-needle SCR/wattmeter, with a full one-year guarantee, costs $69.95. For more information, contact MFJ enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762.

CIRCLE 88 ON FREE INFORMATION CARD

EMI FILTER MODULE

An easy way to eliminate the problems of stray electromagnetic interference (EMI) in signal cables running between poorly filtered equipment is provided by *Coilcraft's EMI Filter Module*. Many pieces of electronic equipment produce large amounts of EMI that can interfere with low-level data and timing signals. If it isn't eliminated inside the equipment, EMI can escape through connector cables, where it mixes with the signal and often spreads to other devices. EMI can cause printer mal-



functions, corrupted data, and errors in modem transmissions.

The EMI Filter Module has two DB-25-type connectors (one male and one female) and plugs between an RS-232 cable and an input or output port. Common-mode circuits filter all lines except the frame ground, attenuating EMI by at least 15 dB over the critical 30–300-MHz range.

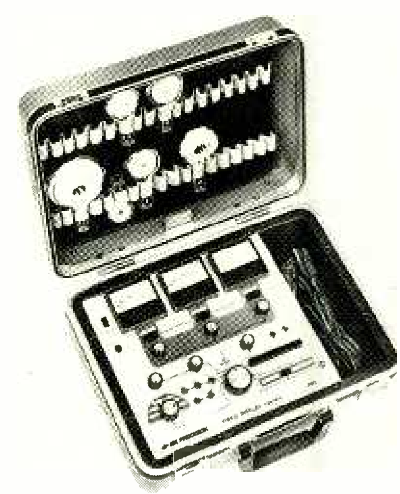
The EMI Filter Module costs $29.95 plus shipping. For further information, contact Coilcraft, 1102 Silver Lake Road, Cary, IL 60013.

CIRCLE 89 ON FREE INFORMATION CARD

VIDEO DISPLAY RESTORER/ANALYZER

Designed for servicing computer video terminals as well as video monitors and television receivers, *B&K-PRECISION's* model *490* can display the condition of a CRT and then, through an exclusive restore capability, extend its life and improve performance. The unit's patented "Tri-Dynamic" multiplex test method simultaneously tests all three CRT gun colors. Only the beam current that actually passes through the G1 aperture to the screen is measured, providing an immediate analysis of cathode-to-cathode leakage. Results are displayed on individual meters. The model 490 also analyzes G1-to-cathode leakage and tests focus-electrode continuity.

The model 490 removes shorts, cleans and balances guns, and rejuvenates cathodes. The restoration process is completely



automatic, requiring no adjustments or special monitoring. The CRT's cathode controls its own restoration duration, reducing the risk of cathode damage. B&K says that more than 95% of the CRT's that have been restored with the technique used by the model 490 function as well as new tubes for as long as two years.

The instrument comes in a rugged, molded plastic case with CRT-adapter storage space in the lid. It is supplied with six CRT adapters, and other adapters for a variety of VDT's, video monitors and television receivers. A CRT Information Updating Service provides users with charts that describe how to use the restorer/analyzer with all common CRT's. The charts are updated twice yearly.

The model 490 video-display restorer/analyzer has a suggested user price of $715.00. For further information, contact B&K-PRECISION, Maxtec International Corporation, 6470 West Cortland Street, Chicago, IL 60635.

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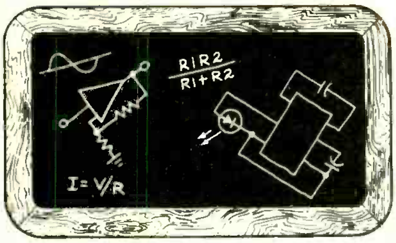
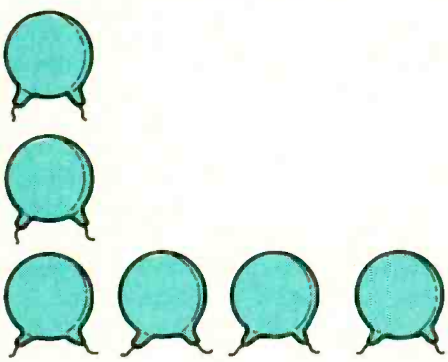


Think Tank

By Byron G. Wels, K2AVB

BRAIN BUSTERS!

I was at home working on a project, busily populating a board and soldering components in place. That's when the doorbell rang. It was my friend Murray, who *always* showed up unannounced. I went back to the dining-room table, which frequently serves as my workbench, and Murray sat down alongside me. I had components all over the place, and he picked up a handful of green disc capacitors. He laid them on the table, like this:



"Byron," he said, can you move only one of these things only once, and have *four* of 'em in each row?"

I glanced at what he had done. Impossible. I put the soldering iron down, and he watched, amused, as I made a couple of tentative moves. "How?" I asked. "Work on it," he said. "Murray," I told him, either show me how to do it, or I'm going to strangle you. That's your choice."

Well, to make a long story short, he *did* it! I didn't believe him, but it can be done, and so simply that you'll be totally flabbergasted. Now I know you guys like these little brain teasers, so this is it for this month. Since you can't reach me to strangle me, I'm safe. Next month I'll give you the answer, okay?

The mail has been pouring in from all of you, with the correct answer to "How to bring back seven gallons of water." And I mean, you have been *flooding* me! I don't really expect too much mail on the one with the disc capacitors, as it is a little tough. Incidently, if you haven't got six ceramic discs, you can do it with coins too.

Now let's get down to business and see what the flood (?) of mail brought in for this month. The guys whose circuits appear here have already received one of our dwindling supply of Fips Books.

And speaking about the Fips Books, I've got some good news. Today, yes, this very day, the boss and I went to the warehouse and located a few additional cartons of the Fips Book. Now the pressure is off, and we've got a brand new supply that should hold us for at least the next week or so!

As I said, the mail has been pouring in (in three- and five-gallon buckets). Let's see what you guys have been up to lately.

Digital Readout. This unit displays a scale using even numbers or odd numbers. It's simple, inexpensive, and uses only three IC's. See Fig. 1. When V_{IN} is below all four references on the LM324, all outputs are low, causing all outputs of the 4070 to be low. That causes a 0 to appear on the seven-segment LED display (DISP1).

As each reference point is passed and its output goes from low to high, DISP1 displays the numbers 2, 4, 6, and 8. As the voltage decreases, the numbers will decrease in value; *e.g.*, 8, 6, 4, 2, 0. By placing S1 (a SPDT toggle switch connected to pin 7 of U3) to V_{CC} from ground, the scale will then read 1, 3, 5, 7, 9 and *vice-versa*. The hardest part will be deciding whether to choose an even- or an odd-numbered scale, and that's the reason for the toggle switch.

The feedback loops on the four op-amps (U1-a–U1-d) are a must to ensure clean switching states and sharp number changes. You can make your own reference scale (resistor network). The one shown covers the full range from ground to V_{CC}.

You can substitute a 7486 (TTL exclusive-OR) and a 7447 (TTL 7-segment decoder/driver) for their CMOS counterparts, but it will be necessary to rewire the circuit somewhat due to differing pinouts. If TTL units are substituted for those shown in the schematic diagram, use LS (low-power Shottky) units only.

I've learned that feeding a signal to a standard TTL device from pin 14 of U1-d (during the low output state) causes the output of U1-d to rise just enough to cause the D-input of the 7447 trouble in recognizing if it's a low or a high state, and consequently the D input will assume a high state and the numerical LED display will show a number eight or nine and a number of Arabic symbols.

I hope that qualifies me for a Fips Book.

—*Michael S. Lewis, London, Ontario, Canada*

Right Mike. It qualifies you and how! This sort of circuit is more a tutorial than anything else, but there's nothing wrong with our learning more from our readers. I do it all the time.

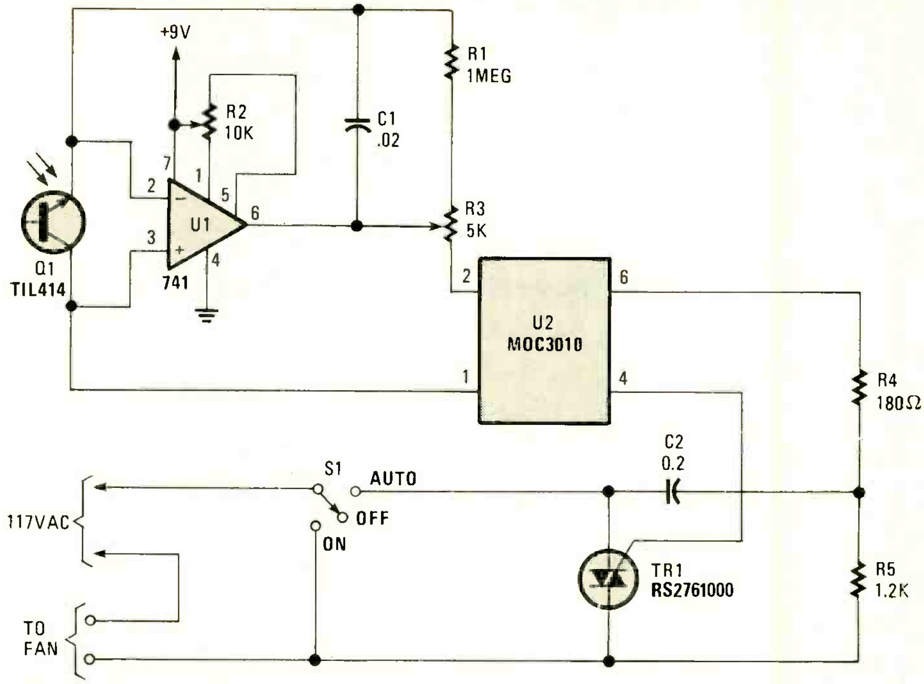


Fig. 2. This simple IR control circuit is designed to activate a kitchen exhaust fan under pre-defined conditions.

Auto Kitchen Fan. While I've got your attention By, look at this Automatic Kitchen Fan (see Fig. 2). In my circuit, the IR detector has a sort of wide-angle view of the whole stove top, but not the exhaust hood light, so it will operate properly. When the IR detector "sees" heat, it automatically turns on the kitchen fan. Mine comes on when there is *any* warmth to be vented at the stovetop, even from the oven's vent up through one of the back burners.

Capacitor C1 can be any value between 0.02 μF and 2.2 μF. The higher the capacity, the less sensitive the circuit will be. The circuit can be powered from any supply that can provide 9-volts DC; a small wall-plug type, for instance.

Okay, I've submitted my two applications circuit, and hope that at least one of them will be worth a book.

—*Don M. Beaver, Santoquin, UT*

Well Don, you've done it again. But I'm not sending you two Fips books. For your effort, you're going to be rewarded with one of our Think Tank *books!*

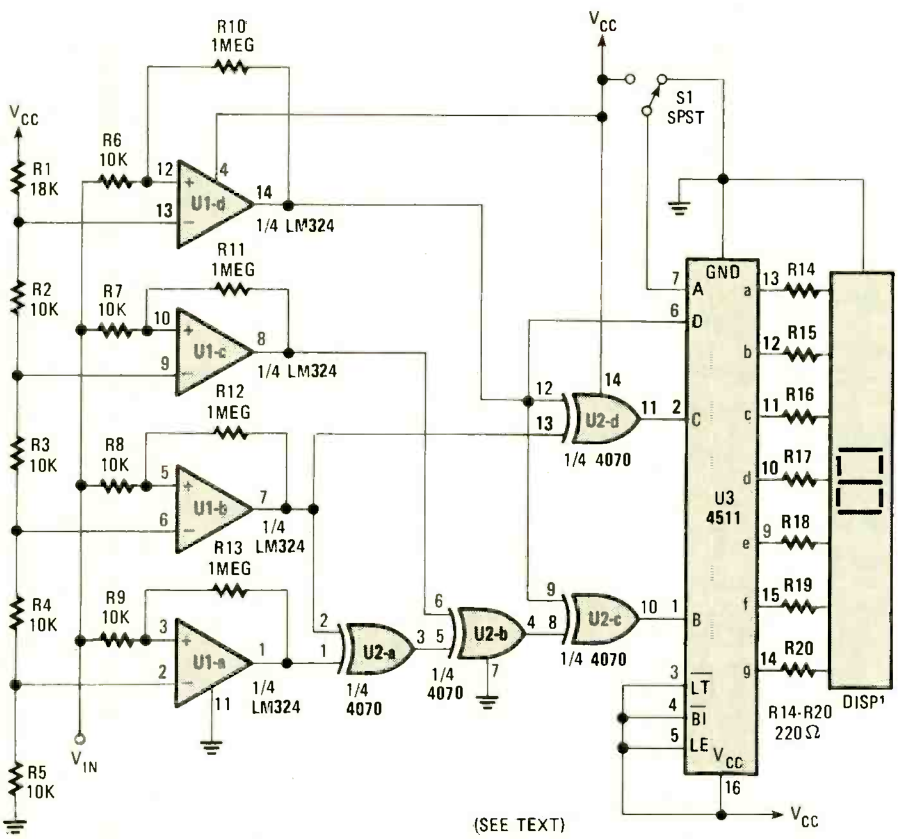


Fig. 1. The Digital Readout displays a scale using either even numbers or odd numbers, from low to high (0, 2, 4, 6, 8) or from high to low (8, 6, 4, 2, 0).

Ultimate Alarm. I had my car stolen, and was not about to have that experience repeated. I shopped around for car alarms, not for prices, as I was determined to build my own. I was looking for features. Finally, armed with sufficient knowledge, I designed a unit that I felt incorporated the best that the others had to offer. I'll grant that it was too complete, but the circuit shown here (see Fig. 3) omits some of those features that aren't really required. I think you'll like it.

You can't forget to set it; the circuit automatically turns on when the car is turned off. It gives you a variable time to

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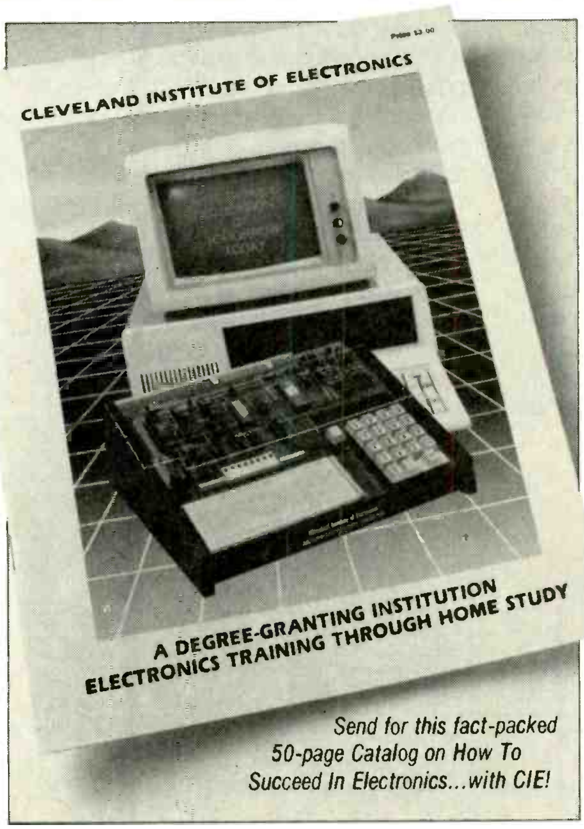

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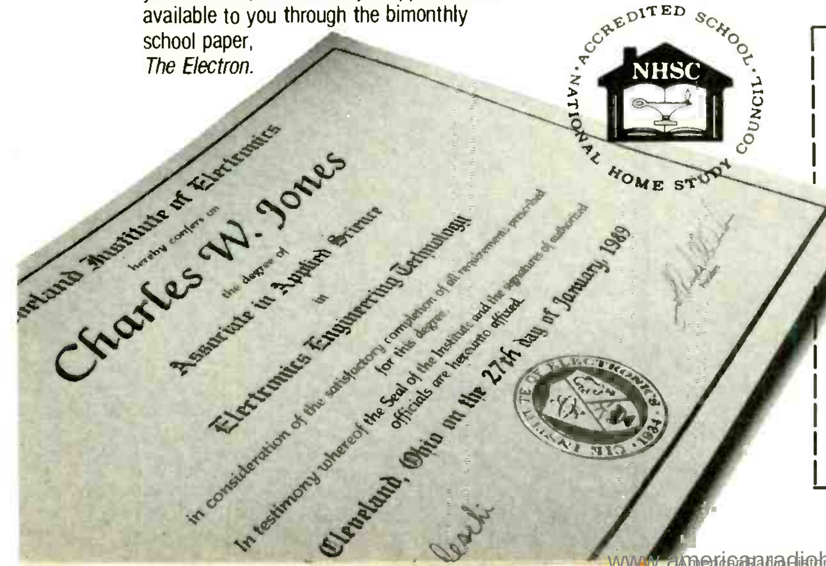

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get out and lock up, and also provides a variable time delay to get in and start the car. The alarm I used was a 110-dB siren from Radio Shack. It's mounted *inside* the car and out of sight. The reason for that is that most outside alarms really don't attract much attention, and the sound from this unit is so loud (on the threshold of pain) that you just can't stay in the car while the siren is sounding.

Here's how it works: Due to the innate instability of 555 oscillator/timers, they are always powered down when the car is on. That keeps the alarm from going off while you're driving. As soon as the car is turned off, Q2 switches off and shunts power to U1. When that happens, U1 immediately sends its output high, keeping Q3 on, and thereby preventing power from returning to U2.

Transistor Q2 also sends power to Q3's collector to be used only when U1 has completed its timing cycle. When U1 has finished, it turns Q3 off, which in turn activates Q4, sending power to the balance of the circuit. That timing period was the time needed to get out of the car. LED1 indicates that the system is disarmed, and LED2 indicates that the system is armed.

At this point, U2 waits for a trigger pulse from the car's door switches or dome light. A positive impulse at the 4011's input sends a negative trigger pulse to the first stages of U2, which is connected as a cascading timer. The first stage's output goes high for a time to allow the car to be turned on.

If that does not happen, the first stage's output goes low, sending a low trigger pulse to the second stage. The second stage then sends its output high, turning on Q5, which sounds the alarm for a given time. Once that time has elapsed, the alarm is shut off by a low output to Q5 and the system is reset.

If the car door is closed or a second door opened while the alarm is sounding, the first stage re-triggers and prepares to extend the on-time of the alarm.

The cascading or counting action continues until the car is left alone. You can add a switch on the positive supply rail at J3 to override and silence the alarm if (for example) you plan to work on the car. Hide the switch well. Switch S1 is a normally-closed type built into the case of the alarm, and is pushed to the open position when the case is mounted flush with a surface, and acts as a tamper switch. Any attempt to remove the alarm will cause the alarm to sound.

—*John Whitebread, Carp, Ontario, Canada*

Obviously a very well thought-out system, John. I've tried mentally, to punch holes in it, and couldn't. You know, it really makes sense, when you think

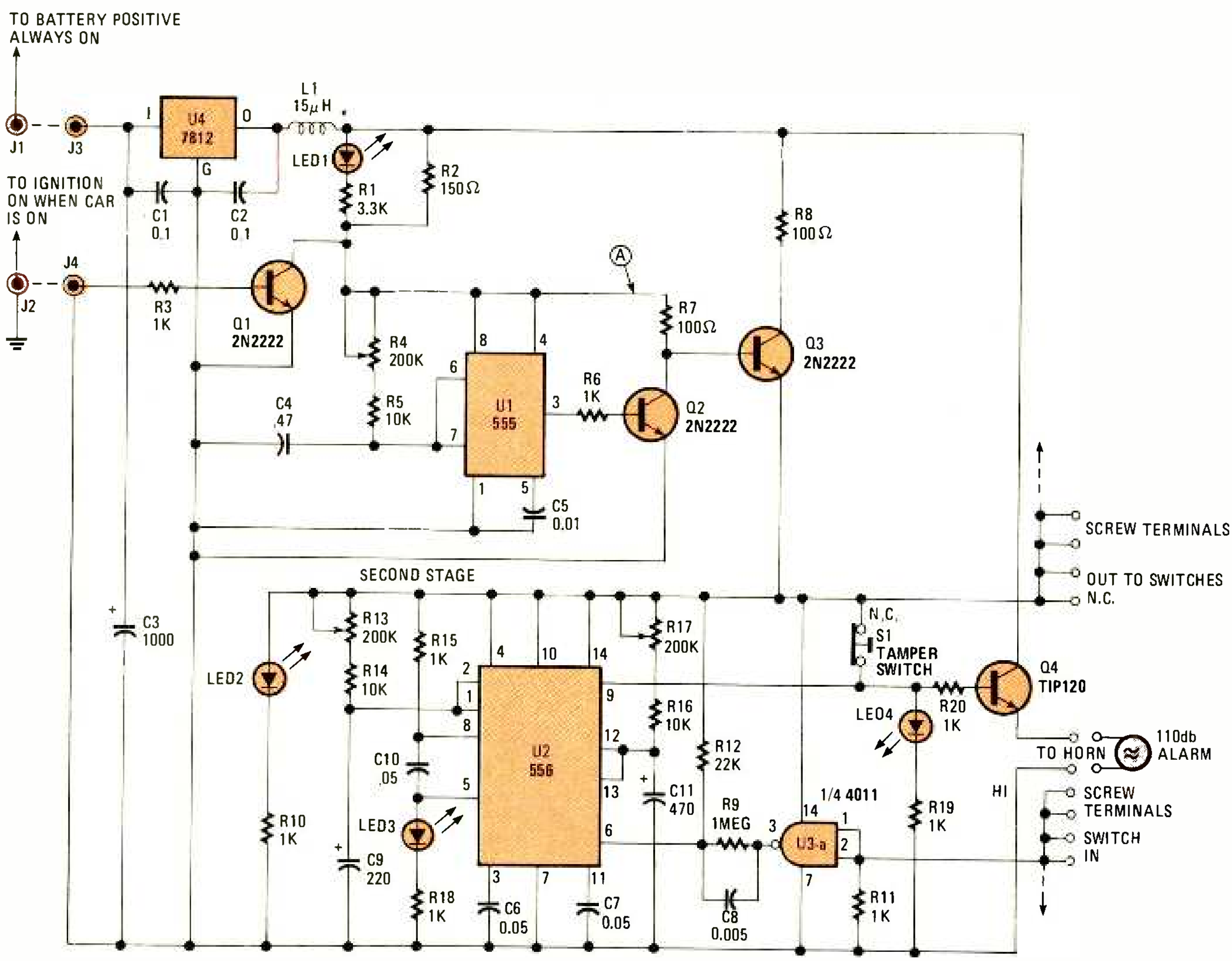


Fig. 3. This alarm circuit, intended as a grand-larceny auto deterrent, automatically turns on when the car is turned off, and has a variable time delay.

about it. I've heard those powerful little sirens, and a crook would really have to want a car to withstand all that noise! All the police would have to do is look for a deaf car thief! One more book, on the way.

Automated Entry Alarm. I'm really writing in reference to Ed Nordheim's "Relay Debouncer" circuit (September, 1989). I had a similar need to switch to a larger voltage by means of a small trigger voltage and used an SCR. I thought Ed might be interested in how I handled the problem.

I needed a way to work in my shop and be able to determine if somebody comes in the front door of the house. This circuit could be hooked up as an automated entry light, burglar alarm, or anything that would react to a change in light and/or motion. I got the light sensor from All Electronics Corp., PO Box 567, Van Nuys, CA 91408; it is part LSMD, and is priced at $5.75. The light sensor senses changes in light, making it very versatile. The rest of the parts come from Radio Shack.

I put the light sensor in a weather-tight container outside the front door. I ran a wire down to the basement to the signalling circuit (shown in Fig. 4), which then triggers a signalling device, in my case a buzzer. It could just as easily be connected to a lamp.

When the light sensor is first turned on, make sure that switch S2 is set to the OFF position while the sensor adjusts itself for ambient light levels. Switch S2 prevents false triggering of the buzzer until it is adjusted. After about 5 seconds, set S2 to the ON position. Now the circuit is ready to go. The LED serves as a troubleshooting device. If the buzzer does not sound, the problem is obviously in the relay hookup.

When the sensor activates, it puts out about three volts, which is insufficient to drive most relays. However, that voltage is sufficient to bias a transistor through a 330-ohm resistor. Forward biasing the transistor applies a gate trigger voltage to the SCR, turning it on. With the SCR turned on, the supply voltage is fed through the relay coil.

The circuit's supply voltage requirement depends on the type of coil being used. In my case, it was 11.7 volts. My SCR is rated at 200 volts and my relay at 125 volts AC. I was able to control a low current (about 1 amp) AC device. The SCR keeps the buzzer on, even after the sensor resets itself. To turn

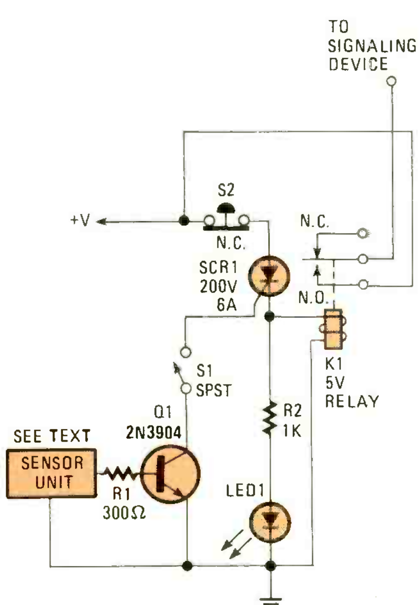


Fig. 4. At the heart of the Automated Entry Alarm circuit is a sensor (All Electronics Corp. part LSMD) that detects changes in ambient light and/or motion.

THINK TANK

the buzzer off, just push S3. That removes the power from the SCR's anode, which turns it off, leaving it ready for the next occurrence.

—*Brian K. Andrews, Newark, DE*

Good circuit Brian, but let's get one thing straight. You called me "Mr. Wels." My name is Byron, or better still, "By." "Mr. Wels" is my father! We're all friends, and I like to keep things informal!

Instrument Alarm. Like most electronics enthusiasts, I have collected lots of test equipment, and when I realized how much money I had invested in this stuff, it knocked me back! Then I wondered how I'd react if it got stolen. So I came up with a circuit (see Fig. 5) that's small enough to fit into almost any empty space in a small piece of test equipment. You just need a small hole for a miniature push-to-open switch (S2) and a few holes at the buzzer location to allow more sound to escape. And if your equipment uses a nine-volt battery, you can derive power for the alarm from it.

The mercury switch (S1) is normally open. Should the equipment in which the alarm has been installed be picked up and tilted, S1 closes, applying a trigger current to the gate of the SCR. Transistor Q1 then latches in a conducting state, allowing current to flow through the buzzer (BZ1). The buzzer will sound and continue to sound until you press S2 (reset) to set the circuit. For better results, use an electromechanical buzzer instead of a piezo type; electromechanical units make a good deal more noise. I recommend building duplicate circuits into each and every piece of equipment you own. I know that I did, and it helps me relax when people come to visit my electronics lab!

—*Thien Nguyen, Bridgeport, CT*

Thien, it's a great idea. The units will be inexpensive, easy-to-build, and can give you a bit of security, especially with test equipment getting smaller and smaller all the time. Your circuit does indeed earn you a book.

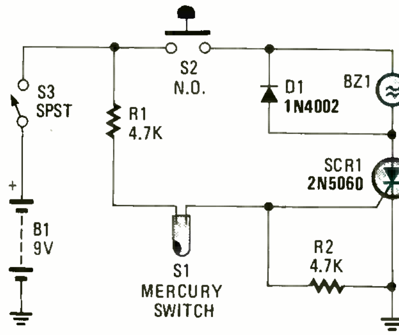


Fig. 5. The Instrument Alarm is nothing more than a simple tilt switch, whose operation is wholly dependent upon S1 (a mercury switch).

Remote Control. This ultra-simple remote-activated AC control circuit is easy to build, and uses readily available components. See Fig. 6.

When Q1 is exposed to a brief flash from an ordinary flashlight, it turns on, feeding a positive pulse to pin 14 of U1 (a 4017 decade/divider counter). Wired as shown, the pin 3 output goes low for every other positive pulse received at pin 14.

When pin 3 goes low, an LED inside U2 (an MOC3010 optocoupler with bilateral or triac-driver output) is biased on, thereby activating U2's internal bilateral switch. The bilateral output of U2 is fed to the gate of TR1, causing it to turn on. With TR1 turned on, the 117-volt AC line voltage is applied to SO1.

When light strikes the phototransistor a second time, the output of U1 at pin 3 goes high, turning off the optocoupler,

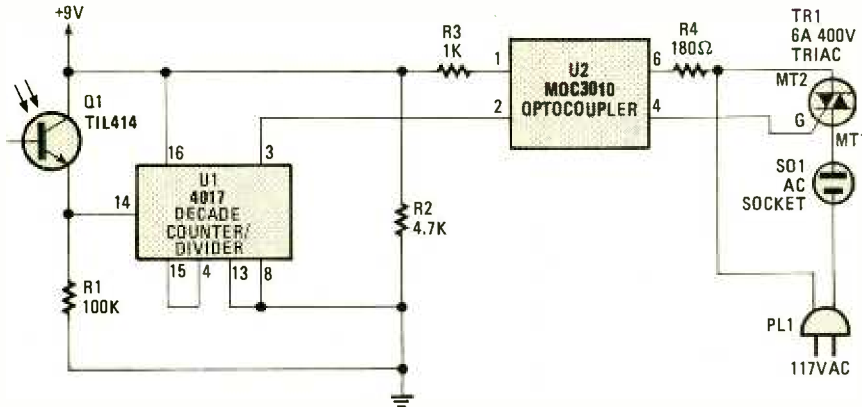


Fig. 6. This ultra-simple remote-activated AC control circuit can be activated by a brief flash from an ordinary flashlight directed at the light-sensitive area of Q1.

interrupting power to SO1. Loads up to 700 watts can be controlled by the circuit if the triac is properly heat sinked. An AC-derived power supply is recommended since constant power is required for the circuit.

You'll need a flashlight with a momentary pushbutton switch, which will serves as the remote transmitter. Mine has a signal button and a bright Krypton bulb. I built the circuit into a small project box, and used a small printed-circuit board. I've already got a Fips Book. Got anything else for me?

—Howard Adair, Jr., Spartanburg, SC

I'm glad you got a Fips Book, Howard. Not to worry, we'll dig up something else for you!

IR Remote Checker. I've been hunting for a simple remote-control checker so I could test all the infrared remotes that seem to be cluttering the house these days. I didn't want to spend the bucks on one of those commercial IR detector cards sold by some of the mail-order houses, so I built my own. I bought an IR phototransistor and designed a Darlington amplifier to allow it to drive an LED.

See Fig. 7. Infrared light striking Q1's base causes it to turn on, feeding the supply voltage to the base of Q2, turning it on, which, in turn, turns on Q3, lighting LED1. The reason for chaining that many transistors, is to get sufficient gain to make the circuit sensitive enough to be useful. Resistor R1 biases Q3 for maximum sensitivity.

To use the unit, just point the business end of a remote at Q1 from up to a foot or so away. Try all the buttons to check for an output. Some buttons will produce a continuous stream of IR pulses, others will fire only once.

You can fit the whole project along with a 9-volt battery in a small project box. Wire it up any way that fits. You won't need a printed-circuit board. I've found this little gadget a real servicing time-saver, and it's a great entertainer for friends. And I'd love a copy of the Fips Book to show off to my friends and family along with it!

—Renard DellaFave, Raleigh, NC

Good show, Renard! And I might add that Renard, along with his submission, sent in the correct answer to the "Seven Gallons of Water" brain buster! Your book is on the way.

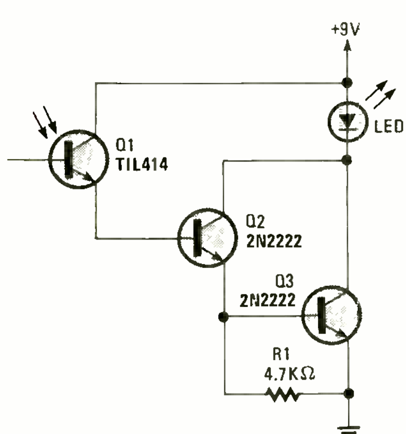
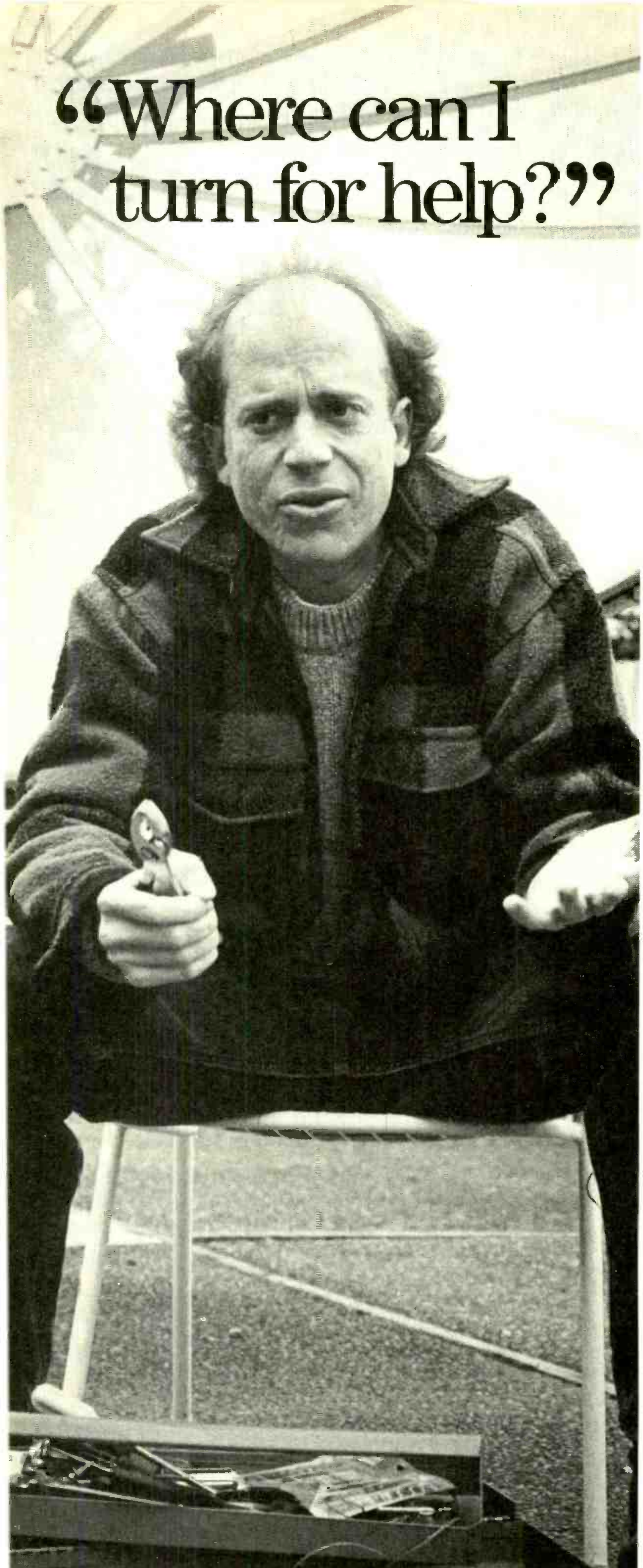


Fig. 7. The IR Remote Checker consist of little more than an infrared-sensitive phototransistor, and a pair of general-purpose transistors connected in a Darlington configuration, to provide sufficient drive to light LED1 (a visible light unit).

Signal Tracer. If you're troubleshooting a multi-stage amplifier, this device is more than helpful. See Fig. 8. It's essentially an amplifier with a variable-gain output, controlled by potentiometer R1. All you have to do is connect the alligator clip to the ground of the circuit

(Continued on page 100)



There is a way to get help when you need it. The American Home Satellite Association. An organization created exclusively to protect and enhance your enjoyment of your satellite TV system.

Take our toll free “Helpline,” for example. From locating satellite signals to locating a reputable dealer, help is just a phone call away. AHSA provides educational videotapes and informative books, too. At very special member prices.

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Build the Sonic Emulator

Give your home or automotive stereo system the sound quality that makes going to concerts so enjoyable.

BY CHADWICK PRYSON

While at one of the more memorable concerts I have attended, I had the opportunity to take leave of my assigned seat and move around in search of better acoustics. As I was moving to my alternate location, I noted the spectral content of the music changing relative to my movement. Certain instruments and passages became accented during my short trek across the auditorium. It occurred to me then that every person there, by virtue of their seat location, was interpreting the concert slightly different than everyone else!

That posed an interesting possibility. I envisioned a method that would emulate the acoustics of a live concert, while allowing the listener the option of altering his or her apparent position relative to the sound stage. Such a process could be applied to any stereo-signal source and by selecting the appropriate minimum delay time, the sonic parameters could be shifted artificially to produce the most pleasing effect per a given listening environment, *i.e.*, a living room vs. an auto interior. That's what the *Sonic Emulator* described in this article does. It gives you, the listener (whether in your car, living room, or elsewhere) the choice of the best seats in the house.

Bucket Brigade Update. The heart of the Sonic Emulator is a current-production, relatively new Reticon bucket brigade IC. For those not familiar with such IC's, a bucket-brigade device (BBD) is basically a long shift register capable of creating time delays of an analog signal within certain bandwidth limits. The shifting clock, which becomes a multiplexed component of the output waveform, is then filtered out to recover a delayed replica of the original input. There are three IC's in the Reticon series used in this project; the RD5106, RD5107, and RD5108. The sample-stage counts of those IC's are 256, 512, and 1024 respectively.

Aside from the different counts, and hence the different delay times (see Table 1), the three IC's are identical. Indeed, because of their similar pinouts, the user can select the time delay most suited to a particular application. For example, studies have shown that a time delay on the order of 2 to 3 milliseconds (available using the 5108) is well suited to a small listening area, such as an automobile.

In a large room, however, existing phase delays that are already a part of the room would severely cross-cancel if processed with excessive delay times. The results would be somewhat muddied by comparison, therefore a shorter delay, as provided by the other IC's in the series, would be warranted. Table 1 gives the number of samples per second and the time delays of the individual units.

The Sonic Emulator differs from similar "stereo expanders" in two respects: First, a variable phase control has been added. Second, no high-passing of the compensatory signal to the delay device (BBD) was deemed necessary to create the effect that occurs all around us—the natural combing effect of the listening environment that emphasizes certain frequencies while attenuating others, no matter where we are.

How the Emulator Works. Looking at the schematic diagram shown in Fig. 1, the left- and right-channels are fed to op-amp U1-b through decoupling networks, consisting of R2 and C3, and R3 and C4, respectively. The gain of that stage, which acts as a difference amplifier, is set by R2, R3, R6, and R7 at −6dB, and with the output being equal to L−R.

The combination of R1, C7, C19, D3, D4 make up the bias supply rail to all

TABLE 1—BBD Specifications

Reticon IC	Samples	Delay Time (ms)
RD5106	256	1.024 to 0.512
RD5107	512	2.048 to 1.024
RD5108	1024	4.096 to 2.048

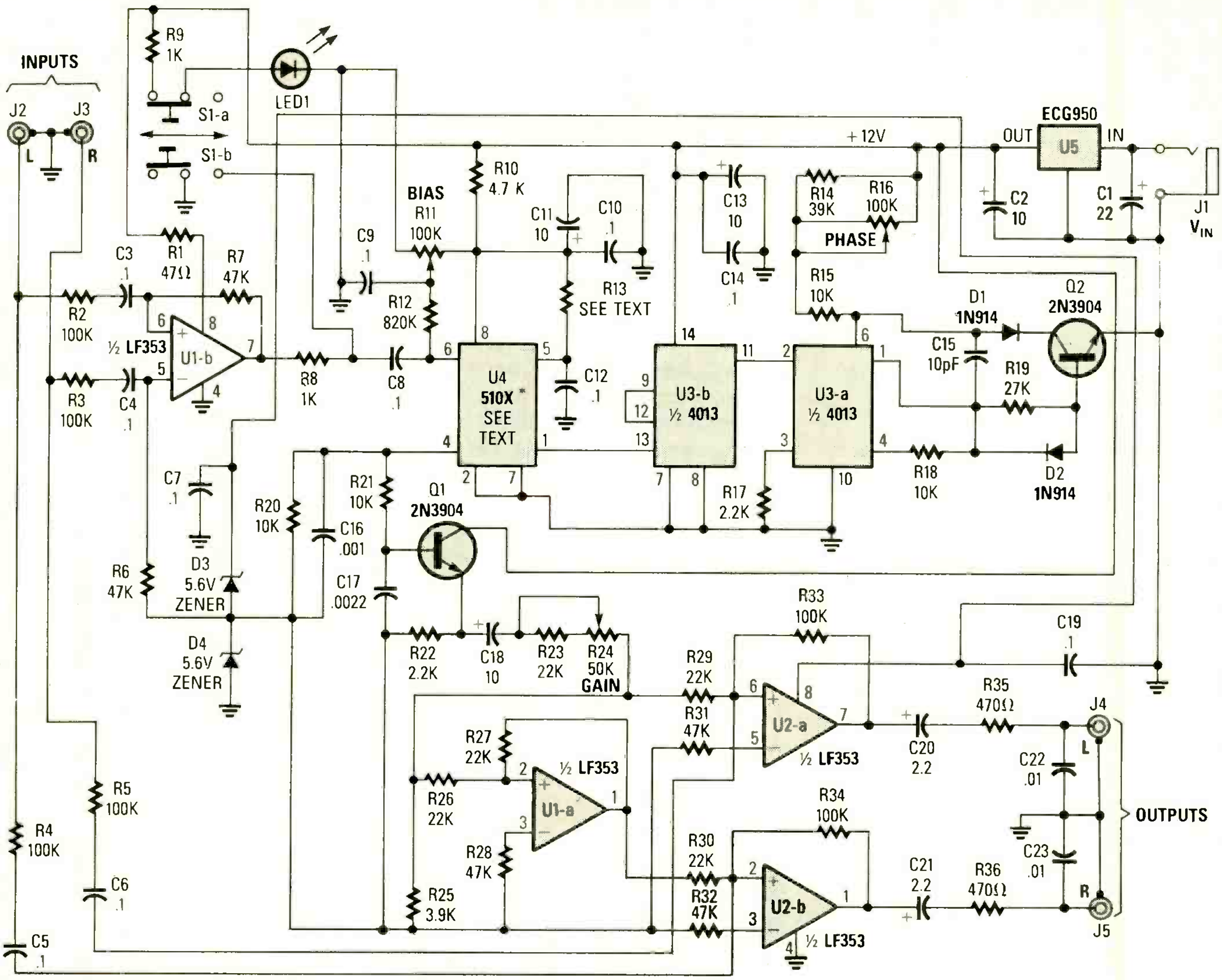


Fig. 1. At the heart of the Sonic Emulator is a bucket-brigade device (U4, one of a series of 510X devices), which is used to place delay in the audio signal, thereby expanding stereo imaging to produce concert-hall-like effects.

the op-amps and to the emitter of Q1, which is configured as a buffer stage. The resistor-capacitor combination of R8 and C8 serves a two-fold purpose; it acts as a load when the unit is bypassed, and it decouples the BBD's bias voltage.

Power for the RD510X device—U4, a variable-state shift register—is supplied to pin 8 (the +V terminal) through resistor R10. Resistors R11 and R12 provide an adjustable bias voltage, which is applied to pin 6. The left and right audio signal from U1-b is also fed to pin 6 of U4 through R8 and C8.

Resistor R13 is used to set the internal bias for the bucket-brigade device (U4). With R13 connected as shown, the circuit is configured to accommodate RD5108, and should have a value of 15k. For the 5106, R13 should have a resistance of 100k and be connected between pin 5 and ground (in parallel with C12). When U4 is the RD5107, R13 is not needed, and should be omitted. Capacitors C9–C14 are used as clock bypass capacitors.

A 2-MHz (maximum) clock generator and divide-by-two delay clock driver are formed by U3 (a dual 4013 CMOS D-type flip-flop). A resistor network, consisting of R14, R15, and R16 comprise an adjustable voltage-divider that is used to vary the voltage applied to a voltage-controlled oscillator (VCO) consisting of Q2, D1, D2, C15, R18, and R19. Resistor R17 serves as a pull-down.

Delayed audio from U4 is present on pin 4 along with clock translations, which are filtered by a second-order filter, consisting of R20, R21, C16, and C17. Transistor Q1 is configured as an emitter-follower buffer, and biased to the common rail by R22. The output of Q1 is decoupled by C18, and fed to the inverting input of U1-a through R23, R24, and R25; R24 (a 50k potentiometer) serves as a GAIN control. A portion of Q1's output bypasses U1-a and is fed directly to the inverting input of U2-a, which provides an inverted replica of the input signal. With the values shown for R26 and R27, U1-a's gain is set at unity.

The inverted output of U1-a results in a delayed R − L signal, which is routed through R30, where it is summed with the left-channel source—producing an L + (R − L) signal—which is fed to the inverting input of U2-b (the right-channel output).

The delayed signal is similarly routed (around U1-a) to the inverting input of U2-a (the left-channel output) through R29 where it, too, is summed with its complement (the right-channel source), thereby producing an R + (L − R) signal. Resistors R33 and R34 set the gain of the left and right output stages at slightly more than 6 dB.

Capacitors C20 and C21 decouple the output stages from the power supply, while two RC networks (consisting of R35 and C22 for the left channel, and R36 and C23 for the right channel) provide final clock filtering and load protection.

Voltage regulator U5 is used to provide a constant 12-volt power source for the operation of the circuit, while C1 and C2 are used to remove any ripple. The input to U5 should be at least 14 volts, and should be well filtered. The two-volt headroom in the source voltage will account for losses in the regulator—which will be somewhere around two volts.

It is possible to power the Sonic Emulator from less than 12 volts, but the delay-line "window" tends to close up or roll off at the extreme ends of the PHASE-control setting. Rebiasing will adjust that condition to a point, and introduce minimum distortion. In some auto installations, it may be necessary to add a hot-line filter to reduce alternator effects.

Construction. Due to the nature of this project, it is recommended that the circuit be built on a ground-plane printed-circuit board. The template for such a board is shown in Fig. 2. For those who have no desire (or lack the ability or the facilities) to produce their own board, one can be purchased from the supplier listed in the Parts List.

Once you've obtain the necessary components, construction can begin. Using Fig. 3 as a guide, start by installing IC sockets at all positions where IC's are indicated, except U3. Install the jumper connection that runs beneath U3 and then install the socket for that IC. Next install the remaining jumpers. After all IC sockets and jumper connections have been installed, the sockets can serve as reference points, making locating the proper positions for the other components a bit easier. Note: Resistor R13 is shown in the parts-placement diagram (Fig. 3) as a dashed line. That unit (if needed) should be tack soldered to the appropriate points on the solder side of the board.

Once all components have been installed on the board, prepare the enclosure that will house your project. The author's unit was housed in a small metal enclosure (GC Electronics part number 16-130), measuring about 4$\frac{9}{16}$ (W) by 3$\frac{9}{16}$ (D) by 1$\frac{9}{16}$ (H) inches. Preparation of the enclosure requires that several holes be drilled in the front and

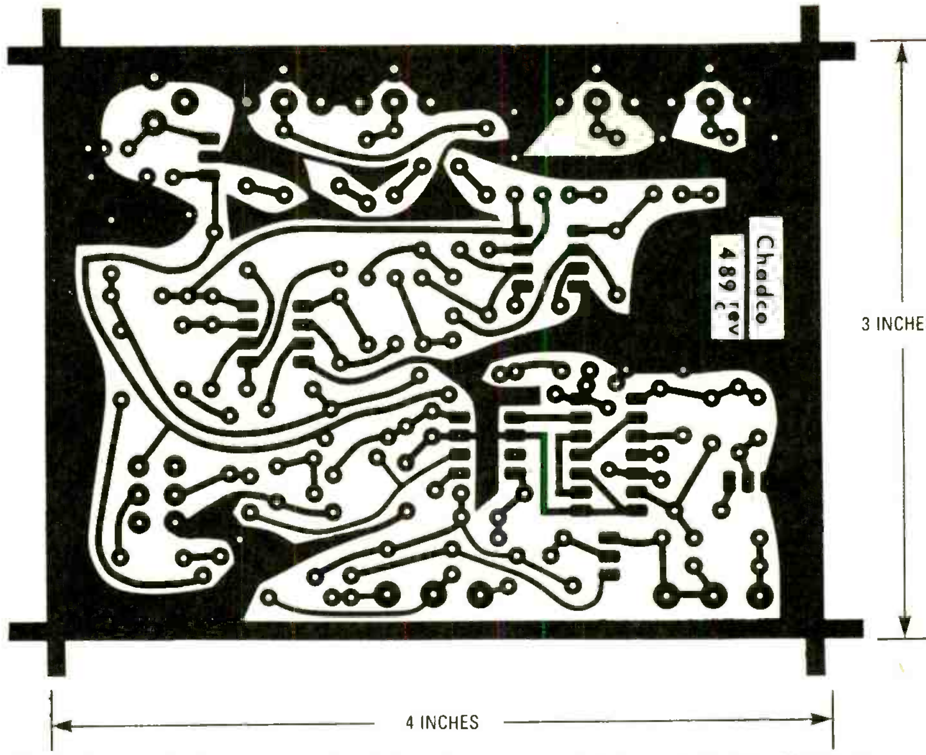


Fig. 2. A ground-plane printed-circuit board is recommended to use a for this project to eliminate the high-level clock pulses that might be present in the circuit. The printed-circuit template shown here is for such a board. You can etch your own or one can be purchased from the supplier listed in the Parts List.

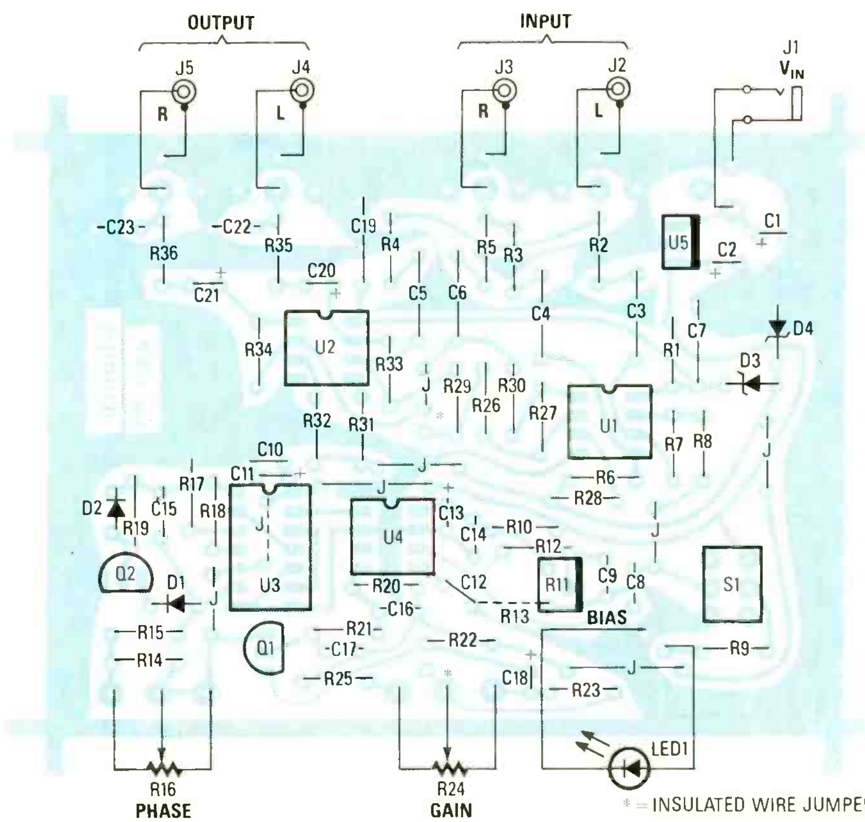


Fig. 3. Using this parts-placement diagram as a guide, begin assembly by installing IC sockets at all positions where IC's are indicated, except U3. Install the jumper connection that runs beneath U3 first, and then install the socket for that IC. After all IC sockets and jumper connections are in position, install the rest of the components—resistors, capacitors, transistors, IC's, etc.

PARTS LIST FOR THE SONIC EMULATOR

SEMICONDUCTORS

Q1, Q2—2N3904 general-purpose NPN transistor
U1, U2—LF353 dual low-noise op-amp, integrated circuit
U3—4013 dual D-type flip-flop, integrated circuit
U4—Reticon RD510X series bucket-brigade device, integrated circuit (see text)
U5—ECG950 12-volt, 100-mA, positive-voltage regulator, integrated circuit
D1, D2—1N914 general-purpose, small-signal, diode
D3, D4—5.6-volt, ½-watt, Zener diode
LED1—Jumbo red light-emitting diode w/panel mount

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—47-ohm
R2–R5, R33, R34—100,000-ohm
R6, R7, R28, R31, R32—47,000-ohm
R8, R9—1000-ohm
R10—4700-ohm
R11—100,000-ohm trimmer potentiometer
R12—820,000-ohm
R13—15,000- or 100,000-ohm (see text)
R14—39,000-ohm
R15, R18, R20, R21—10,000-ohm
R16—100,000-ohm linear potentiometer (Mouser 31CN501)
R17, R22—2200-ohm
R19—27,000-ohm
R23, R26, R27, R29, R30—22,000-ohm
R24—50,000-ohm linear potentiometer (Mouser 31CQ405)
R25—3900-ohm
R35, R36—470-ohm

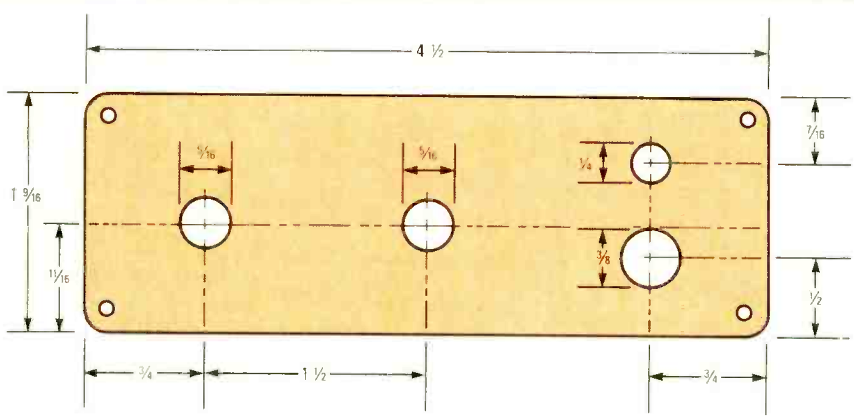
CAPACITORS

C1—22-µF, 25-WVDC, tantalum
C2—10-µF, 16-WVDC, tantalum
C3–C10, C12, C14, C19—0.1-µF, ceramic-disc
C11, C13—10-µF, 16-WVDC, tantalum
C15—10-pF, NPO, ceramic-disc or Mylar
C16—.001-µF, polystyrene
C17—.0022-µF, polystyrene
C18—10-µF, 16-WVDC, electrolytic
C20, C21—2.2-µF, 16-WVDC, electrolytic
C22, C23—.01-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

S1—Push-on/push-off DPDT switch (GC Electronics 35-491)
J1—2.1-mm DC power jack (Mouser 16PJ031)
J2–J5—RCA phono jack PC-mount type (Mouser ME161-4216)
Printed-circuit or perfboard materials, enclosure (GC Electronics 16-130), IC sockets, knobs, wire, solder, hardware, etc.

Note: The following items are available from Chadco Enterprises, PO Box 5872, Knoxville, TN 37928: A partial kit containing Reticon IC (U4, please specify version), etched, drilled, and silk-screened printed-circuit board, case, and all hardware (except IC sockets), plus R11, R16, R24, S1, J1–J5 for $30.00, plus $2.50 for shipping and handling; printed-circuit board only, $7.50, plus $1.25 S/H. The bucket brigade devices are priced as follows: 5106, $7.50, plus $1.25 S/H; 5107, $11.50, plus $1.25 S/H; 5108 $19.50, plus $1.25 S/H. Tennessee residents please add 7.75% sales tax. No personal checks accepted, payment by money order only. Please allow 6 to 8 weeks for delivery



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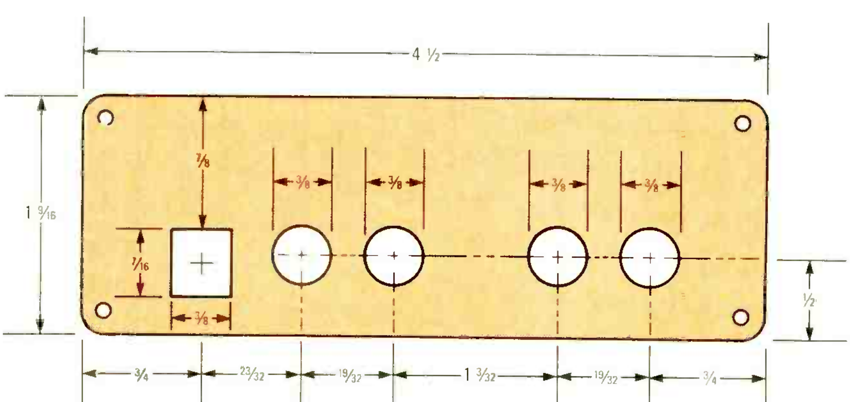


B

Fig. 4. Here are the front- and rear-panel layouts for the enclosure used by the author to house his prototype unit; A shows the template for front-panel layout and B is the rear-panel layout.

rear panels of the enclosure to accommodate the panel-mounted components. The author's front- and rear-panel layout is shown in Fig. 4.

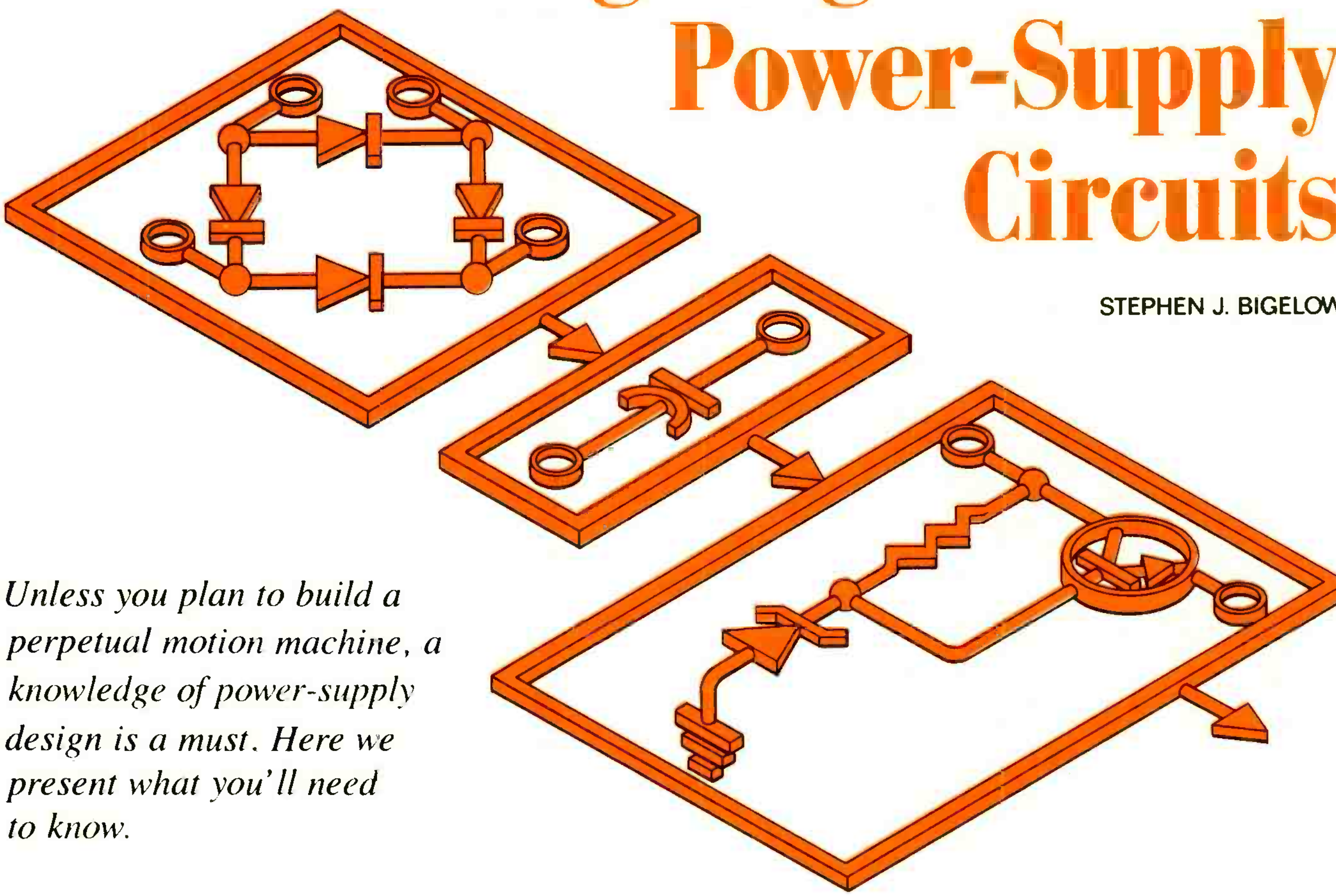
Check your work for construction errors—solder bridges, cold solder joints, improper orientation of the components, proper seating of the IC's, etc.—before sealing the project in its enclosure. If all seems as it should be, and if a DMM is handy, take a resistance reading from the output of U4 to ground; any reading of less than about 5k should be considered suspicious. If all is okay, you are now ready to move on to the next phase of construction.

Finishing Touches. The next step is to ensure that the circuit components (where necessary) are properly biased. The easiest and most-accurate method of handling that task is with an oscilloscope; preferably a dual-trace unit. A sine-wave-signal source (100 to 200 mV at 1 kHz) would also be helpful, but you may be able to accomplish the task without one, provided that you can do an input comparison with the source you are using.

Connect one scope channel to the center wiper of the GAIN control (R24) and set it to 10 o'clock. Set the scope

(Continued on page 100)

Designing Power-Supply Circuits



STEPHEN J. BIGELOW

Unless you plan to build a perpetual motion machine, a knowledge of power-supply design is a must. Here we present what you'll need to know.

All electronic circuits require some source of power, yet the power supply is often the most overlooked and least understood part of a project. A power supply not only converts an AC line voltage into the DC voltage and current that a circuit needs, but it protects the circuit from line noise and any erratic voltages that might be entering the supply. For that reason, if for no other, it's important to understand how supplies function.

This article will explain the principles of power-supply operation and construction using practical circuits as examples. The article will also cover important power-supply limitations, safety practices, and conclude by describing some interesting features found in many supplies.

A Typical Supply. Power supplies come in many shapes and sizes, with a vast selection of options and controls, but all supplies, no matter how complex, can be broken down into five functional building blocks: the AC input, the transformer, the rectifier, the filter, and the regulator. Figure 1 shows a block diagram of a typical supply. Let's examine each of its sections in detail.

Due to differences in household circuitry, AC line voltage applied to the input leads of a supply can range from 105 to 125 Vrms in the United States, or 210 to 250 Vrms in Europe. A supply will operate correctly as long as the input voltage remains in some reasonable range. If the AC line voltage falls too low—such as on a heavily loaded AC circuit—the supply might not be able to sustain its rated DC output voltage and current to a load.

Conversely, if the AC line voltage is too high—such as if you were close to a power substation or were on a lightly loaded AC line—the supply will produce more than its rated DC output, or overheat and destroy the regulator circuit (if it is a regulated supply). It is always a good idea to check the line voltage before connecting a power supply to be sure that the input voltage falls within the proper range. A "buck/boost" transformer can be used to correct high or low line-voltage problems.

Fuses can provide protection against excessive current flowing into or out of the supply. A fuse is nothing more than a fine wire encapsulated by a glass or plastic tube that is placed in series with a circuit. Increasing current will raise the temperature of the wire link. When current exceeds the fuse rating, the resulting heat will melt the link and break the path of current, protecting the supply.

Circuit breakers are switches that automatically open themselves in the presence of excessive current to protect a circuit. Inside one, a trip sensor is connected in series with the breaker (switch) contacts. As long as current remains below the rated value, the breaker contacts remain closed. If current exceeds the rated value, the sensor will open the breaker contacts, which will stay open until the breaker is physically reset. Some breakers react instantly to small increases in current, others have a built-in time delay that will allow the breaker to trip only after a significant current surge.

Transformers. A transformer is used to

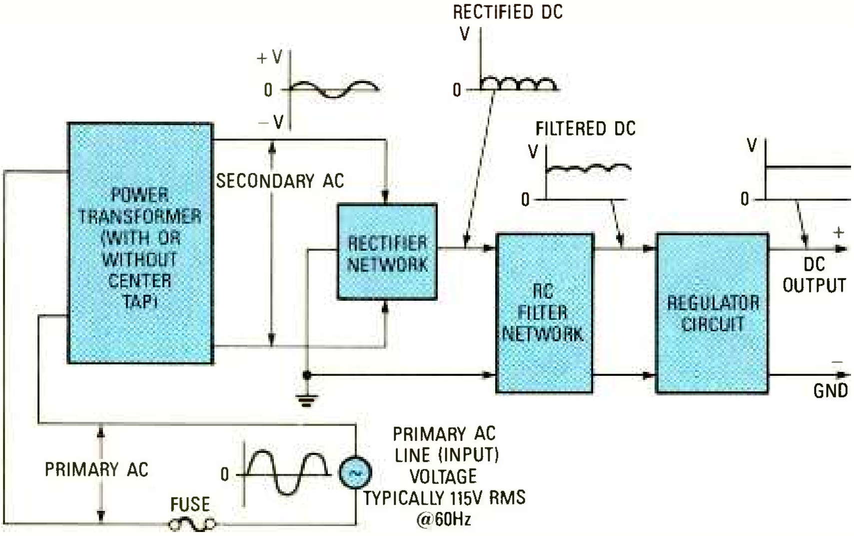


Fig. 1. This block diagram of a typical regulated power supply makes its most commonly used sections apparent. Note, however, that the regulation stage is not required for all circuits.

convert the AC line voltage into a higher or lower AC voltage. A transformer operates on the principle of "magnetic coupling"—varying line voltage applied to the primary windings will generate a strong, varying magnetic field that in turn sets up an alternating current in a secondary winding. That principle is often called "inductive coupling." Direct current can not be coupled through a transformer since its current, and thus its magnetic field, is always constant.

The AC voltage at the secondary terminals depends on the ratio of primary-to-secondary windings. For example, if the primary and secondary coils have an equal number of windings, the turns ratio, as it's called, of primary-to-secondary windings would be 1:1, and the secondary AC voltage will equal the primary AC voltage. If the primary has twice the number of windings as the secondary, the turns ratio would be 2:1 and the secondary AC voltage would be half of the primary AC voltage. The transformer is said to be a step-down transformer.

If the secondary has twice the windings of the primary, the turns ratio would be 1:2, resulting in a secondary AC voltage twice that of the primary. So the transformer is a step-up transformer.

Current is also "transformed", but in an inverse fashion: If AC voltage is stepped down in the transformer, the current is stepped up by that same proportion, and vice versa. For a 1:1 turns ratio, the current at the secondary (like the voltage) will be the same as the primary. However, if the secondary voltage is stepped down by a ratio of 3:1, the secondary current will be stepped up by a ratio of 1:3. If the secondary voltage is stepped up by 4 times, the secondary current will be stepped down one quarter. That's because there can never be more power (voltage × current) coming from the secondary than is entering the primary. In fact, there will always be less power available at the secondary than applied to the primary—exactly how much less will depend on the efficiency of the transformer.

A power supply might use either a step-up or a step-down device depending on the particular application for the supply. For an average supply, a step-down transformer is the most common. High-voltage power supplies, such as one used to fire a carbon-dioxide laser, require a step-up transformer. This article, however, will deal only with step-down transformers.

A transformer should be chosen based upon the secondary voltage and current required. It is always a good practice to add a 50% safety margin when specifying the secondary's output current to guarantee that the supply can meet the power demands of the anticipated load. For example, if the supply must produce an output of +12 VDC and provide up to 2-amps DC while operating from a 117-

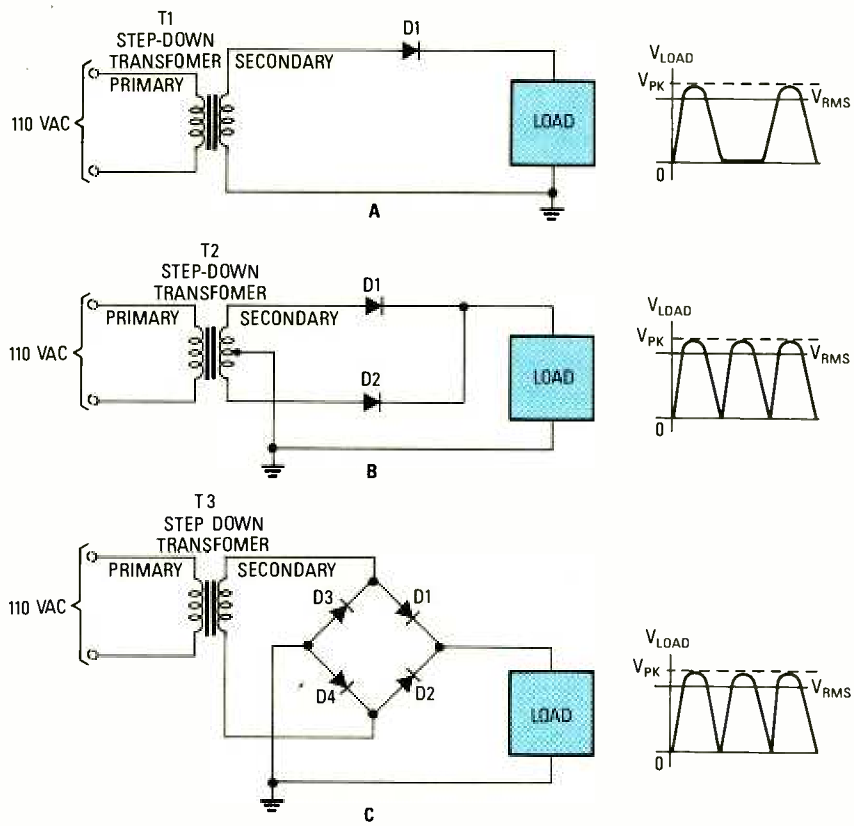


Fig. 2. The schematic of the half-wave rectifier (A) indicates just how few parts go into one. The full-wave rectifier (B) provides cleaner DC but it uses only half the secondary voltage at a time. The full-wave bridge rectifier (C) provides full rectification and uses the full secondary voltage.

volt line, choose a transformer with a 117-VAC primary and a secondary winding rated for about 12.6 Vrms (or about 25.2 Vrms if you use a center-tapped transformer, which we'll discuss) and 3 amps (2 amps × 1.5), current output.

Rectifiers. The rectifier stage converts the secondary AC voltage into a pulsating-DC signal. Even though the voltage output of the rectifier varies greatly, its polarity doesn't change, thus the term "pulsating DC".

Rectifying stages are often composed of semiconductor-diode networks or discrete solid-state bridge-rectifiers. There are three classic rectifier circuits used in power supplies. The half-wave rectifier is the simplest and most direct type of circuit (see Fig. 2A) since it requires only one diode and no center tap on the transformer secondary. The major disadvantage of the half-wave rectifier is that only one half of the secondary AC voltage is rectified, which leaves a gap between pulses. That results in a lower average output voltage and a higher amount of AC (or ripple) riding on that output. For that reason, a power supply containing a half-wave rectifier isn't suitable for heavy loads. Half-wave rectifiers are almost never used in commercial power supplies.

Full-wave rectifiers are a significant improvement over half-wave designs (see Fig. 2B). In one, two diodes allow both halves of the secondary AC voltage to be rectified into pulsating DC. With almost no time delay between pulses, the ripple is drastically reduced and the average DC voltage output is steadier and can support heavier loads. One drawback of the full-wave rectifier is the center-tapped transformer required to provide a ground reference for the circuit. It increases the wiring complexity a bit and allows only one half of the secondary AC to appear at the rectifier output at any time. For example, if the transformer secondary of Fig. 2A is rated at 12 Vrms, a pulsating 12 VDC will appear at the load as shown. If the same transformer is used in Fig. 2B, the use of the center tap as a ground will cut the voltage appearing on each diode in half, so that with the same 12 Vrms center-tapped secondary, only a pulsating 6 VDC will appear at the load. The center-tapped transformer used with such a circuit must have a secondary voltage that is twice the desired output voltage. A 24 Vrms transformer would

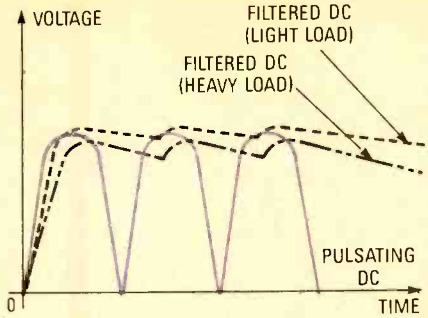


Fig. 3. As you can see, when pulsating DC is filtered insufficiently the troughs between peaks deepen. Using the right capacitor for the right job is a good motto to learn from this.

be needed for Fig. 2B to provide the desired pulsating 12 VDC.

That confusion can be eliminated by using a bridge rectifier circuit (Fig. 2C). The bridge network provides full-wave rectification of the secondary AC voltage, as well as its own ground reference so there is no need for a center-tapped transformer. The full secondary AC voltage applied to the bridge network will appear as pulsating DC at the bridge output, so if 12 Vrms is applied to the bridge, pulsating 12 VDC will be available at the rectifier output. Bridge rectifiers are found in more expensive unregulated supplies, and in almost all types of regulated supplies.

The two most important factors in choosing rectifiers are the forward current (often denoted I_f) and the peak inverse voltage (or PIV). The I_f is the maximum current that can flow through the diode in the forward-biased, or conducting state. It should at least equal the maximum expected load current plus 50% for safety. For example, a supply built to provide 2-amps DC should use diodes with an I_f of 3 amps (2 amps × 1.5). The PIV is the maximum voltage that the diode can stand in the reverse bias, or off state. It should be at least twice the peak secondary voltage plus an additional 50% as a safety margin. For a transformer with a 24-Vrms secondary, the peak voltage is 24 Vrms × 1.414, which is 34 volts peak. The minimum PIV should then be 84 volts or greater (100 PIV is typical for a rectifier diode). Do not worry about high PIV ratings; diodes that can carry heavy current almost always have high PIV ratings. As long as the ratings are higher than required diodes will work properly.

Filters. Power-supply filters smooth out pulsating DC to form a somewhat steady DC output. The effects of the pulsating DC can still be seen in filtered output in the form of an AC ripple riding on steady DC. Often an electrolytic power capacitor, usually with a value in excess of 1500 µF, is used to form the filter. A power capacitor is basically an energy-storage device that will charge to the peak voltage of the pulsating DC. The charged capacitor will discharge slightly to provide energy to the load in-between pulses. The amount of discharge that occurs between pulses depends on the value of the capacitor and the current drawn by the load. If the load is heavy, more current will be required and the filter will discharge more fully between pulses. That causes a larger amount of ripple to appear at the output (see Fig. 3). A lighter load will draw less current, resulting in a much lower ripple.

Several capacitors might be placed in parallel to increase the value of the filter capacitance. Additional capaci-

Glossary

Boost/Buck Transformer—A multi-tapped transformer used to correct high or low variations in line voltage to maintain the optimal AC line voltage.

Derating—Reducing the rating of the supply output current as the ambient temperature around the supply increases. Derating is usually needed when the ambient temperature at the supply exceeds 50 deg C.

Efficiency—The ratio of power output to power input, usually expressed as a percentage.

EMI (Electro-Magnetic Interference)—Electrical noise or any sporadic signal that might be radiated or conducted into a circuit and cause abnormal operation.

Operating Temperature—The temperature range that a supply will operate within and still maintain its rated output voltage.

Line Regulation—The ability of a power supply to maintain its rated DC output as the AC line voltage changes.

Load Regulation—The ability of a power supply to maintain its rated DC output as the Load current changes.

Ripple—The AC voltage component appearing on the output voltage of the power supply, usually expressed in peak-to-peak voltage.

Stability—The change in output over time while line voltage, load, and ambient temperature remain the same.

Inrush Current—The initial surge of current into a supply to charge the filter capacitors when the supply is first turned on. ■

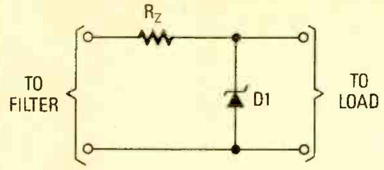


Fig. 4. Although this Zener-based regulator works fine, it has a drawback: the diode will probably blow out if the load is removed.

tance will reduce the ripple in the DC output by allowing more energy storage between pulses. More energy will then be available to sustain a load and that will reduce the degree of discharge between pulses, so ripple will be lower. Use caution when the filter capacitance becomes more than 10,000 µF. At that level, the inrush current to initially charge the filter when the supply is first turned on might be great enough to blow the AC input fuse. High capacitance also tends to hold a charge that can become a shock hazard. To reduce the possibility of a shock, a high value "bleeder resistor" should be added in parallel to the network. A 1- or 2-megohm resistor is usually a good value; not enough load to draw significant current, yet it will slowly dissipate any energy remaining in the filter when the supply is turned off.

Choose a working voltage for the capacitor that is about 50% above the peak voltage of the pulsating DC that feeds it. If a 12-VDC filter is fed by pulsating 12 VDC, the peak voltage of the pulses is 12 × 1.414, or 17 volts. After adding a 50% safety margin, the working voltage of the capacitor should be 26 WVDC (17 × 1.5).

The amount of ripple voltage can be measured easily by placing an AC voltmeter across the DC output. Ripple can then be read directly in Vrms. In a well-filtered supply operating at full load current, the ripple voltage should not exceed 0.1% of the AC input voltage.

Unregulated supplies are used in applications that do not require a precise voltage control, such as driving relays, solenoids, and lamps.

Regulators. Regulators allow a very precise control and adjustment of the DC voltage output. By adding a regulating circuit after the filter network, ripple might be almost completely eliminated through a wide range of loads.

The simplest regulator consists of a Zener diode and a current-limiting resistor, as shown in Fig. 4. The unregulated voltage from the output of a filter stage is fed into the resistor-Zener "clamping" circuit in order to regulate a voltage down to that used to drive some load. Any Zener diode with a voltage rating less than the unregulated input voltage can be used. Resistor R_Z will dissipate the extra energy and help reduce the unregulated voltage to the desired level. The value of R_Z depends on the voltage drop across it (the difference between the unregulated voltage and the regulating voltage of the Zener), and the current that must be provided to the load.

For instance, if an unregulated supply produces 12 volts that must be reduced to 10 volts, then the resistor has to drop 2 volts. If we know the maximum load current is 1 amp, then by Ohms Law, the resistor's value has to be 2 volts/1 amp, or 2 ohms. The power dissipated by R_Z is also related to the load current; In this instance, the power dissipated by R_Z will be (1 amp × 1 amp) × (2 ohms), or 2 watts. It is also a good practice to add a 50% safety margin to that value, so R_Z should be a 2 ohm resistor that can dissipate 3 watts.

A fuse is usually placed in series with the Zener. That is to protect it from carrying the full load current if the load should accidentally be disconnected. Normally, the load will take most of the current flowing through R_Z. The remaining current will flow through the Zener.

Integrated-circuit regulators, such as the 7800 and 7900 series, are good alternatives to Zener regulators. The "intelligence" built into a three-terminal regulator (or TTR) will compare the output voltage to an internal reference (see Fig. 5). Any difference causes the current flow to change at the pass transistor. That works to keeps the regulated output voltage constant for any given load. Capacitors C1 and C2 act as additional noise filters to help eliminate any high-frequency noise or ripple entering or leaving the TTR.

Voltage drop and load current are also important in the choice of a TTR. The unregulated input voltage must exceed the regulated DC output by several volts in order for 7800- and 7900-series regulators to function properly. Tables 1 and 2 list the input and output voltages for each 7800 and 7900 device. The load current should not be greater than 1 amp when using them. The great advantage to using TTR's is their tolerance to changes in the load. A load might be completely removed from the power supply without any damage to the regulator.

Heat sinks should be attached to regulator IC's when power dissipation is expected to be greater then 1 watt. Mica insulators are used to electrically isolate the regulator from the metal of the heat sink. That reduces the possibility of any short circuits to the heat sink, and is necessary when the regulator must be

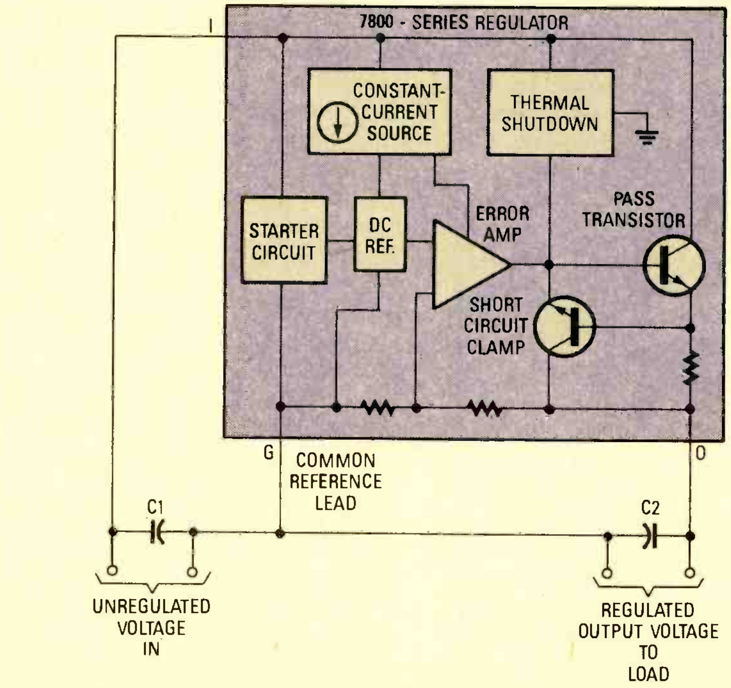


Fig. 5. This block diagram of a typical TTR doesn't really give one the feel for the level of complexity normally found in such devices.

mounted to the metal chassis of the enclosure. Thermal grease should be used on both sides of the mica insulator to guarantee a good flow of heat away from the regulator. If a regulator is expected to dissipate more than 5 watts, the supply enclosure should be thoroughly vented to allow free air flow in that area. Above 5 watts, the regulator should also be mounted to the chassis within the enclosure. Heat kills integrated circuits; proper mounting and cooling is very important to ensure the long, reliable working life of the regulator.

Load regulation can be calculated by measuring the DC output of the supply with no load (V_{NL}), then measuring the DC output of the supply under full load (V_{FL}). The voltage output of a well-regulated supply under full load should drop no more than 1% from the no-load output voltage. If $V_{NL} = 24$ VDC and $V_{FL} = 23.8$ VDC, the difference is 0.2 VDC, or 0.83% (that's 0.2/24) regulation, which is within regulator limits.

Negative Output. Once a transformer, rectifier, filter, and regulator are in place, a simple, single-output regulated power supply is formed. But there are also several other features that can be added to improve the versatility of the supply.

For example, negative-output power supplies can be made. The polarity of a power supply is determined by the rectifier network. Each of the rectifier applications discussed so far have been for a positive voltage output. A negative output can be obtained by simply reversing the direction of each rectifier diode, and the polarity of the filter capacitors. The reversed diodes will pass the negative half of the secondary AC voltage to produce a negative, pulsating DC to feed the filter network. The filter capacitors are reversed because the polarity of the output is reversed.

The rule to remember is that the positive electrolytic lead should always be connected to the "more positive" part of the circuit. So in a negative supply, the plus lead goes to ground because that is at a higher or more-positive voltage than the output. The component values for the rectifiers and filter components would be determined in the same way as they are for a positive supply, except a negative voltage regulator (*i.e.* one from the 7900 series) should be used.

Multiple Outputs. A second output voltage can easily be added to a power supply by tapping into the filtered DC to provide voltage for a second regulator (see Fig. 6). The extra current drawn by a second load (I_2) will add to the current drawn by the original load (I_1), which will put a greater strain on the transformer, rectifier, and filter. Find the total current (I_t) by adding the maximum expected load currents for each output. Choose a transformer with a secondary that can handle the value of I_t plus a 50% safety margin.

Use rectifier diodes with an I_f equal to I_t plus 50%, and a PIV that is twice the peak inverse (or reverse) voltage plus 50%. You'll have to select the filter capacitors to provide extra energy at a working voltage that is twice the peak voltage of the secondary AC plus 50%. The use of heat sinks on both regulators is highly recommended.

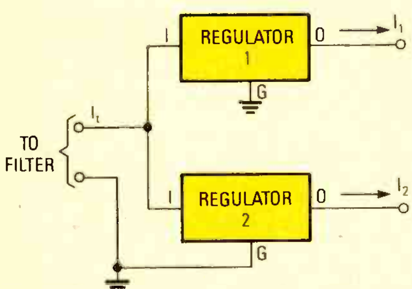


Fig. 6. To get multiple voltage outputs from a power supply you simply have to piggy-back the regulators provided the other components can handle the additional current requirements.

TABLE 1—VOLTAGES FOR 7800-SERIES REGULATORS

Part No.	Regulated Output	Minimum Input
7805	5.0 Vdc	7.3 Vdc
7806	6.0 Vdc	8.4 Vdc
7808	8.0 Vdc	10.5 Vdc
7810	10.0 Vdc	12.5 Vdc
7812	12.0 Vdc	14.8 Vdc
7815	15.0 Vdc	17.8 Vdc
7818	18.0 Vdc	21.0 Vdc
7824	24.0 Vdc	27.2 Vdc

TABLE 2—VOLTAGES FOR 7900-SERIES REGULATORS

Part No.	Regulated Output	Minimum Input
7905	−5.0 Vdc	−7.4 Vdc
7906	−6.0 Vdc	−8.4 Vdc
7908	−8.0 Vdc	−10.5 Vdc
7909	−9.0 Vdc	−11.5 Vdc
7912	−12.0 Vdc	−14.6 Vdc
7915	−15.0 Vdc	−17.8 Vdc
7918	−18.0 Vdc	−21.0 Vdc
7924	−24.0 Vdc	−27.2 Vdc

Variable Output. Every three-terminal regulator requires a common terminal to act as a reference level for the input and output voltages. In a fixed-output application that terminal is usually connected to the supply ground. Some regulators can reference a voltage above ground that will offset and adjust the output voltage of the device. The LM317 is an example of an adjustable power regulator ideally suited for use in variable supplies. Figure 7 is a schematic diagram of an adjustable power supply using an LM317 regulator.

The ADJ pin of the LM317 is connected to a variable voltage-divider network formed by resistors R1 and R2. As the value of R2 is increased, the reference voltage on the ADJ pin rises, that in turn will raise the DC output voltage from the LM317. Check the regulator's application notes for the equations you'll need to determine values for the resistor network. The output voltage range for the circuit shown is from 1.25 VDC up to the limit set by the value of R2. Voltage output can not be adjusted

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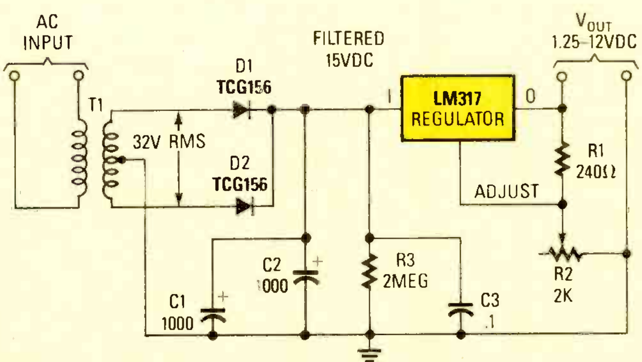

Fig. 7. You could actually construct the variable-output power supply shown here. It can supply your workbench with 1.25 to 12 volts DC.

Build an *Audio Sweep/*

Tone burst generators are something of a rarity these days and function generators offering such a feature are most likely to be found among the more expensive units. The *Audio Sweep/Burst Generator* described in this article is inexpensive to build, and can produce sine waves that cover the entire audio range. It can also be made to automatically sweep the audio spectrum; provide variable duty-cycle pulses; and provide a variable linear ramp.

Description. The Audio Sweep/Burst Generator has three modes of operation—*continuous, burst,* and *sweep*—and each mode has two frequency ranges; from 20 Hz to 2 kHz and from 200 Hz to 20 kHz. There is also a frequency control that allows you to adjust the output of the circuit to anywhere within those limits for the burst and continuous-output modes.

The dial markings for the manual control are almost linearly spaced, eliminating crowding of the frequencies at the high end and that helps considerably when laying out the dial itself. The sweep is linear and the dial's range markings were selected to mesh with the grid markings of an oscilloscope so that you'll know what frequency is where once you've adjusted the oscilloscope controls properly. For example, on the low range, each vertical line except the leftmost, will be at 200 Hz intervals, and the end will be on the rightmost line at 2 kHz. If your scope has the five short hash marks between major lines, you'll have a sweep broken into segments of 40 Hz. That gives a very useful expanded view of the low end of the spectrum. The high range uses the same setup, but all frequencies are ten times higher.

The sweep and bursts both are automatically recurring signals with an adjustable "dead-time." The dead-time has three ranges and an adjustment for fine control. Burst-time can range from as little as 1 millisecond to more than 15 seconds. That gives a burst containing 20 cycles at 20 kHz or 1 cycle at 1 kHz.

The circuit is designed to start with a positive alternation, but occasionally it may start with the negative alternation. An adjustment to the dead-time will usually eliminate that if it's objectionable. Since the burst time and sweep times are the same, a 1-millisecond sweep is possible, even though impractical. The sweep time can be something more than 15 seconds. The best sweep time will be the slowest that your oscilloscope can match (perhaps 10 seconds, or more, when the scope's sweep is not in its calibration mode).

The output impedance of the circuit is 600 ohms, with an output level that's varied from 0 to 2.5 volts peak-to-peak into a 600-ohm load, or twice that with no load. The sweep signal can be heard when the output is connected to an 8-ohm speaker, particularly when set to the 300 Hz to 2 kHz range.

The SYNC output is used to initiate the sweep of an oscilloscope, and is the same +12-volt pulse that creates the dead-time; the frequency and duty cycle can be varied via the DEAD TIME and BURST-TIME controls.

Theory of Operation. A schematic diagram of the Audio Sweep/Burst Generator is shown Fig. 1. At the heart of the circuit is an XR2206 function-generator (U2). The output frequency of U2 is determined by the amount of current applied to pin 7, through transistor Q3 (which acts as a voltage-to-current converter). When the circuit is set to the CONTINUOUS or BURST modes, a voltage is applied to the base of Q3 through the wiper of R33 (a linear potentiometer).

When Q3's bias voltage is zero, Q3 is cut-off and no trigger is applied to pin 7 of U2, so it does not oscillate. But when a positive bias of few millivolts is applied to the base of Q3, the transistor turns on (pulling pin 7 low), causing U2 to oscillate at either 2 kHz or 20 kHz, depending on which timing-capacitor bank (C15–C18 or C19–C22) is selected.

Each timing-capacitor bank consists of four capacitors of equal value; with the values shown, the capacitance of the two capacitor banks are .04 µF and 0.4 µF. The output of U2 at pin 2 is a sine wave that can be varied from about DC to roughly +6 volts, which is fed to U7-a (half of an LF354N dual op-amp). The output of U7-a is fed to the non-inverting input of U7-b through a simple voltage-divider/LEVEL control, consisting of R38 and R39. Resistor R40 sets the sine-wave output impedance at nearly 600 ohms (and may, or may not, be included, as the builder wishes).

Two monostable multivibrators, U1-a, U1-b, are configured as an oscillator whose output is used to provide the timing signals for the dead-time and burst (or sweep) time function. The Q output of each monostable is fed to the falling-edge input of the other. The timing for U1-b is provided by C8, R15, and R16. Timing for U1-a is handled by capacitors C2 through C7, which are

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BY JOHN WANNAMAKER

Burst Generator

charged via Q1. Transistor Q1 acts as a constant-current source.

The charge stored in the timing capacitor is discharged as a linear ramp, which is fed to the non-inverting input of U3. Op-amp U3 buffers the discharge voltage, so that it maintains linearity when it is later adjusted for proper amplitude (via R20) and offset (via R24).

Transistor Q2 assures that the timing capacitor discharges to near ground potential and remains that way during the dead-time.

When R34 has been adjusted, R33 (FREQ. ADJUST) can supply a proper voltage variation to the base of Q3 (via R17) for the desired frequency coverage. Once the minimum and maximum voltage is known, the ramp is adjusted so that it covers the identical voltages and, therefore, sweeps the same frequencies as the manual adjustment.

Construction. The author's prototype of the Audio Sweep/Burst Generator was assembled on a printed circuit board, measuring 4¾ by 2¹⁄₁₆ inches. The foil pattern for that printed-circuit board is shown in Fig. 2. You can either etch your own board from the pattern provided or purchase one from the supplier listed in the Parts List.

Note that the pattern in Fig. 2 shows a small notch in the heavy copper trace near U8. That notch was necessary in the author's prototype so that the line cord could be connected to the front-panel mounted POWER switch (S5). Once you've obtained the board and all the components construction can begin. An important word of caution; not all 4538's are equal. Only those bearing the "BCN" suffix should be used in this project (note a 14538 is the equivalent to a 4538; the suffixes of the IC part number are the important consideration in this project).

Start by installing IC sockets at the IC location shown in Fig. 3. Installing the sockets first allows them to be used as reference points so that the proper positions for the other components can be easily located. After installing the sockets, install the resistors and the capacitors, and then the transistors; do not install the IC's at this point. In assembling the circuit, there are two places where you might want to make substitutions, both of which will make frequency-range adjustments go smoother. The first is to substitute an upright multi-turn trimmer for the single-turn unit used for R34. The second has to do with fixed resistors R31 and R32, which are in series with FREQ ADJUST R34. Pads have been placed so that a 2K upright multi-turn unit can replace both resistors.

Without that, the value of R32 must be determined by trial and error, because not all 78M12 regulators will regulate to the same value; there is a ± 0.5-volt tolerance associated with those units. A 0.2-volt rise above the ideal 12.00 volt value will increase the high-end frequency of the $\times 10$ range by 400 Hz. Even with the suggested multi-turn units, obtaining the desired frequency will be an *iffy* proposition since each unit affects the other. For that same reason, a 20-minute warmup is recommended so that any thermal changes that affect the voltage will have settled down.

A convenient ground point (TP1) may be installed to be available from both sides of the board. Enlarge the hole in the big round pad near one end of U2 and insert a length of #14 solid copper wire until about one-half inch sticks out below the bottom. Solder and then cut to leave a similar length on the foil side. TP2 can be a small loop of hookup wire.

Once all of the on-board components have been installed, connect lengths of hook-up wire to the board at the appropriate points—4 or 5 inches each should be enough—and tem-

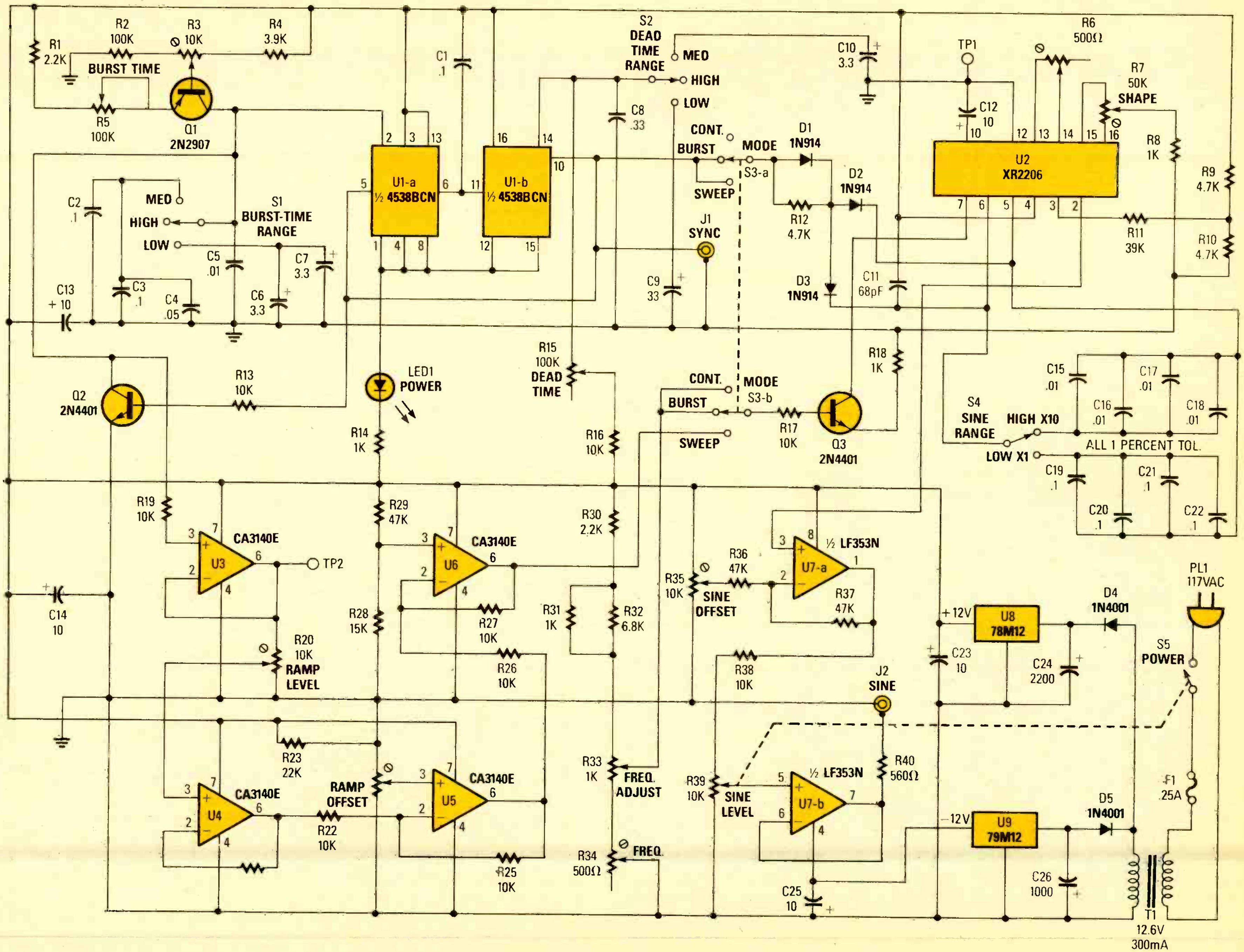


Fig. 1. This schematic diagram of the Audio Sweep/Burst Generator shows that the heart of the circuit is an XR2206 function-generator, which is capable of providing three output waveforms: sine waves, square waves, and triangle waves.

PARTS LIST FOR THE AUDIO SWEEP/BURST GENERATOR

SEMICONDUCTORS

U1—CD4538BCN, CMOS dual precision-monostable, integrated circuit (see text)
U2—XR2206, function-generator, integrated circuit
U3, U4, U5, U6—CA3140E, op-amp, integrated circuit
U7—LF353N wideband, JFET-input, op-amp, integrated circuit
U8—78M12, positive 12-volt, .5-mA, voltage regulator, integrated circuit
U9—79M12, negative 12-volt, 100-mA, voltage regulator, integrated circuit
Q1—2N2907 or 2N2905 general-purpose PNP transistor
Q2, Q3—2N4401 general-purpose NPN transistor
D1, D2, D3—1N914, general-purpose small-signal diode
D4, D5—1N4001, 1-amp, 50-PIV, general-purpose rectifier diode
LED1—T-1-3/4 red light-emitting diode w/panel mount

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R30—2200-ohm
R2—100,000-ohm
R3, R20, R24, R35—10,000-ohm trimmer potentiometer (⅜-inch square)
R4—3900-ohm
R5, R15—100,000-ohm potentiometer, linear taper
R6, R34—500-ohm trimmer potentiometer, (⅜-inch square; R34, see text)
R7—50,000-ohm trimmer potentiometer, (⅜-inch square)
R8, R14, R18, R31—1000-ohm
R9, R10, R12—4700-ohm
R11—39,000-ohm
R13, R16, R17, R19, R21, R22, R25, R26, R27, R38—10,000-ohm
R23—22,000-ohm
R28—15,000-ohm
R29, R36, R37—47,000-ohm
R32—6800-ohm (see text)
R33—1,000-ohm potentiometer, linear taper
R39—10,000-ohm potentiometer, linear taper, w/SPST on/off switch (S5)
R40—560-ohm

CAPACITORS

C1—0.1-µF, ceramic-disc
C2, C3—0.1-µF, low leakage, ceramic-disc
C4—0.05-µF, low-leakage ceramic-disc
C5—0.01-µF, low-leakage ceramic-disc
C6, C7, C10—3.3-µF, 35-WVDC, tantalum
C8—0.33-µF, ceramic-disc
C9—33-µF, 16-WVDC, radial-lead electrolytic
C11—68-pF, ceramic-disc
C12, C13, C14, C23, C25—10-µF, 16-WVDC, radial-lead electrolytic
C15, C16, C17, C18—0.01-µF, 1% precision ceramic-disc
C19, C20, C21, C22—0.1-µF, 1% ceramic-disc
C24—2200-µF, 25-WVDC, radial, electrolytic
C26—1000-µF, 25-WVDC, radial, electrolytic

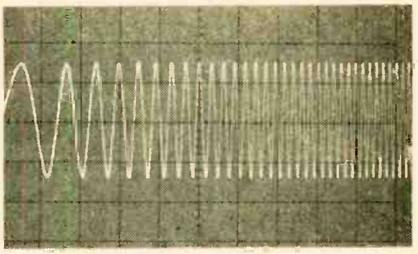
SWITCHES

S1, S2—Miniature SPST, center-off toggle
S3—4P3P rotary
S4—Miniture SPDT toggle
S5—SPST (part of R39) tee text

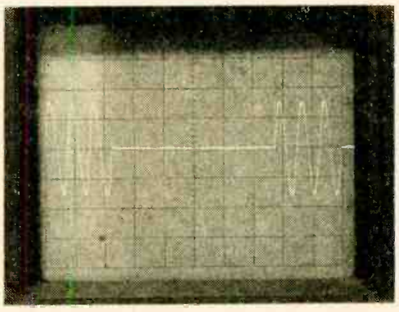
ADDITIONAL PARTS AND MATERIALS

T1—12.6-volt, 300-mA, step-down power transformer
J1, J2—RCA panel mount phono jack
F1—0.25-amp fuse
Printed-circuit or perfboard materials, enclosure (Radio Shack 270-250), IC sockets, knobs, line cord, fuse holder, hook-up wire, solder, hardware, etc.

Note: A printed-circuit board for the Audio Sweep/Burst Generator is available for $15.75 (ppd.); from John Wannamaker, Rt. 4, Box 550, Orangeburg, SC 29115; payment by money orders only; South Carolina residents, please add 5% sales tax.



An expanded view of the frequency-sweep signal output by the Audio Sweep/Burst Generator. The signal starts (left) at a relatively low frequency (left), and increases at a rate determined by the operator, as the generator's output is swept through the audio spectrum.



The Audio Sweep/Burst Generator can produce many signal patterns; shown here is a sine-wave burst followed by a dead-time period, which is follow by another burst.

porarily connect the other ends of those wires to their respective off-board components. When that's done, put the board to the side; the next step is to prepare the enclosure that will house the circuit.

Preparing the Enclosure. The author's prototype was housed in a rather small plastic enclosure of about 5⅝ by 5⅝ by 2⅞ inches (available from Radio Shack as part 270-250), but any plastic or metal enclosure of sufficient size can be used. Assuming that you've decided to house your unit in the same case, the small slot (mentioned earlier) cut in the board will be necessary to feed the power lines through to the POWER switch.

Prepare the enclosure to receive the panel-mounted components. You'll need to drill 10 holes of various sizes to accommodate the switches, potentiometers, and phono jacks. An additional four holes are also drilled in the rear panel: two for T1's mounting hardware, and the others for mounting F1's holder and a feed-through hole for the line cord.

Begin by making a tracing of the outline of the front panel area (you'll need two; one will be used for a front-panel drill guide layout, and the other you will later prepare as the front-panel dial with interval markings and control labels). Within the parameters of the trace, make circles at the points where the panel components are to be mounted; it will necessary to allow sufficient space between components for the front-panel dial markings.

Once the drill guide (tracing with the panel layout) is complete, tape or tack-glue the drill guide to the front panel of the enclosure, and drill holes through the guide and panel, using an appropriate sized drill bit (about ¼ to ⅝ inch).

Next drill holes at any convenient or desirable location on the rear panel of the enclosure for the rear-panel mounted components. Mount the power transformer (T1) to the rear panel along with a three-terminal soldering lug strip (barrier block), using T1's mounting hardware. Install F1's fuse holder and a grommet in the line cord's feed-

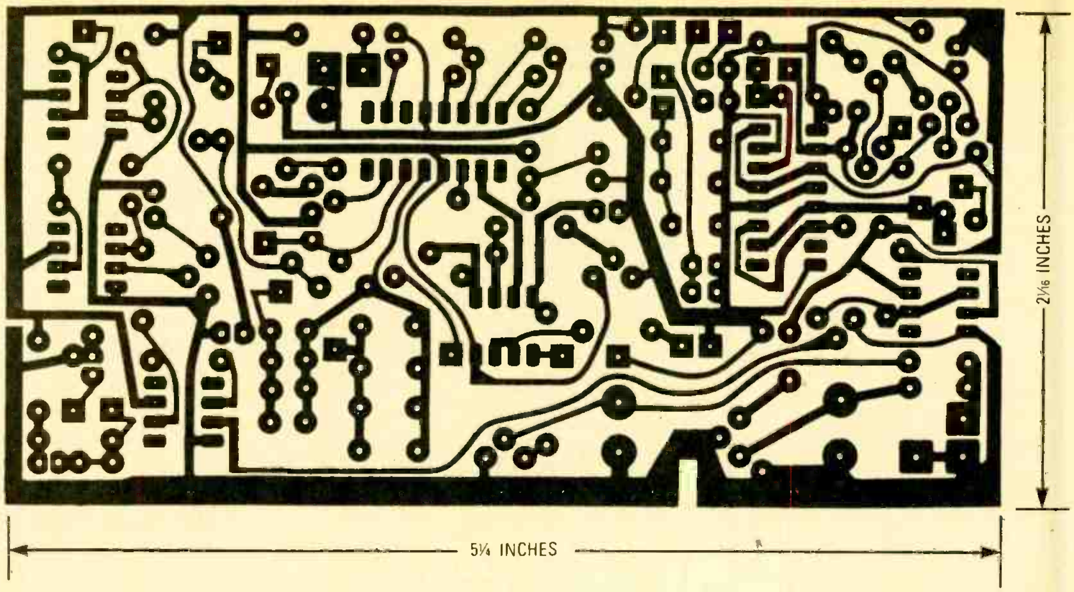


Fig. 2. This printed-circuit template was used by the author to produce his prototype unit. This pattern can be copied to a printed-circuit slug (unetched PC board material) to produce your own board.

through hole. If you have a strain relief of the proper size to accommodate the line cord, use it instead of the grommet.

Feed the line cord through the chassis, and connect one lead of the line cord to the fuse holder and tie the other line-cord lead to the barrier block. After that, finish wiring the off-board, power-supply components into the circuit. Now let's return to the front panel of the enclosure.

In the prototype, the paper tracing of the front panel was laid out with handwritten dial markings and the lettering typed on. Copies were then made to get rid of any correction blemishes. The final (blemish-free) copy was laid face down and its back sprayed with yellow paint. After drying, the copy was taped down flat to the front panel face up and two coats of polyurethane were sprayed on. An X-acto knife blade was then used to cut out the holes with the drilled panel below acting as a guide.

The MODE switch, S3, need only be a 2-pole unit, but a 4-pole switch is easier to find and will readily index to match the panel markings. A moderately small switch will be necessary here, since it is so close to an inner plastic protrusion (assuming that you've selected the same case as the author). Because the switch might have to be rotated for best fit, it might not be possible to use the "flat" side of the switch shaft to key with the screw in the knob.

Checkout. An oscilloscope and a frequency counter will be needed to check out the circuit's operation. If a counter isn't available and your scope's time base is accurate, you can get by using it alone.

First remove the rear panel of the enclosure for safety—it has exposed wires carrying 117 volts AC—and wrap it in something to protect yourself. As you adjust the circuit trimmers and probe around, be careful of the voltage at the contacts of S5 (the POWER switch) on the front panel.

No chips should be inserted until the power supplies are checked out. Apply power momentarily as you check the output of the regulators (U8 and U9) for the proper DC voltages; U8 should have a positive 12-volt output, and U9 should be at negative 12-volts. Using an oscilloscope, check the ripple content of the regulator outputs; ideally, there should be none. Any problem will most likely be a backwards diode or regulator, one of the several filter capacitors that are spread throughout the board, or a solder blob.

If everything seems okay, keep power applied for several minutes and then check the tabs of the regulators for overheating. They should be barely warm; if the circuit, thus far, seems to be functioning properly, proceed to the next step in the checkout procedure. If not, check your work to find out why.

Next, remove power from the circuit and wait for the charges on the capacitors to decay. The discharge of the capacitors can be hurried along by placing a direct short across them. In fact that's a good habit to get into when servicing equipment that has recently been under power (personally, I make sure the capacitors are discharged, even when I have no knowledge of the equipment having been recently under power).

Once the charges have been bled off, insert U1 and U3 in their respective sockets, and power up the circuit. Set the BURST-TIME RANGE selector (S1) to high, the BURST-TIME control (R5) to mid-range, the DEAD-TIME RANGE switch (S2) to high, and the DEAD-TIME control (R15) to mid-range. Adjust the BURST-TIME trimmer (R3) to mid-range.

Now set your oscilloscope for a DC input of 2V/div (2-volts-per-division). Using the scope's AUTO-TRIGGER control, adjust for zero volts to be on the bottom graticule line. Adjust the sweep for 10ms/div., positive (+) slope triggering. Connect the scope ground to the circuit ground. Connect a one-to-one probe to the SNYC output (J1) of the Audio Sweep/Burst Generator. Adjust the scope's triggering level (as needed) to display a positive 12-volt pulse of roughly 17 ms. Adjust the BURST-TIME trimmer (R3) until two pulses can be seen. If no pulses are observed, U1 is not oscillating.

Next adjust the generator's BURST-TIME control (R5) for the closest pulse spacing. Adjust the DEAD-TIME control (R15) for the narrowest pulses (both should be fully CCW). Adjust the scope for 1 ms/div, and readjust the BURST-TIME trimmer (R3) so that the spacing between pulses is 1 millisecond or just a hair less. The pulses should be 3- to 4-ms wide. There is no adjustment for pulse width; that's determined by C1 and R16.

Observe TP2 near U3. Scope triggering may have to be adjusted. Ramps of 1 ms in duration, separated by a zero-volt time of 3 to 4 ms should be seen. The ramp should start at almost exactly zero volts and have a linear rise to about +8.5 volts. The BURST-TIME control should be able to extend the ramp to more than 25 ms. It may be more convenient to trigger the scope with a negative slope.

Particularly observe the ramp for linearity by holding a straight paper-edge against the CRT. Any non-linearity will be due to a leaky C5, or any other leakage path attached to pin 2 of U1. Note: If you try to observe the ramp anywhere along the pin-2 line, the scope will create non-linearity.

Disconnect power, and bleed the capacitors by shorting them out. Once that's done, insert U4, U5, and U6. Set the MODE switch (S3) to the SWEEP position. Adjust the scope input for 1V/div. Adjust RAMP-LEVEL trimmer (R20) and RAMP-OFFSET trimmer (R24) to mid-position. Connect the scope probe to the end of R17 furthest from Q3.

Again restore power to the generator, and connect your scope to the circuit, with the scope set to auto-trigger until the scope is triggered on a ramp-like waveform (which may have clipping at either the top or bottom). Adjust the RAMP OFFSET trimmer (R24) so that the ramp starts at +0.5 volt. Switch the scope to 0.5V/div for better accuracy, but make sure that zero volts is still on the bottom line. Adjust the RAMP-LEVEL trimmer (R20) so that the ramp peaks at +3.2 volts. Those are preliminary adjustments and will be done again.

Disconnect power, bleed the capacitors, and insert U2 and U7 in their respective sockets. Set the front-panel SINE-LEVEL control (R39) to mid-range. Set the FREQ-ADJUST potentiometer (R33) about ¾ clockwise. Set the SINE-RANGE switch (S4) ×10, and adjust R34 (the FREQ trimmer) to mid-range. (If you've used a multi-turn trimmer as suggested, set R34 at about its mid-range point). Adjust the SINE-OFFSET trimmer (R35) to mid-range.

Adjust the SHAPE trimmers (R6 and R7) to mid-range. Set S3 to the CONTINUOUS mode, and adjust the scope to 0.5V/div, with the scope set to AUTO-TRIGGER. Adjust the trace position so that zero volts is on the middle line of the CRT (be very precise). Set the scope-sweep rate to 10μs/div, and for just this test only, select AC input. Again, check that zero volts is dead on center.

Connect the scope probe to the SINE output jack (J2). Restore power, and adjust the scope's triggering as needed until you see a sine-like waveform. Adjust R6, R7 alternately for the best sine-wave shape, taking into account that precisely equal positive and negative alternations (areas and peaks) should appear on their side of the zero-volt line.

Adjust the SINE-LEVEL control and the scope's time base to your best advantage when shaping the waveform. A good shape is definitely possible, but there may be a very small irregularity near the peaks of the output waveform; that's a peculiarity of the XR2206 IC. Keep the same setting for the next step.

Switch the scope back to DC input while observing the output at SINE output jack J2. The waveform will shift away from the zero-volt axis. Judging as before, adjust the SINE-OFFSET trimmer (R35) so that the waveform is again precisely centered about the zero-volt axis. That completes the offset adjustment.

Now select CONTINUOUS mode, and connect a frequency counter to the generator's SINE output and its ground to ground. Set the front-panel FREQ-ADJUST control for the lowest frequency on the ×10 range (that should be fully CCW). Adjust R34 to mid-range. The counter might indicate 100 Hz or more. Verify the frequency by checking the time of one cycle on the scope, convert the time into seconds, and divide into 1.

Be sure that the scope's timebase is in the CAL. position. (Use this method if a counter is not available or as a check of the counter since some indicate double a true low frequency. Check against the scope for at least 95 percent agreement.)

Adjust FREQ trimmer (R34) for a frequency anywhere between 185 and 195 Hz; that may be a delicate adjustment. Pad space is provided to allow the use of an upright multi-turn trimmer R34 if you have trouble. On the scope, the time of one cycle at 190 Hz is about 5.2 milliseconds.

If you have shut the unit off for any length of time, allow for a 20-minute warmup. Vary the front panel FREQ-ADJUST

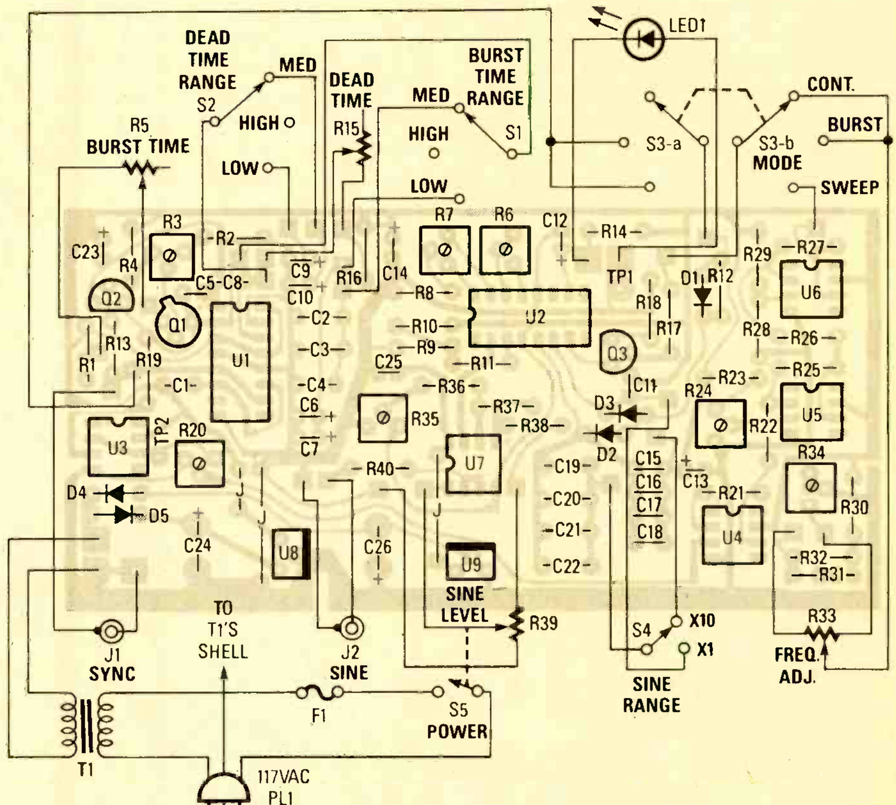
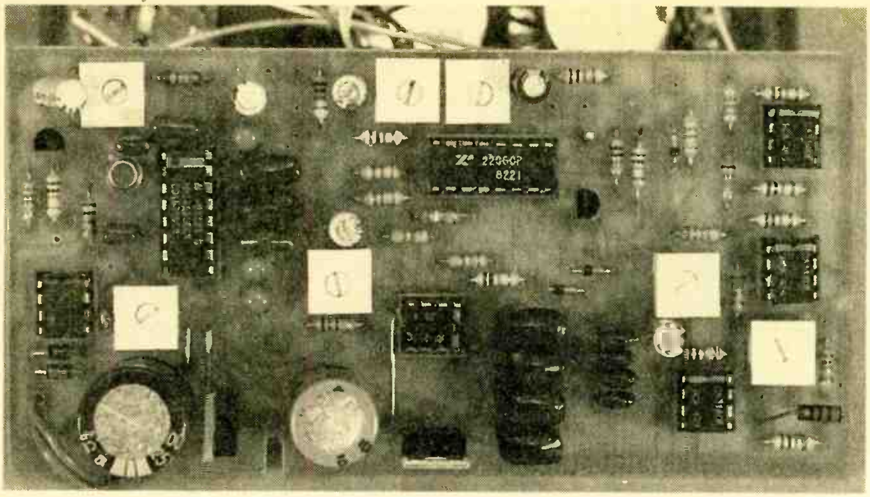


Fig. 3. Here is the parts-placement diagram for the foil pattern shown in Fig. 2. The wise way to begin assembly is to install IC sockets at the appropriate locations on the board, and then use the sockets as reference points to the proper positions for the other board-mounted components.



In the author's prototype, low-profile trimmer potentiometers were used for the internal adjustments to the circuit, however, vertically mounted, multi-turn units can be substituted.

control fully CW for the highest frequency on the ×10 range in the CONTINUOUS mode. An acceptable frequency is anywhere between 20,020 Hz and 20,220 Hz. If not, the value of R32 (6.8k) must be lowered to increase frequency or raised to decrease frequency. If trial and error is too tiresome, pads have been provided for replacing both R31 and R32 with a 2k upright multi-turn trimmer.

Whichever you choose, the highest frequency on the dial should be about 20,120 Hz and the lowest about 190 Hz. Adjusting either end affects the other. Adjustments must be repeated until both ends are acceptable. When the ×10 range is correct, the ×1 range will be also. Disconnect the counter.

The automatic sweep must be adjusted to cover the same range as the FREQUENCY dial. Adjust the scope for DC input, 0.5V/div, 2ms/div, auto trigger, and place the trace so that zero volts is on the bottom line of the oscilloscope display. Connect the probe to the end of R18 nearest to Q3. Rotate the FREQ ADJUST control fully CCW, then fully CW, and note the minimum and maximum voltages as precisely as you can (it never quite goes to zero).

Now switch to S3 to the SWEEP mode. Adjust the scope triggering as required to observe the ramp now applied to R18. Adjust the RAMP-OFFSET trimmer (R24) so that the ramp starts at the lowest voltage previously noted. Adjust the RAMP-LEVEL trimmer (R20) for the peak to just reach the maximum voltage noted. If the ramp starts too near zero, it will have a noticeable curve just as it is beginning. There will be a little irregularity here even when adjusted properly. That completes all adjustments.

Now we must check the burst and sweep functions. Trigger the scope from the SYNC output (J1), using negative-slope triggering. Select the BURST mode and set the FREQ-ADJUST control fully CCW. Observe the SINE output (J2). Adjust the scope as necessary to see that the BURST-TIME and DEAD-TIME controls work properly. A burst containing many sine waves, one or a part of one sine wave should be attainable, followed by 4 ms to about 3 seconds dead-time.

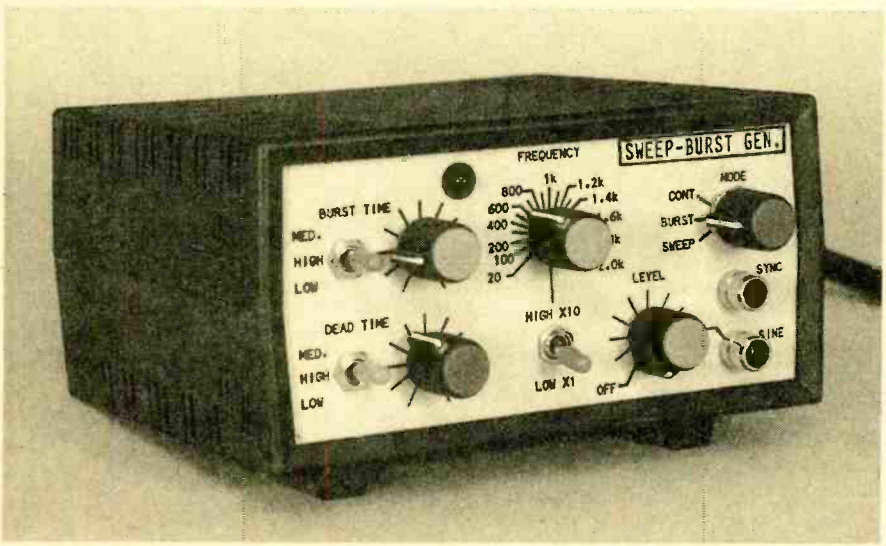
Adjust for a burst that just about fills the graticule (left to right) when using 2ms/div, then switch to the SWEEP mode. Although that setting is too fast for any practical sweep and will cause the first cycle to be badly distorted, it should be easy to see the frequency increase from left to right. Also check it on the ×1 range. That completes the checkout procedure.

Using the Sweep Properly. The slowest sweep speed will be the best since the sine wave will undergo the least distortion. That will be awkward with a conventional scope and you may wind up tracing on the CRT with a grease pencil.

Adjust the scope for the slowest sweep possible, taking it out of the CAL mode if necessary. That will be about 10 seconds for most scopes. The sweep should start a little to the right of the leftmost graticule, exactly one-half of one small hash mark. On the ×10 scale of the generator, that's the equivalent to where 200 Hz should be since the first hash mark has to represent 400 Hz. Adjust the BURST-TIME control so that the sweep ends exactly on the right-most line where 20 kHz should be. The same arrangement applies to the ×1 scale where all frequencies are ten times less.

When you display the frequency response of your device under test, there will be a mirror-image response curve also. Position the display downward so that the bottom graticule line splits the two halves and the distracting mirror image is mostly off the bottom of the CRT.

The generator is fairly versatile for such a simple-looking small unit and its easy enough to use. But see if you can come up with some unique use for those tone bursts. ■



Here is the author's finished prototype unit; note the close spacing of the front-panel mounted controls. The locations of the controls in relation to each other is unimportant, and the dial markings of the individual controls must be determined by the builder.

GIZMO®

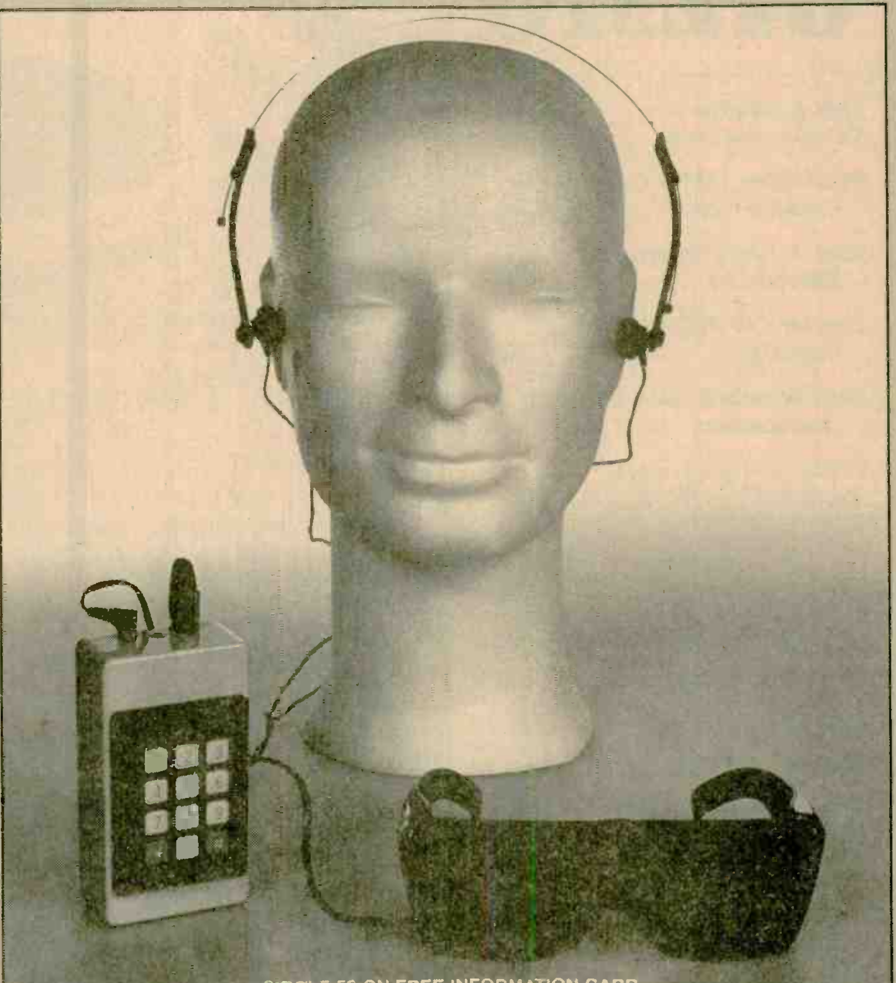
FEBRUARY 1990

VOLUME 3, NUMBER 2

A CHRONICLE OF CONSUMER ELECTRONICS

Serene Machine

MC²-DREAMACHINE. Produced by: Light & Sound Research, Inc., 6991 E. Camelback Road, Suite C-151, Scottsdale, AZ 85251. Price: $329.



CIRCLE 50 ON FREE INFORMATION CARD

Since the 1950's and '60's, research has been conducted on what the brain is doing when the body is observed to be in a particular state. It has been found that at least four distinct states of brain activity, discernable by low-frequency electrical waves generated by that organ, can be detected. Those states (and the frequencies typical of them) are:

Beta (13 Hz): Wide awake, talking, driving, working

Alpha (8–12 Hz): Meditation, eyes-closed state

Theta (4–7 Hz): Creative, "super-learning" state

Delta (1–3 Hz): Deep sleep

Over the past twenty years it has also been determined that the brain can be stimulated into producing waves of those frequencies, thereby inducing the mental states associated with them. The stimuli are simple, external ones—light and sound. The *MC²-Dreamachine* marketed by *Light & Sound Research* is a simple device that claims to be able to induce the beta, alpha, and theta states of mind and thus be used "as a tool to guide the user to a state of deep relaxation to enhance creative visualization, self-development, spiritual explorations, or any of the other consciousnesses associated with deep relaxation or meditation."

To be honest, we're not especially interested in spiritual exploration, creative visualization (whatever *that* is), or other concepts of that ilk. We're not even into healing crystals—the only crystals into which we put our faith are the 3.1415975-MHz color-burst ones in our TV sets and those that keep our computers and digital watches running. However, we are interested in finding ... shall we say ... "non-toxic, non-destructive, and legal" ways of unwinding. The MC²-Dreamachine looked as though it might be worth a try if the mystical mumbo-jumbo were peeled away.

There's not much to the device. The heart of the unit is a small box not much larger than the *Touch Tone* pad mounted on its top. Into the box you plug a set of stereo headphones and something that looks like it used to be pair of dark designer sunglasses. The "glasses" have a pair of red LED's mounted inside each lens, pointing at your eyes. After making sure that the unit's wall-plug adapter is plugged in (there's also a rechargeable battery pack available as an option for portable use—say, relaxing or indulging in spiritual explorations while on a transcontinental plane trip), you settle yourself in a comfortable spot, punch in a number from one to zero on the keypad to select one of the ten preset programs, don the phones and "glasses," and close your eyes.

As the program goes into motion the LED's start to flash and you start to hear a string of low-pitched beeping tones that seem to echo through the phones. As the program progresses, the repetition rate of the tones and flashes (which you can easily perceive through your closed eyelids) slows and so, supposedly, does the frequency of your brain waves as they synchronize with the external stimuli.

(Continued on page 8)

TURN PAGE FOR CONTENTS

This month in GIZMO®

Gizmo is published by Gernsback Publications Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735. Senior Writer: Josef Bernard. Contributors to this issue: Joan Chernok, Milford Fletcher.

CIRCLE 51 ON FREE INFORMATION CARD

Wishful Thinking

SOUNDESIGN MODEL 3836 AM/FM CLOCK RADIO WITH CASSETTE PLAYER. Manufactured by: Soundesign Corp., Harborside Financial Center, 400 Plaza Two, Jersey City, NJ 07311-3962. Price: $32.95.

Do you remember the fairy tale about the farmer and his wife who were granted three wishes by a passing fairy, or a magic fish, or some such thing? The farmer, being hungry at the time, expressed his desire for a sausage to eat. *Bingo!*, one appeared on the table. His wife berated him for his foolishness in wasting one of their precious three wishes on something as trivial as a stupid sausage—really laid into him—and the farmer, still hungry and now enraged beyond reason, screamed at his shrew of a wife, "I wish that sausage was stuck on the end of your nose!"

Bingo!

The third wish, of course, was used to get the sausage *off* the end of the farmer's wife's nose. The moral of the story is probably that "You get exactly what you wish for, so be very careful how you phrase it." (Either that, or "Don't marry a shrew." Maybe both.)

Out where we live, there's only one radio station worth listening to, at least as far as we're concerned. And it usually has good music to fall asleep to. There's a catch, though. The station goes off the air at midnight and if we don't hurry up and fall asleep on schedule, there's nothing left to fall asleep *to*. The solution? Wouldn't it be nice to have a clock radio with a cassette player built in? That way we could provide our own "falling asleep music" anytime we wanted it.

Well, we wished for a clock radio with a cassette player in it, and that's precisely what we got. *Soundesign*, whose products you may have come across in department or large chain stores, has a product that fits the description to a "T": the *Model 3836*. This little cube-shaped lullaby machine includes an AM/FM clock radio and a cassette player. It doesn't have much else to offer, though.

The only frill on the model 3836 is the cassette player; everything else is strictly utilitarian. The monophonic (of course) AM/FM radio works OK; indeed, although it takes a second or so to come up to speed (probably resulting from a cut-to-the-bone-to-keep-costs-down power supply) its sensitivity and selectivity are good and we didn't even need to fully extend the wire antenna that's attached for FM use. The quality of the audio is nothing to write home about—the unit uses a single three-inch side-mounted speaker—but it's adequate for falling asleep to and waking up by. The mechanical slide-rule-style dial was accurate enough, although it has no light and in a darkened bedroom you have to tune the radio by ear rather then by setting the frequency on the dial.

The large (½-inch) red-LED 12-hour clock display is easily legible, although we had trouble remembering which of the little red dots at the side of the display indicated AM/PM and which indicated that the alarm was set in the dark. There's no way of adjusting the brightness of the clock display, but if you're in the habit of sleeping with your eyes closed it shouldn't bother you. A backup timekeeping function is powered by a 9-volt battery, which you supply. Should it be called into play, the clock will continue to run for eight to ten hours (until the battery gives out) although the display will not be active.

The alarm can be either a "buzzer" (actually a "beeper") or the radio. The cassette player is only for falling asleep to. The volume of the alarm beeper is fixed at "*LOUD*," and that of the radio alarm is the same as what you fall asleep to. That may be a source of trouble for people who like to be lulled to sleep quietly but who need something with a bit more volume to be awakened. We were pleasantly surprised when we found that we *did* awaken to the radio's quiet morning murmurings. A "snooze" feature allows you to catch an extra eight or ten minutes of sleep in the morning after being awakened by the alarm, and the alarm automatically resets itself for the next day when you turn it off in the morning. The falling-asleep part of the clock radio allows you to have up to an hour of lullaby before it turns off. That, however, applies to the radio only.

The cassette player, although it did play cassettes, was something of a disappointment. We record our own, and use a good quality high-bias tape and Dolby-C noise reduction. The 3836's cassette player has no provision for anything other than standard-bias, no-noise-reduction-at-all, recordings. That made ours sound a little thin and screechy. A tone control could have smoothed things out a bit, but there is none.

Worse is the fact that while you can play or fast-forward a cassette, there is no provision to rewind it. If you are in the habit (as we are, and it's one we should get out of) of stopping a tape partway through, you're going to have a problem when you put that tape on to fall asleep by. You either have to get out of bed and go rewind it on another cassette player, or turn it over to the side that you don't want to listen to, fast-forward it to the end, and then flip it back to the side you want. We'll grant that this player is intended for less-than-professional purposes, but no rewind? Come on, Soundesign!

Also missing from the player is a timer. You start the tape from the beginning (or wherever you happen to be if you don't want to fast-forward it back to the beginning) and it runs until the end, at which time the player shuts off. If you're still awake then and need more music, you have to open the cassette compartment, turn the cassette around, and press the PLAY button again. At least you're at the beginning of the side when you do that. The 3836 does not allow you to wake up to taped material.

Well, you get what you ask for. We wanted a clock radio with a cassette player, and that's what we got. The clock worked, the radio worked, and the cassette player played cassettes. For a list price of less than $33 we suppose you could not wish for much more. ■

CIRCLE 53 ON FREE INFORMATION CARD

Dauphin de Siecle

DAUPHIN LAPPRO-286 LAPTOP COMPUTER. Manufactured by: Dauphin Technology, Inc., 1125 E. St. Charles Rd., Lombard, IL 60148. Price: $3495.

Several years ago we wrote a book on the then-brand-new subject of laptop computers. When we began the book there were only two of them: one from Radio Shack, and one from NEC, both built on the same Kyocera chassis. They had eight-line, 40-column LCD screens and, if you chose to expand them all the way, could have 32K of RAM. A proprietary operating system was included in ROM, as were a rudimentary word processor, communications program, and interpreted BASIC. Radio Shack's version of the system also had a 300-baud modem built in, as well as two additional utilities in ROM. If you wanted to save programs or data externally, you did so using an audio cassette recorder. By the time we had finished the book there were about a dozen manufacturers of laptops, IBM included, tussling for their share of that promising market.

The rush to fill the void has slowed somewhat, but has not stopped entirely. The newest company to enter the field, and one devoted exclusively to laptops, is *Dauphin Technology*, a startup firm located far away from Silicon Valley in Lombard, Illinois. Its initial product is the *LapPRO-286* computer, one of the first of which we were able to obtain for review. Because it was one of the first of its kind, the computer we received contained some of the design flaws that are seemingly inevitable in first-off-the-line products. We hope you'll understand this, and keep in mind the fact that Dauphin, too, is aware of the problems and is working to eliminate or correct them.

Two of Dauphin's big selling points for the LapPRO-286 are its relatively low price of $3500, and what you get for that price. Dauphin claims that the features built into the LapPRO-286 cannot be found elsewhere for much less than $5500, two-thousand dollars more than it is charging. A brief survey of the market shows that to be pretty much the case. Here's some of what we got as standard equipment with our LapPRO-286:

- 80286 microprocessor with socket for 80287 math coprocessor
- Backlit, 25-line by 80-column, Hercules-compatible LCD
- One megabyte of RAM (640K plus 360K user-configurable as either EMS or EXT—expanded or extended memory)

(Continued on page 5)

Of Koss, of Koss

KOSS JCK/300 KORDLESS INFRARED STEREOPHONE. Manufactured by: Koss Corporation, 4129 North Port Washington Avenue, Milwaukee, WI 53212. Price: $275.

We, as a society, do not do too much of our music listening through headphones ... yet. We prefer to use loudspeakers that leave us unencumbered. However, as the Walkman Generation grows and comes into its own, headphone listening is becoming more acceptable and more widespread. Part of the appeal of that way of listing to music may lie in the way in which sounds are perceived through a set of phones, and part may be the beginning of a social movement that recognizes that loud music is not to everyone's taste and that there is a way to enjoy it without disturbing those around you too much.

Finally, in a world having a population of over 6.1 *billion* people, headphone listening, with your own "personal" music coming straight into your ears, allows you to build a barrier between yourself and everything else. We do not say that is a good thing, but like it or not it's happening, as you can easily see on any mass-transit vehicle, or even by observing the young skateboarders careening about the parking lots in the twilight, each equipped with his own personal music system. (About forty years ago social-/science-fiction author Ray Bradbury wrote a story in which most of the populace walked about with little seashell-shaped earpieces stuck in their ears, listening to what they poured forth and oblivious to the world around them. How sad. And now prophetic.)

Be that as it may, let's now snap ourselves back to reality and examine the *Koss JCK/300* cordless (or *kordless* in Koss' parlance) stereophone. It's not for skateboarding. The JCK/300 is a high-quality circumaural headphone set intended for serious listening while liberating you from the trailing cable that makes at-home headphone use such an annoyance.

The term "circumaural" means "around-the-ear," and refers to the fact that cushions on the earpieces fit against the skull around the ears rather than just against the ears, as do the foam cushions used in open-air designs. The advantages of that are twofold. First, the path between the transducer and ear is unobstructed, ensuring that there is no absorption of sound at critical frequencies; it all gets through to your ear. Second, the cushion forms a seal and makes it impossible for sound waves to leak into the air (as they do rather copiously with open-air phones). That improves low-frequency response tremendously and, incidentally, does away with that tinny "*chink-a-chink-a-chink*" that we find so irritating when we're in close proximity to most wearers of open-air phones.

The sound from the Koss phones is very good, as it should be considering that Koss has been in the headphone business ever since we can remember. The most impressive thing to us, though, about the phones is their near-total lack of background noise, or hiss, which is a problem in some underpowered infrared headphone systems. The JCK/300 system is anything but underpowered. Its infrared transmitter panel contains an array of thirty infrared LED's arranged in a 5 × 6 pattern. If those were ultraviolet-emitters, we could use the panel as a sunlamp! Actually, by our calculations the power consumption of the LED array is only about 600 mW. Still, if that were RF, it would be about the equivalent of the output of a low-power portable cellular phone. No wonder there's no hiss!

The power of the LED panel ensures very good coverage. (A considerable amount of that seems to have been provided, in our case, by reflections from our light-colored walls.) We could even walk around behind the transmitter panel and get acceptable results. And, turning our back on the transmitter did not seem to affect the quality of the signal. Whether that was due to reflections in our listening room or to the design of the infrared sensor mounted atop the headband of the phones we cannot say; all we know is that the results were good no matter how difficult we tried to make it for the system to work well. Our only failure came when we aimed the transmitter outside through a window. The infrared radiation was apparently reflected back inside by the glass, and we got no reception out of doors.

Setting up the JCK/300 took a little more effort than we had expected, but would not present a problem to any audiophile in search of quality cordless-headphone sound. A signal from your amplifier (or TV receiver, or other signal source) is fed by cable to a flat box called a modulator base, which in turn drives the aforementioned LED panel. Koss supplies all the necessary cables, connectors and adapters, and input can come from a headphone jack or, more elegantly, from any of an amplifier's line-level outputs such as that used for taping. The connectors at the amplifier end of the Koss cable allow you to piggyback another set of RCA plugs onto them, so you can drive both the modulator base and the tape deck (or other device) that was originally connected to the output jacks. There is also a mike-input jack at the rear of the modulator base for use in case the device to which you wish to listen has no means of output other than its speaker. You are supposed to place a microphone (not supplied) in front of the speaker with the volume level turned down low. The sound is picked up by the mike and then amplified at the modulator base before being fed to the transmitter panel. We did not try that method.

The LED transmitter panel fits into a swivel mount atop the modulator base that allows you to aim it in the direction of your listening position. Koss also supplies a separate base for the panel if you want to mount it away from the modulator. And, if you want to extend the coverage of your system beyond its already considerable range, you can daisy-chain additional LED panels, one to the next.

The modulator base has two LED's on it: The red one is a POWER ON indicator, and the green one works in conjunction with a level control on the side of the base. You are supposed to adjust that control until the green LED just starts to blink. That, say the instructions, indicates the optimum modulation level for the transmitter. In our tests we couldn't make the LED blink; it stayed on all the time. However, we did not let that hitch prevent us from enjoying the phones by adjusting the level by ear.

The phones themselves are comfortable to wear, although, as is the case with all sealed-ear designs, we found that the local "ear-weather" got a bit humid after a while. The phones weigh only a bit over 11½ ounces (350 grams) even with the 9-volt battery used to power them in place in the left earpiece. The battery, we should mention, has a working life of between 20 and 30 hours. Two slide switches control power and mono-stereo selection respectively. A small red LED indicates that the power is on, and begins to blink when the battery starts to run down.

A volume control is built into the right earpiece, and controls the sound level in both. We were bemoaning to ourselves the lack of a balance control on the JCK/300 when we happened to glance over the press release on the product. Lo and behold, it talked about a *dual knob* volume control on the unit, which allowed the sound levels of the left and right channels to be adjusted independently. When we looked, there it was. When we scrutinized the instruction sheet, there it *wasn't*. Sometimes reading the instructions isn't enough! Being a member of the press does have its advantages.

If you are a devotee of circumaural-design headphones and want the quality for which Koss has become known over the years in a cordless (or kordless) implementation, try the JCK/300. It's a nice set of phones. ■

DAUPHIN COMPUTER

(Continued from page 3)

- One 1.44-megabyte 3.5-inch floppy-disk drive
- One 40-megabyte, 28-ms, hard-disk drive
- Two serial ports and one parallel port
- Provision for external video monitor
- Rechargeable battery plus operation from 120 or 240 volts AC or 12-volts DC
- DR DOS operating system, LapLink file-transfer software, and Alphaworks integrated software.

That's quite a bit! And it all comes in a package weighing 16.5 pounds, battery included, and measuring about 15 × 12.5 × 3 inches. You would expect that to offer all that some sacrifices would have to be made and, yes, it appears that a couple were. All in all, though, the LapPRO-286 is a substantial product.

Most of the complaints we had with our unit stemmed from the fact that, as originally designed, the computer did not meet FCC radio-frequency emissions requirements, and a new case had to be produced to satisfy the law. The case currently in production (which satisfies the FCC regulations) has a number of bothersome points about it—little things, but enough of them to be annoying.

For instance, the catch that holds the LCD in its closed position is awkward to release, and the computer is difficult to pick up from a lying-down position because of the way the handle is constructed. At the rear of the case, a small projection—actually, the jack for inputting 12-volts DC—sticks out far enough to prevent you from standing the case on its tail, as you would want to do, say, while shuffling along the check-in line in a busy airport. That may be a good idea, since it prevents you from standing the case in what may be an unstable position (we're not sure where the computer's center of gravity is), but it also keeps you from resting the unit, even lightly, on the floor as you move along. That could have been remedied simply by the addition of a couple of rubber or plastic feet on the back of the case, and such feet are included on the carrying case that's available as an option (more about that case later).

The computer's keyboard had a good feel to it and, despite the somewhat unorthodox layout of some of the keys (which seems to be the case with every laptop we've used—a consequence of mapping all the functions onto a keyboard of reasonable size), it was quite usable. There are no separate function keys—functions F1 through F10 are activated by pressing a key in the top row marked FUNCTION together with one of the number keys in the same row. That is not as awkward an operation as it sounds, although it does require two hands for functions higher than F6 or so.

The biggest problem our review model had was with its LCD. Although the contrast of the screen, even with the backlighting turned on, was not spectacular and we sometimes lost the cursor (a difficulty so common with LCD computer screens that an aftermarket program is available to create a large visible cursor to replace the one that keeps disappearing), the screen was usable under most conditions, although somewhat disconcerting to watch when scrolling rapidly. However, one pleasant day when we chanced to take the computer out of doors to do some work in the fresh air we got a rude surprise. The display seemed to develop a very annoying flicker, almost bad enough to induce a form of seasickness. At first we thought it was the heat affecting, perhaps, our eyes; then we thought it was the heat affecting, perhaps, the display. It turns out that, heat or no, the Hercules-compatible display that came with our unit did have a serious flicker problem. It is not apparent (to us, at least) under artificial light, which is where we'd have expected it to show up, but out of doors it made the computer unusable except for very short periods of time. We spoke to Dauphin about that difficulty and they told us that (by the time you read this review) you will be able to order the LapPRO-286 computer with one of several displays. The others are said by the company not to flicker and to have better contrast, as well. Order what you like, but stay away from the high-resolution Hercules-compatible display if you plan to use the computer under natural light.

Despite its weaknesses, we found a lot to like about the LapPRO-286. For example, the battery pack (which will power the computer for about an hour and a half) uses lead-acid, not nickel-cadmium cells. That means that you don't have the "Catch-22" situation of having to unplug the computer when its batteries are fully charged to prevent them from developing a memory problem and yet *insisting* that they always be kept fully charged else they'll run down more quickly than you expect. Lead-acid cells like to be kept up to charge, and by keeping the unit plugged in you're doing them a favor by providing them with a constant trickle charge. The power supply will automatically conform itself to source voltages of 120- or 240-volts AC, at either 50 or 60 Hz, and a separate jack is provided for operation from an external 12-volt source—an automobile cigarette-lighter receptacle, for example.

We also like DR DOS (the "DR" stands for Digital Research, the software firm that created it), which is the operating system provided with the computer. DR DOS is an MS-DOS 4 clone, with a few improvements such as on-line help for many of the DOS commands. The operating system also has an XDIR command that we find more informative and convenient than the standard DIR command, as well as several other niceties not included in MS- or PC-DOS, such as password protection. The manual, while not especially long, is nicely intelligible.

And the computer did work as we expected it to. That's no insignificant point!

The soft carrying case that's available at extra cost is well worth it. Not only does the carrying case give you a convenient means to *schlep* the computer around comfortably over your shoulder (even 16 pounds gets heavy to carry around after a while), but it also provides plenty of storage space for disks, manuals, cables, and all the other paraphernalia you need to get your work done on the road.

In sum, if you are willing to put up with a little inconvenience to save a couple of thousand dollars, we think the LapPRO-286 is worth investigating. We wish Dauphin had done more of its market research *before* releasing the LapPRO-286 to the public, but even so, the relative value of that computer is good. We look forward expectantly to Dauphin's new-and-improved models. ■

The Eggs and I

OHM CAM 32 COHERENT AUDIO MONITOR LOUDSPEAKERS. Manufactured by: Ohm Acoustics, 241 Taaffe Place, Brooklyn, NY 11205. Price: $450.

The two-way speaker system designated *CAM 32* by *Ohm Acoustics* is the middle one of a group of three sporting an unusual design feature—a small egg-shaped protuberance projecting from the top of the enclosure. (More precisely, the "egg" resembles the "bullet"-shaped housing used for many communications microphones. However, a rose by any other name...) Inside the "egg" is the system's ¾-inch tweeter, and it is that egg tweeter, or "ET" as some refer to it, that sets the CAM series apart from other speakers in their price range.

Ohm claims two advantages for outboarding the tweeter in that fashion. The first is that by removing it by an inch or so from the vicinity of the main enclosure's surfaces and corners, diffraction effects that can alter and distort the high-frequency waveform are avoided. The sound waves generated by the tweeter leave it and travel straight through the air to your ear without even brushing against anything in between.

The other benefit from having an outboard tweeter, says Ohm, is that it can be made rotatable. That allows you more flexibility in positioning the speakers in a "real" listening area that may already have furniture or other items occupying the spaces in which the speakers would ideally be located. The CAM (which stands for *C*oherent *A*udio *M*onitor) instruction manual says that by redirecting the high frequencies, which are one means our ears use to localize sound sources, displacements that may occur because of less-than-ideal speaker locations can be offset so that sounds produced by the system seem to originate from the points they were intended to.

Setting up the CAM 32's was simple enough. Spring-loaded push-type connectors (the kind with a hole into which you insert about half an inch of bare wire or a banana plug, which is then trapped tightly by a spring-loaded clamp) make cabling easy. The egg tweeters are packed separately in each shipping case. They are attached at the base to microphone plugs that plug into jacks atop the main-speaker enclosures. That makes the ET's rotatable, and a rudimentary scale marked in degrees is provided around the jacks, presumably to make position settings repeatable. Of course, the only indicator for that scale is the somewhat pointed rear end of the bullet-shaped "egg" enclosures; if Ohm had been really serious about that they would have come up with a more accurate pointer. What there is is probably good enough, though.

Ohm recommends that you set up the speakers initially with the tweeters aimed so lines drawn through their axes cross slightly in front of your listening position. We started out that way, and found there was so much treble it made listening unpleasant. Even decreasing our amplifier's treble output didn't ameliorate the situation. We next tried aiming the tweeters away from our ears, but that didn't help much either. Nor did turning the eggs so they faced backward, completely away from us. We sat down to think about it and, as we gazed into space beyond the speakers, came to the realization that the tweeters were exactly at the level of our ears and that all their output was in the same plane as our hearing apparatus. Checking the manual, we saw that Ohm recommends that the main enclosures be at ear level, which places the tweeters' line of fire somewhat above the head. We inclined our set of CAM 32's a bit so they fired slightly upward, and the problem cleared up. The sound immediately became more mellow and much more listenable.

We already knew that the CAM 32's had plenty of high-frequency output. Their bass response, while adequate, was not spectacular, although we suppose we shouldn't expect miracles from a system with a 6½-inch midrange/woofer assisted by a ten-inch passive radiator. If you like the egg-tweeter idea, the CAM 32 has a big brother, the CAM 42, with an 8½-inch midrange/woofer and 12-inch passive radiator that may provide enough bass to satisfy you. Or you can add a subwoofer.

When we first started listening to the CAM 32's, we noticed an unusual effect—an almost unreal expansion of the stereo soundstage. It was particularly noticeable in the case of the announcers on our favorite radio station, who sometimes sounded as though they were speaking almost from offstage, in the wings. "Wow!" (we thought) "Ohm really has something here. The phase-matching on these speakers must be exceptional!" Of course, the system didn't seem to be able to localize particular instruments very well, but who cared with that incredible spread!

It was when we started rotating the egg tweeters to see whether Ohm's claims about them were true that we discovered what was really going on. We were running our amp in its monophonic mode to generate a single sound source that we could pinpoint easily, and discovered that we couldn't do that—something just didn't sound right. We checked our cabling, and everything there was as it should have been. Then, on a hunch, we reversed the connections to one of the two speakers. Aha! The mono sound source suddenly took on location and when we switched to stereo, the imaging improved tremendously and the sound took on a solidity it had lacked before.

What was the problem? Phasing. One of the two speakers apparently had been shipped either with connections crossed internally, or with its insides mechanically out of phase with those of the other. That isn't supposed to happen, but it did. (We had originally suspected the radio station of playing phase tricks, but listening to it in the car and on other receivers did not produce that same spectacular effect; that's when we started to think the speakers might be responsible.) By changing the phase relationships in a stereo signal, all kinds of interesting effects can be obtained. For instance, sounds can be made to seem to come from beyond the space bound by the speakers producing them. Indeed, the extraction of surround-sound rear-channel information from a stereo signal depends on the out-of-phase information contained in that signal. When we switched around the leads to one of the speakers, we reversed the reversed-phase relationship and caused it to be hooked up properly.

Now we could play with rotating the eggs. And, as we had been told they would be, they were effective in shifting sound sources to compensate for our listening position. The trick is to point the egg of the nearer speaker away from you, and the one on the farther speaker toward you. Since, as we mentioned earlier, one of the ways we localize sounds is by the intensity and source of their high-frequency content, hearing more high-frequency sound from the farther speaker (and less from the closer one) displaces the apparent center of the soundstage. We'd always thought that was the purpose of the BALANCE control on our amplifier, but now we know you can do it with speakers as well.

While we wouldn't term the CAM 32's to be outstanding performers, we have to point out that they are not outstandingly expensive, either. Their performance is about commensurate with their price, and the "ET" feature does work. If you can use it, take a listen to these or the smaller CAM 16's or larger CAM 42's. ■

Look Ma, No ... Antenna

COBRA MODEL CP-482 INTENNA CORDLESS PHONE. Manufactured by: Cobra Electronics Group, Dynascan Corp., 6500 West Cortland St., Chicago, IL 60635. Price: $179.95.

The companies that sell cordless telephones probably do an enormous aftermarket business in replacement antennas. It's so easy to turn around and snap off an extended antenna against a wall or the top of a low doorframe. Collapsing one of the telescoping whips too energetically can cause it to crumple like a drinking straw, and if you drop your phone in just the right way you can just as easily render it antennaless.

Besides that, antennas are a pain in the neck to use—unless you're right by the base unit you have to extend the antenna to get and maintain a usable signal, and then collapse it when you return the phone to its cradle. And carrying around a cordless phone with its antenna extended can be dangerous. You could poke somebody's eye out! (Ask your mother.)

Well, the people at *Cobra*, who've been in the cordless-phone business for quite some time, seem to have found a solution to the antenna problem. They now make a phone without one. It's called the *Intenna*. There are several phones in the Intenna line: we chose to look at the middle-of-line model *CP-482*.

Of course, the Intenna phone really *does* have an antenna, but it's inside the handset. That's how the phone got its name. The base station, incidentally, uses a conventional telescoping whip. The internal Intenna antenna is a piece of nickel-plated brass (we're told that Cobra experimented with a number of different metals before settling on that combination) shaped to fit inside the upper portion of the handset. At least, that's the way it began; the shape was then refined to optimize radiation characteristics while still fitting inside the handset shell.

Since the big difference between this cordless phone and other types is in the design of its antenna, we attempted to find out something about how the new design works. No luck. The best we could get from Cobra was something to the effect of "...you have to stop thinking of antennas in traditional linear (?) terms..." That's not much of an explanation. We think that what they meant was either "None of your business!" or "Gosh, *we* don't know how it works, either."

In making design compromises of this nature—"linear thinking" or not, we still believe that a long external antenna is the better and more efficient design—you may have to accept certain compromises. One of them is in the cordless phone's range of operation. Actually, we were pleasantly surprised by the range we got out of the "antennaless" phone. While the phone's range was not quite as great as that of some more conventional cordless phones we've used, the range of the Intenna allowed us sufficient latitude (and longitude) of movement to roam throughout, and around the outside of, the house—probably as far away from it as you'd normally find yourself strolling in the course of a phone conversation.

We found that the orientation of the antenna on the base unit, as well as its proximity to metal objects such as lamps, had a considerable effect on the quality of the phone's signal. Also, Cobra warns that you should hold the handset at its lower end, away from the location of the internal antenna. If you hold it near the top of the handset, your hand will, in effect, become part of that antenna through capacitive coupling, and you'll interfere with the unit's transmission and reception characteristics.

To be honest, we had a few difficulties with the phone portion of the CP-482. We've been extremely pleased with some of Cobra's other cordless phones, but the Intenna, we're told, is produced at a different factory (and using different materials) from them, and the differences in design, and maybe manufacture, show. The incoming audio, for example, is very "peaky," and is difficult to listen to for long periods. (We're told that what's heard at the other end also partakes of the same characteristic.) In our use of the phone, that peakiness sometimes rendered callers—especially women with heavy ac-

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cents—nearly unintelligible, and more than once we had to switch to another phone just to figure out what was going on at the other end. The phone's audio characteristics also made extended conversations something of an ordeal.

We did not care for the numeric keypad's rather mushy feel, which made it seem as though the phone were hesitating for an instant before generating the tones for the keys pressed. The keypad's characteristics made it impossible for us to dial a number with the rapidity to which we are accustomed; it was sort of like dialing through molasses. Those with a more positive outlook than ours might refer to the keypad's "soft touch" rather than its "mushiness."

When taken off hook, the phone was somewhat sluggish to respond. The delay involved is probably only a few dozen milliseconds, but that was more than enough to cause a problem when we were expecting an immediate response. For example, the phone took longer than we think it should have to realize that it was off hook. We did not get a dial tone as quickly as we should have, and consequently occasionally got a recorded " 'you must first dial one' ..." message when attempting to call long distance. We also had to learn to wait a few moments before speaking when we picked up the phone, otherwise our first one or two "hellos" never made it out of the house.

Hidden switches on the handset and base unit allow you to select one of several digital codes to help keep other cordless phone users in your neighborhood from getting into your system. In addition, Cobra claims that when your Intenna system is on hook (hung up), it is inaccessible to other cordless-phone systems that might otherwise be able to dial out on your line and thereby ring up considerable long-distance charges at your unwitting expense.

What did we like about the Intenna CP-482? Well, this particular Intenna model also includes an intercom function, which can be used independently of the phone line (in essence, you use the system's radio transmitters and receivers as a wireless intercom link). That worked pretty well, although it was subject to the same range limitations as the phone itself. The Intenna phones also include the now-standard memory, redial, and pulse/tone-dialing features that no modern phone would be caught dead without.

We like the idea of the Intenna system, and, except for the peculiarities we've noted, the phone worked well. We sort of missed the "Captain Kirk" feeling of being able to snap the telescoping whip smartly out to its full extension before embarking on a conversation, but we certainly *didn't* miss snapping off that antenna as we stepped through the hatch to the transporter room. ■

DREAM MACHINE

(Continued from page 1)

And you know what? It seems to work! We haven't tried all ten of the programs built into the MC²-Dreamachine, but the ones we have tried have left us feeling that something more happened to us than just half-an-hour or so of beeping and flashing. At the end of one of the shortest programs, which lasts fifteen minutes, we did, indeed, feel much more calm and clear-headed than when we began. And it wasn't a fluke—we could repeat the experience (one of the tenets of the scientific method, repeatability) any time we wanted to. The MC² doesn't put you into a trance or anything like that—you're always conscious and fully aware of the world around you—but it does seem to allow your mind to uncoil and free itself from some of its more temporal concerns, at least temporarily. The state of mind induced by the unit is not permanent—after a little while your brain starts setting its own pace again. The effect is hard to describe if you haven't experienced it; it's what you supposedly get after practicing just about any relaxation technique—Transcendental Meditation is what comes to mind—except that you have an electronic assist and don't have to do it all yourself.

The MC²-Dreamachine has a number of parameters that you can adjust from the keypad. After you've selected your program and started it running, the keys allow you to raise or lower the volume of the sound coming through the phones, as well as to change its pitch. Apparently, pitch is not nearly as important as is the repetition rate, and you can even remove the sound's tonal characteristic entirely, leaving a series of hissing pink-noise pulses (not nearly as objectionable as it sounds). A small control on the "glasses" allows you to adjust the intensity of the flashing red LED's.

A jack on the main box allows you to mix the output of a cassette recorder (or other audio device) in the phones with the sound generated by the MC². Light & Sound suggests several uses for that feature: Quiet music and "inspirational messages" are two of them. The theta state is said to be a receptive state of mind, and a catalog included with the unit lists a number of instructive cassette programs, with titles such as "Mind Aerobics" and "Meeting Your Inner Mate," that are available for purchase from Light & Sound. There are also a few more practical titles, as well as a number that we (our opinion, only, of course) consider to be metaphysically out of bounds. The manual also provides suggestions for scripting your own "mind-movies" to teach yourself new and improved patterns of behavior while in the receptive theta state. We restricted ourselves to coming up with new ideas for **Gizmo**.

Should you be interested in exploring the MC²-Dreamachine further, here's what the ten preset programs are said to do, although what works best for you for a particular purpose might be a different program than the one suggested. The figures in parentheses indicate the "running time" in minutes of each program.

1 (15) High energy, focusing
2 (15) Relaxation, brainstorming
3 (30) Meditation, topic tapes
4 (30) Relaxation, learning
5 (30) Sleep learning, visualization
6 (30) Motivation, relaxation
7 (20) Intense relaxation, focusing session
8 (45)* *Programs 8-0 can be set
9 (60)* for deep relaxation,
0 (75)* accelerated learning, dream enhancement, and advanced visualization

The MC²-Dreamachine is said to be harmless *with one possible exception*. Some epileptics are subject to photoconvulsive seizures—that is, seizures brought on by flashing lights. Light & Sound recommends in several places that epileptics not use their product unless it is with their physicians' approval.

We don't know how much a relaxed state of mind is worth to you, nor to what lengths you're willing to go to attain some measure of serenity. However, if you are a hard-core serenity seeker, in the long run the MC²-Dreamachine might be a worthwhile investment for you. One thing that's certain is that it won't leave you with a hangover the next morning.

Coming Next Month in GIZMO®

- Bose AW-1 "Acoustic Wave" Compact Music System
- Casio CT-650 Tone Bank Musician's Keyboard
- MaxTrek SmartMax Automatic Fax Machine/Telephone Switch
- Canon A1 Hi8 High-Band 8mm Camcorder
- Yamaha DSP-100 Digital Sound-Field Processor
- AudioSource EQ Ten Computerized Graphic Equalizer/Spectrum Analyzer
- And Much More!

For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

High-Tech Labelmaker

A portable labeling and lettering system with keyboard that's half the size and one-third the price of comparable machines has been introduced by *Kroy Inc.* (P.O. Box C-12279, Scottsdale, AZ 85267-2279). The Kroy *DuraType 240*, which is about the size of a desktop calculator or telephone, prints characters onto a transparent or opaque tape that is then bonded to a clear overlay, creating a letter strip that resists scratching, water, and heat. The unit, which operates from either four "D"-size dry cells or an optional AC adapter, weighs four pounds and includes a QWERTY keyboard and a 16-character LCD. Its built-in, high-resolution, thermal printer produces lettering on half-inch-wide adhesive-backed tape—clear tape with black letters and opaque white tape with black, red or blue letters. A typestyle corresponding to Helvetica medium 10-, 20- and 30-point sizes is resident in the system and a total of 13 slip-in typestyle cards are available. Typestyles can be changed in about ten seconds. The DuraType 240 prints upper- and lower-case English-language letters, numerals, and punctuation marks as well as graphic symbols useful for architectural and engineering drawings and a full set of western-European-language characters. Price: $495.

CIRCLE 56 ON FREE INFORMATION CARD

Kroy Label Maker

CD Personalizer

Can you prove ownership of your CD's? You can if you've protected them using the *Identadisc* system being marketed by *Hi-Pro-Tech* (Box 1357, Lansdale, PA 19446). Using only pressure, a sharply embossed metal ring inside the Identadisc embosses a factory-issued personal identity code permanently and safely on the CD's inner gripping ring, away from the information area. That personalized security code is also entered in the the Identadisc Computer Network (which will also register the serial numbers of your high-fidelity equipment), with a $1000 cash reward being offered by Hi-Pro-Tech for information leading to the arrest and conviction of a thief found with discs and equipment protected by the Identadisc system. In addition to the Identadisc stamping unit, the Identadisc System includes warning labels for your individual CD boxes, car windows, and stereo system ("Warning—Protected by Identadisc"); automatic registration in a national reporting and checking system; access to a toll-free phone number to assist owners, police, or swap shops in the recovery of imprinted stolen discs; and discounted prices on CD log books, collector CD's, and other items. Price: $49.95.

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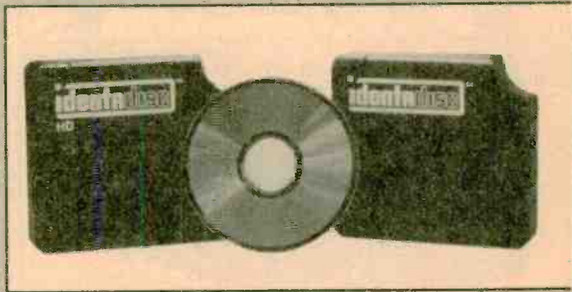


Hi-Pro-Tech's Identadisc System

Speaker Protector

Power Shields are aftermarket loudspeaker-protection devices from *Allison Acoustics* (1590 Concord St., Framingham, MA 01701) that can be installed in-line with any speaker system to prevent driver damage or destruction caused by high signal levels. Power Shields differ from fuses and circuit breakers in that, after they have been triggered, they automatically reset when signal levels are reduced. Four different power ratings (equating to eight wattages—four into four-ohm and four into eight-ohm loads—are available. Price: $39.95.

CIRCLE 58 ON FREE INFORMATION CARD

Allison Acoustics Speaker Protector

Music Maker

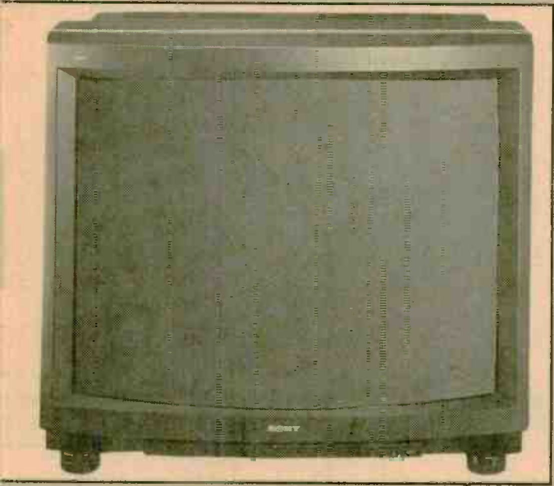
You can create your own "hip tunes" while you dance with *Hip Tunes*, a product of *Nasta Industries* (200 Fifth Ave., New York, NY 10010). Hip Tunes is a portable electronic music system with its own amplifier and speaker. To use it, you clip it to your belt or waistband and select one of four background rhythm buttons (ROCK 1, ROCK 2, LATIN, OR RAP) to start the beat. Then, after adjusting the tempo, you start dancing. Moving to the right makes one sound, moving to the left another, and jumping in the air still another. You can create entirely new music by selecting another rhythm. If that's not enough for you, you can add to the music with a special "accent sound" triggered by a button on the microphone included with the device. Or, you can use the mike simply to sing along with your newly created tunes. Hip Tunes is recommended for ages six and up, unless you think someone's going to catch you at it. Price: Under $35.

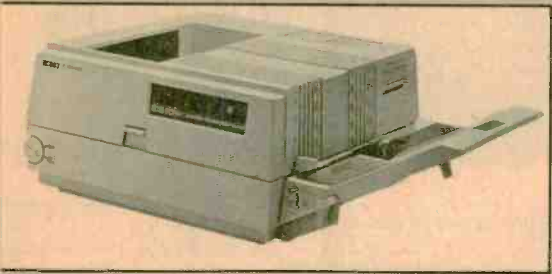
CIRCLE 59 ON FREE INFORMATION CARD

Nasta Industries' Hip Tunes

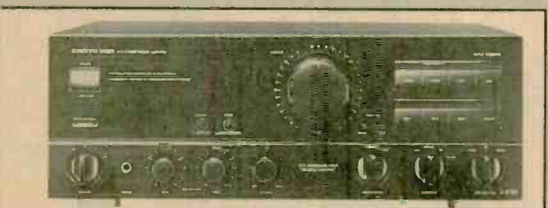
ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.


Sony 43-Inch Trinitron


Ricoh Laser Printer

Kansas Microtech Auto Alarm


Onkyo Integrated Amplifier

Huge Trinitron

The world's largest direct view Trinitron television set is *Sony's* (9 West 57th St., New York, NY 10019) 43-inch *PVM-4300* receiver. Aimed at the videophile and elite-consumer market, this limited-production receiver weighs over 450 pounds and is said to be so large it is unable to fit through a standard doorframe. However, its IDTV (Improved Definition TV) non-interlaced scanning system and digital frame memory may, for some, outweigh those inconveniences. Sony's IDTV system allows all 525 scan lines to be displayed simultaneously rather than half in one video field and half in the next. That results in an image with greater density, less inter-line flicker, and an improvement in vertical resolution of as much as 50% compared to conventional TV receivers. The set's digital frame memory includes motion sensors and motion-adaptive circuitry to produce a crisp image, provides accurate color reproduction, and reduces picture noise. An on-screen display uses multiple windows to simplify adjustments of picture hue, color, sharpness, brightness, treble, bass, and stereo balance. The unit contains a pair of 15-watt-per-channel stereo amplifiers and, for high-resolution sources, three S-Video inputs. Price: About $1000/inch, or $40,000.

CIRCLE 60 ON FREE INFORMATION CARD

Controller-less Laser Printer

Realizing that many laser-printer users want more flexibility than has traditionally been available, *Ricoh Corporation* (5 Dedrick Place, West Caldwell, NJ 07006) has introduced the *PC Laser 6000/EX*, a six-page-per-minute laser printer that uses a computer-resident control to tailor its performance to a user's requirements. The printer has a standard 50-pin video interface that connects it to a controller card in one of a host computer's expansion slots. Controller cards, which are available from more than a dozen companies, shape the printer's personality to include such "traits" as PostScript or another PDL capability and to provide a choice of processing speeds. If your printing requirements change, they can be accommodated by a simple controller-card replacement rather than the acquisition of an entire new printer. The 37-pound PC Laser 6000/EX printer produces text and graphics at a resolution of 300 dots per inch. It can accept letter-, legal-, and international-size paper formats and can also print on envelopes, transparencies, and label stock. Output can be configured to be either face-down or face-up. The printer's paper capacity can be expanded from 150 to 400 sheets with the installation of a 250-sheet auxiliary paper tray. Price: $1895 (less controller).

CIRCLE 61 ON FREE INFORMATION CARD

Portable Auto Alarm

CarCop is a portable automobile alarm that uses patented motion- and vibration-sensing circuitry to detect even the slightest disturbance to a vehicle. Manufactured by *Kansas Microtech* (7300 West 110th St., Suite 990, Overland Park, KS 66210) the alarm, which is powered by a single 9-volt alkaline battery, requires no installation and can be moved easily from vehicle to vehicle. To use CarCop, the owner simply mounts it on a window, turns the power switch on, and rolls up the window. Ten seconds after the car door is closed and locked, the device arms itself, emitting a chirp to indicate that it has entered the armed state. The alarm, which offers three selectable levels of sensitivity, emits a 105-dB warble tone when it is triggered. Re-entry to the car is accomplished by unlocking and opening the door. Because of the high-visibility way in which it is mounted, CarCop is said also to provide a visible deterrent to would-be thieves and vandals. Price: $149.95.

CIRCLE 62 ON FREE INFORMATION CARD

Integrated Amplifier

The *A-8700 Integra* integrated amplifier from *Onkyo* (200 Williams Drive, Ramsey, NJ 07446) is rated at 105 watts-per-channel and provides up to 305 watts-per-channel into two ohms. The Class AB linear-switching amplifier uses an *ELF* (*E*xtremely *L*ow *F*requency) phase-cancellation servo circuit to prevent DC leakage at its outputs. Among its virtues is an extremely stable power supply that uses such exotic measures as opto-coupling rather than Zener diodes to ensure unvarying operating current, and an adjustable load for its moving-magnet/moving-coil phono stage. Price: $530.

CIRCLE 63 ON FREE INFORMATION CARD

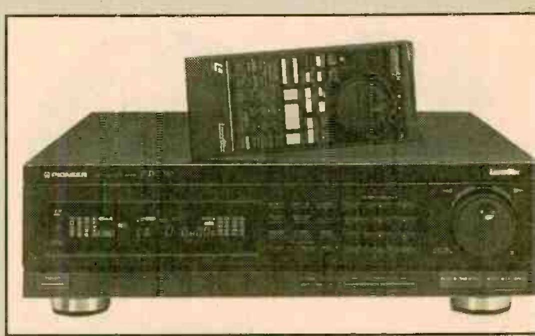
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Combination Disc Player

Able to play 8- and 12-inch laser discs, 5-inch CD's and CDV's, and 3-inch singles, *Pioneer Electronics'* (2265 E. 220th St., P.O. Box 1720, Long Beach, CA, 90801-1720) *CLD-3070* combination player also permits both sides of CLV (extended play) and CAV (standard play) 12-inch laser discs to be played without having to turn them over manually. The turnover function is performed automatically by a fast "alpha turn" mechanism. The CLD-3070 uses a four-times-oversampling (176.4 kHz) digital filter and twin D/A converters to provide clean phase response and audio. Besides offering a variety of programming options too numerous to mention, the CLD-3070 has many other useful features. A "jog-and-shuttle" dial—found on both the main unit and on its remote control— permits rapid scanning of material both forward and backward at a variable rate of from 2- to 40-times normal speed. An 8-bit digital field memory provides clean special effects such as freeze frame or slow motion on CAV and CLV disks and can freeze a single scene while CD music continues to play. The player is capable of delivering 425 lines of horizontal resolution and features a 47-dB video signal-to-noise ratio. An "S" video output separates chrominance and luminance signals to eliminate video artifacts such as dot crawl. The player's audio signal-to-noise ratio of 98 dB makes it comparable to high-quality audio-only CD players. Price: $1200.

CIRCLE 64 ON FREE INFORMATION CARD



Pioneer Combination Disc Player

Avionics Headset

The first aviation headset said to effectively cancel unwanted noise has been introduced by *Bose Corporation* (The Mountain, Framingham, MA 01701). The *Bose Aviation Headset* combines both physical and electronic noise-attenuation systems to offer two major improvements over conventional headsets. First, the cushions used on the headset's earcup, which are filled with a combination of silcone gel and soft foam, conform to the shape of the head and seal out noise without the use of an inordinate amount of force. Second, an active-cancellation circuit uses microphones in the earcups to monitor sound at the user's ear. That signal is compared with the signal the user wants to hear—a radio signal or, perhaps, silence. The difference signal generated by combining the two is then used to create an out-of-phase noise-cancellation signal. Price: $965.

CIRCLE 65 ON FREE INFORMATION CARD

Bose Noise-Cancelling Headphones

Video Enhancer/Stereo Mixer

With *Ambico's* (50 Maple St., Norwood, NJ 07648) model *V-0629 A/V Maestro* you can orchestrate a professional-sounding mix of narration and background music into the soundtrack of any home video while, at the same time, enhancing the quality of the video image. The A/V Maestro has three stereo-audio inputs, each with its own volume control, that let you mix and fade among camcorder or VCR audio, music, and narration inputs. The unit can provide an audio boost of up to 14 dB, and includes a master volume control for overall control of sound-signal level. The video portion of the A/V Maestro allows you to add up to 6 dB of boost, which is said to result in richer colors and more detailed images. A microphone for narration is included. Price: $69.95.

CIRCLE 66 ON FREE INFORMATION CARD

Ambico Video Enhancer/Audio Mixer

LCD Video Projector

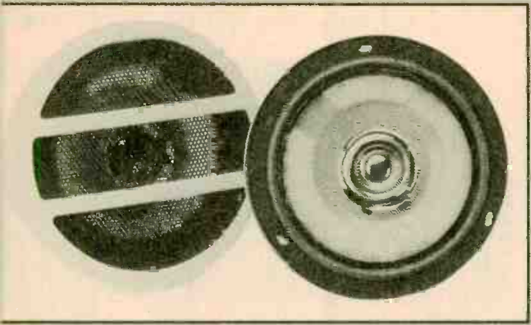
Three 3-inch LCD panels control the red, blue, and green beams in *Sharp Electronics'* (Sharp Plaza, Mahwah, NJ 07430-2135) *XV-100* video-projection system. The panels, manufactured using *TFT* (*T*hin-*F*ilm *T*ransistor) technology, contain over 268,000 pixel elements and can provide more than 300 lines of horizontal resolution. The projector is equipped with a zoom lens that allows the projected image to be enlarged or diminished in size from 100 to 25 inches (diagonal measure) to suit room and screen size, and images measuring up to 200 inches diagonally are possible if you are willing to trade brightness for size. Two standard video inputs and an S-video input allow for connections to VCR's, laserdisc players, or other video-signal sources. Price: $6500.

CIRCLE 67 ON FREE INFORMATION CARD

Sharp LCD Video Projector

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.



Sony Weatherproof Speakers

Weatherproof Speakers

Realizing that with the proliferation of all-terrain vehicles, open-vehicle four-by-fours, motorcycles, and boats there comes a need to protect speakers from the rigors of heat, sunlight, water, and corrosion, *Sony* (One Sony Drive, Park Ridge, NJ 07656) has introduced an all-weather speaker designated the *Mariner XS-616*. The 6½-inch unit, with a power-handling capacity of 75 watts, uses a polypropylene cone material to resist damage from water and sun, and zinc plating and rust-resistant white enamel add further protection. To complement the XS-616, a waterproof stereo receiver cover, the *GMD-616*, is also available. Price: $89.95 (XS-616), $49.95 (GMD-616).

CIRCLE 68 ON FREE INFORMATION CARD

Vector Research Programmable Turntable

Programmable Turntable

Filling an increasing void in the analog record-player arena is the *VT-320* linear-tracking programmable turntable from *Vector Research* (1230 Calle Suerte, Camarillo, CA 93010). An optical sensor in the pickup assembly senses the shiny blank vinyl intertrack areas, and that information is used to keep track of the cuts that contain the program material. The VT-320 can be programmed to play up to eight tracks, and a REPEAT function allows the same track, side, or selection of cuts to be played as many as 16 times. A row of buttons on the front panel provides direct access to any or all of the selections on a record. The unit also includes a tone-arm muting circuit to eliminate the "thump" that is heard when the stylus is set down on or lifted from a record's surface, and allows you to override its automatic speed and size selectors in the event that transparent or other non-standard-type records are played. A dual moving-magnet cartridge is included with the turntable. Price: $199.

CIRCLE 69 ON FREE INFORMATION CARD

Vivitar Wireless Microphone

High-Power Wireless Mike

To use while recording those l-o-o-o-n-g telephoto shots, you may want to consider *Vivitar's* (9350 DeSoto Avenue, P.O. Box 2193, Chatsworth, CA 91313-2193) *WMK-2* wireless microphone kit. With an RF output of 50 milliwatts, its transmitter has a range extending up to 1500 feet. To avoid interference, the crystal-controlled unit can operate on either of two frequencies in the 170-MHz range. The WMK-2's specifications indicate a frequency response extending to 15 kHz. The microphone has a 20-Hz to 20-kHz response (± 3 dB), with a dynamic range of 120 dB. The receiver has MUTE ADJUST and OUTPUT LEVEL ADJUST controls. That latter feature can be extremely useful in matching the receiver's output to the requirements of the recording unit. Both transmitter and receiver operate from 9-volt alkaline batteries; the life of the transmitter battery is between six and eight hours. Price: $249.95.

CIRCLE 70 ON FREE INFORMATION CARD

Krell Digital Processor

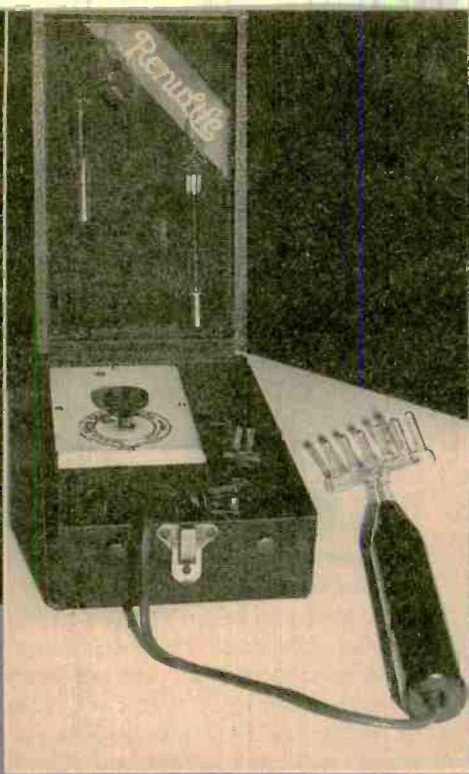
Digital Processor for CD's

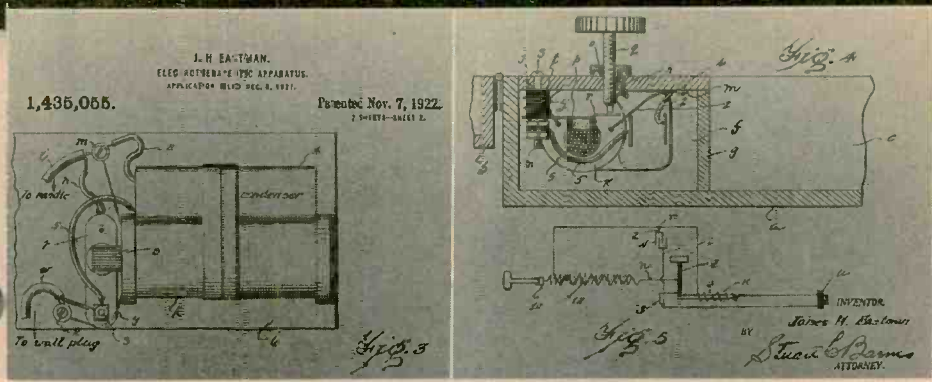
Krell Digital, Inc. (20 North Plains Industrial Road, Suite 12, Wallingford, CT 06492) has introduced a firmware-based signal processor for CD players named the *SBP-64X Digital Processor* that is supposed to eliminate noise and restore sonic qualities previously thought to be missing from digital music. Using four Motorola DSP-56001 digital signal processors, the Krell unit can carry out more than 60-million computations per second on the digital information it processes and provides 18-bit, 64-times oversampling. That high-speed signal processing results in a dynamic-range capability in excess of 300 dB. The SBP-64X is said to be the first digital system to effectively challenge high-end analog systems for leadership in the reproduction of pure, high-resolution sound. Price: $8950.

CIRCLE 71 ON FREE INFORMATION CARD

VIOLET-RAY GENERATORS

BY STAN CZARNIK





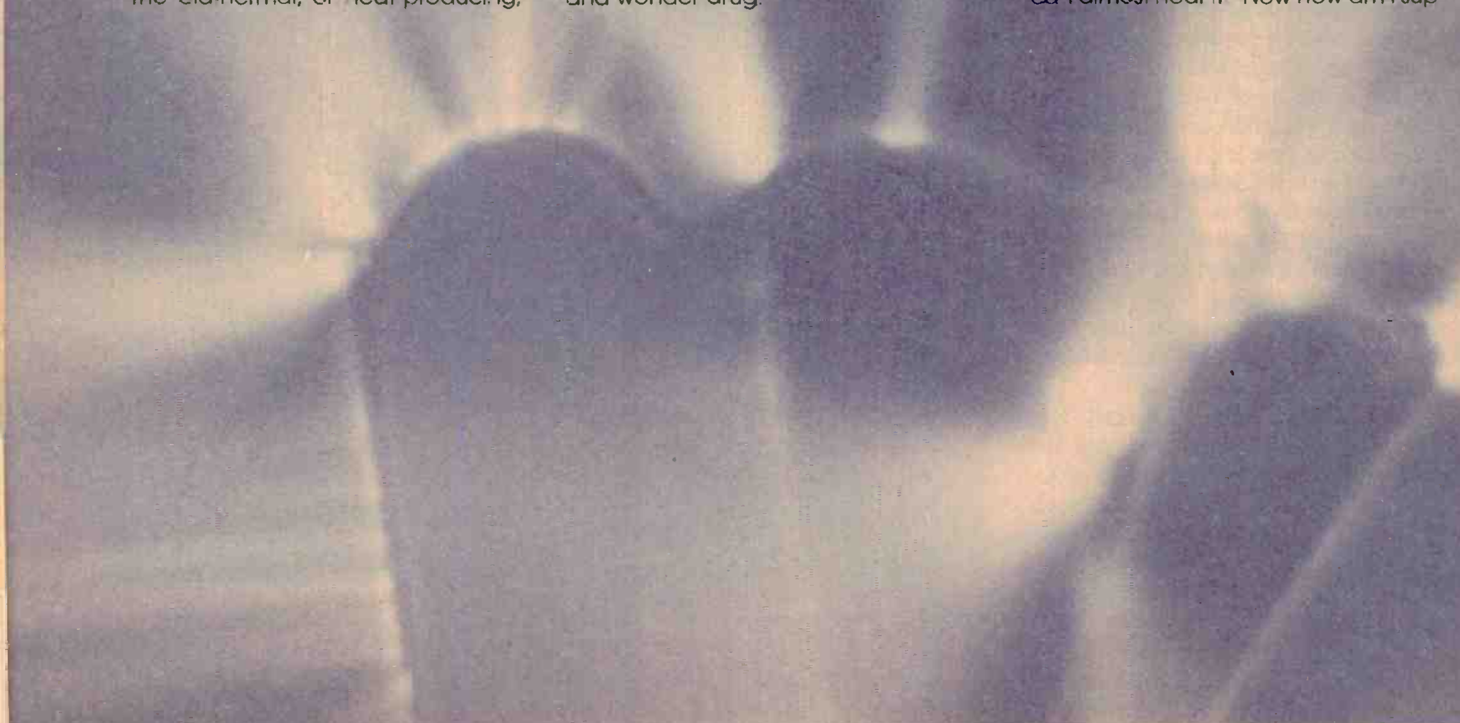
Restore a curious electrical instrument from years ago and perform high voltage experiments that are timeless.

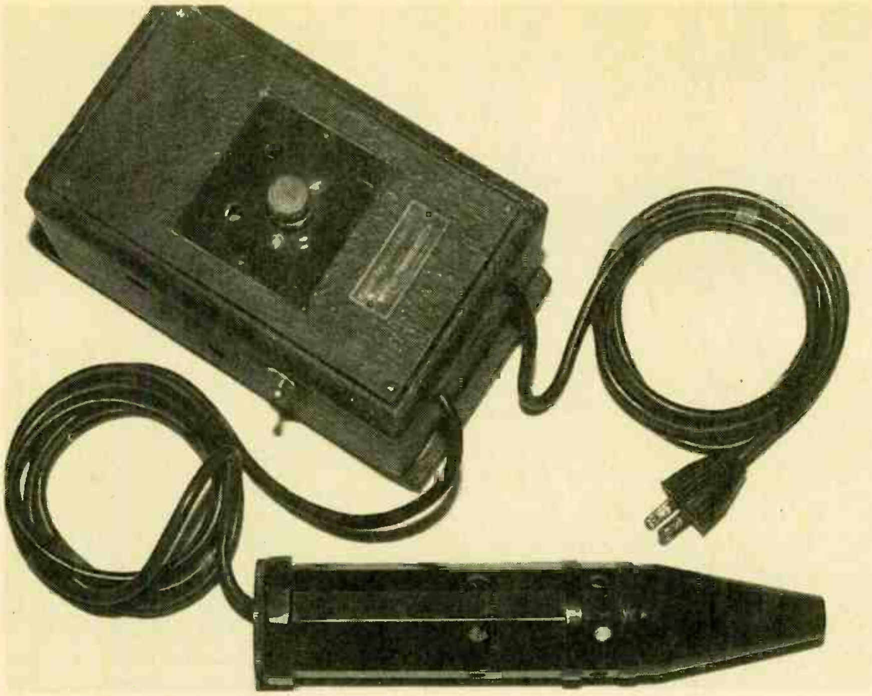
On May 20, 1891, Nicola Tesla delivered his famous lecture on "Experiments with Alternate Currents of Very High Frequency" before the American Institute of Electrical Engineers in New York City. Tesla's unique and unusual demonstrations attracted an enormous amount of attention. The interest exhibited by the medical profession was especially strong. Physicians were quick to begin speculating on the possible therapeutic value of high-frequency currents.

The diathermal, or heat-producing, effect of high frequency on organic tissue was obvious. However how that novel form of electrotherapy actually benefited the body was unclear. But that didn't stop those fascinated with the idea of electrical medication: Between the end of the nineteenth century and the Second World War a small industry flourished around what was sometimes called "Violet Ray Therapy" after the distinctive color of a high-voltage discharge. High-frequency currents became an inexhaustible cure-all and wonder drug.

You can recreate authentic Violet Rays in your home workshop and, moreover, possess an excellent source of high-frequency, high-voltage electricity for experimental purpose. What you need to locate is a Violet Ray Generator. Unfortunately, it's not something you can usually pick up at the local electronic-parts store. But they're not uncommon, and finding one is well worth the effort.

Where To Look And What To Pay. I can almost hear it: "Now how am I sup-





This generator was manufactured by Master Appliances. These machines do not seem to be as common as the Renulife units, at least in the Midwest. In other parts of the country the situation may be different. Note the power switch and the shape of the electrode handle.

posed to find one of those things?" Well, this is a clear case of "Seek and ye shall find." They are out there. I know it. But you must look for them.

If you don't have a lot of time, you might try checking out small antique stores. Sometimes all it takes is a phone call. Many antique dealers are familiar with Violet Ray Generators. If they're not, show them the pictures in this article. Occasionally, dealers will be eager to get rid of them because they don't really have a lot of decorative appeal.

Expect to pay about twenty-five dollars for a unit in satisfactory shape. That means one with an electrode handle and compartment lid. The electrode handle is the long, black thing containing the induction coil. On RenuLife units like the one pictured, the compartment lid is the slab of wood screwed to the inside of the case with a small knob on top. Units with no electrode handle or a damaged compartment lid should be avoided, unless you're ready to start collecting parts. Of course a missing line cord can always be replaced.

Larger machines or machines with one or more glass electrodes can be more expensive. The presence of electrodes is often a good sign. It indicates a machine that may be in above-average condition. Violet Ray Generators in nice shape with a lot of electrodes can cost over one hundred dollars.

Flea markets are another place to look. That is where I found the RenuLife unit in the photos. It cost only twelve dollars. The set of electrodes are from another machine. The same market yielded a dilapidated but operational Master Appliance generator at a cost of only eight dollars. That Master Appliance unit was found in an old building being cleared for repair.

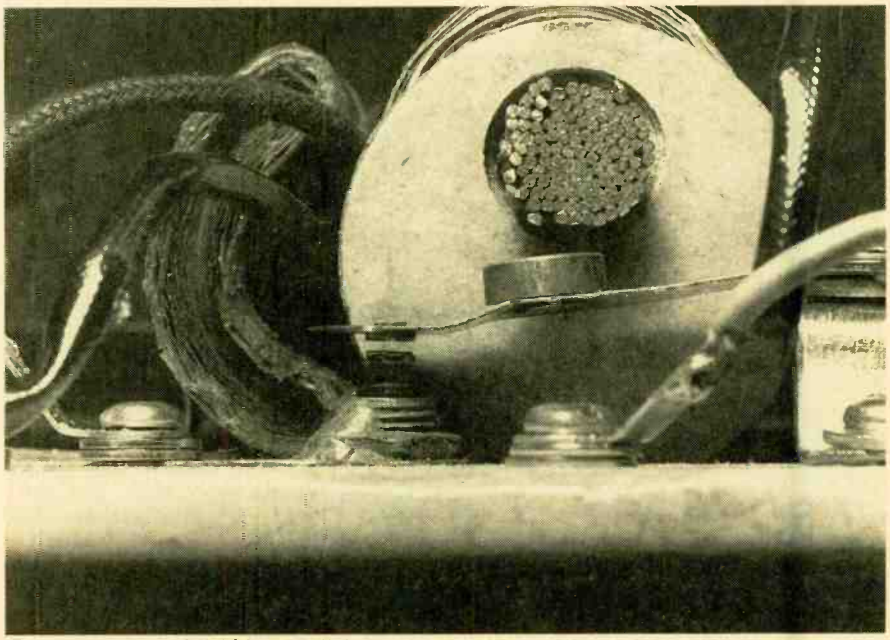
Violet Ray Generators come in a number of shapes and sizes and not all of them resemble the ones pictured. But they all have electrode handles. And all electrode handles have a hole in one end and a cord coming out of other. You'll know one when you see one.

Does it Work? You've finally found a Violet Ray Generator and you're anxious to see if it operates. There is a safe way of checking it, which will be explained; but first a word of caution. **Violet ray generators are not toys. They are crawling with high voltages that can seriously shock you. Be extremely careful.**

The following instructions are written with RenuLife Violet Ray Generators in mind, specifically the model patented by James Eastman in 1922. If you have found another kind of machine, the operation may be a bit different. But it is never very complicated. Simply think about what you are going to do before you do it and you should have no problem.

So let's see if it works. First, set the unit on a dry *non-conductive* surface. A large, solid wooden table top is perfect. Also, make sure no metal objects or other potential conductors, like a glass of lemonade, are anywhere near the electrode handle. That will prevent the electricity from jumping all over your workbench. If the line cord and the wire leading to the electrode handle are tangled up, untangle them.

Second, and *before plugging the*



Contact surfaces should be parallel. You can bend the armature arm with your fingers so be careful. Note how all the wires have been bent clear of the interrupter gap assembly.

machine in, turn the adjusting screw counter clockwise several revolutions. That is a precautionary measure. It separates the contact points and keeps the generator from working until you're ready. Now, plug in the machine and *slowly* turn the knob clockwise.

If the internal wiring is in fairly good shape and if the contact points are fairly clean, the Violet Ray Generator should operate and you will hear a high-pitched buzz. No buzz? Don't worry, you can probably fix it. And even if the unit *does* operate, chances are that it is not working as well as it should, but you can make it better.

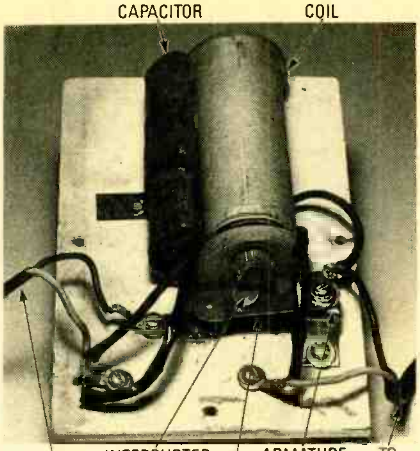
Restoration. Unplug the unit, unscrew its lid, and turn the device over. You should be now looking at something called a *vibrator*. A vibrator is an electro-mechanical device used to change a steady current into a pulsating current. The output of the vibrator energizes the primary of a small Tesla coil inside the electrode handle. One end of the secondary winding is connected to the electrode socket inside the barrel.

The output of Violet Ray Generators can be restored and improved by carefully cleaning the contact points and resoldering all accessible connections. Let's start with the so-called armature post—a structure that holds the armature arm in a horizontal position. Remove the armature post and armature arm. Make sure to note the position of all washers, spacers, and other original hardware. Now take a look at the contact points. The surfaces are likely to be dirty and pitted. That is not good. They should be clean, shiny, and flat. Fine emery cloth is excellent for contact cleaning.

When you're done polishing the points, rebuild the interrupter gap. Do not allow the armature arm to rub against the end of the magnet coil. Make sure all electrical connections are solid, tight, and free of corrosion. If the line cord is in bad shape, replace it.

Once the interrupter gap has been restored, the rest of the job is just a matter of rewiring. Go slowly and be careful not to mix up any of the wires. If you think you might be making a mistake, check your work against the photos.

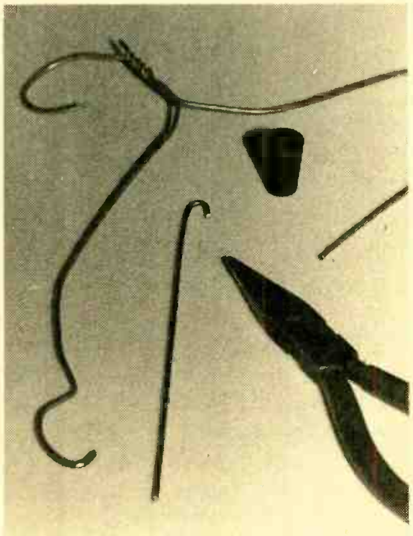
Now's the time to look for cracked or broken insulation on the wires coming off the capacitor. You can cover those imperfections with tape, spaghetti tubing, or something similar. If the leads coming off the magnetic coil are too short they can be made longer with any bare narrow-gauge wire; bus wire works fine. Insulate the leads, too.



Here's a restored generator circuit. Use as much fresh hardware as possible. The screws going into the compartment lid should be fairly short; long ones will go straight through and damage the outer surface.

When you're finished, wipe the inside of the compartment lid with a clean cloth moistened with solvent alcohol. Take a moment to contemplate the technical simplicity of this strange contraption. Now check the wiring one more time and screw the lid back into the case.

If you were lucky, your generator came with two or three electrodes, and you probably already know whether or not they work. So just a couple of tips. If you're having trouble getting the electrodes into and out of the handle, try cleaning the metal end with fine sandpaper or steel wool. Be gentle. The electrodes break and develop leaks very easily. Finally, don't ever, ever, ever twist the electrodes into the electrode handle. That's one sure way to wind up with a handful of sharp glass. Just push to install and pull to remove.



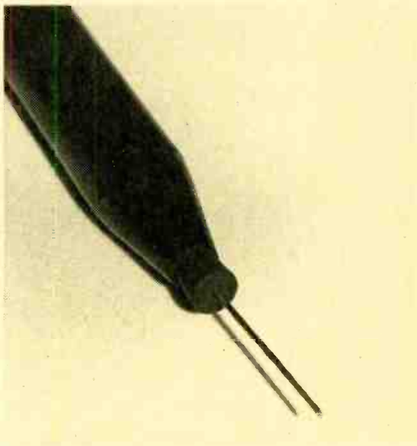
Here's everything you need to make an attractive electrode for your generator: pliers, and old coat hanger, and a size-0 one-hole rubber stopper (optional). Cut a seven- or eight-inch length of wire, scrape off the paint, and bend one end into a small loop about 3/8 of an inch in diameter.

If you were very lucky, your generator also came with a small pamphlet entitled "Electrode Applicators." It is a catalog-like document that explains how the various electrodes were used. There were electrodes for the hair, the throat, and even the teeth!

For those of you who choose to *play* with these things, my advice is: Don't do it. For those of you who choose to ignore this advice, it becomes necessary to say that you proceed at your own risk.

Diversions. Violet Ray Generators are electrotherapeutic devices and were never intended for use with anything other than the electrodes made to fit inside the handle. That makes getting at the high-voltage terminal for experimental purposes a little difficult. Any metal rod or piece of wire will solve the problem, but neither makes for a secure connection. A fine general-purpose electrode may be made in a few minutes from a stiff wire coat hanger and a size-0 one-hole rubber stopper. It looks good and it won't fall out.

Start by cutting a length of coat-hanger wire to whatever size suits your needs. Sand or scrape its paint or coating off. Bend a small hook in one end of the wire and place that end into the



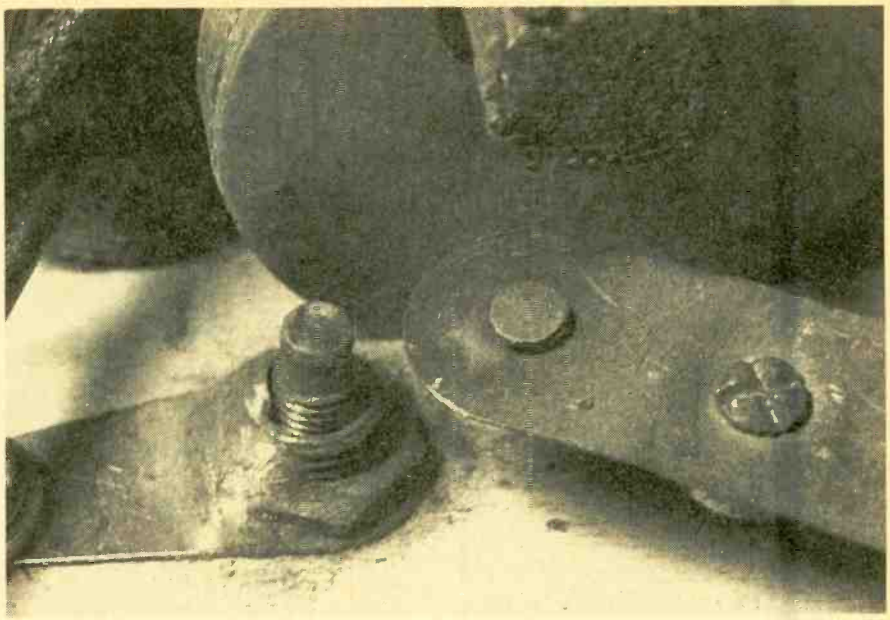
Push the loop into the barrel, fit the stopper down over the wire, and your probe is done.

electrode handle. Push the stopper onto the coat-hanger wire until it seats itself in the handle.

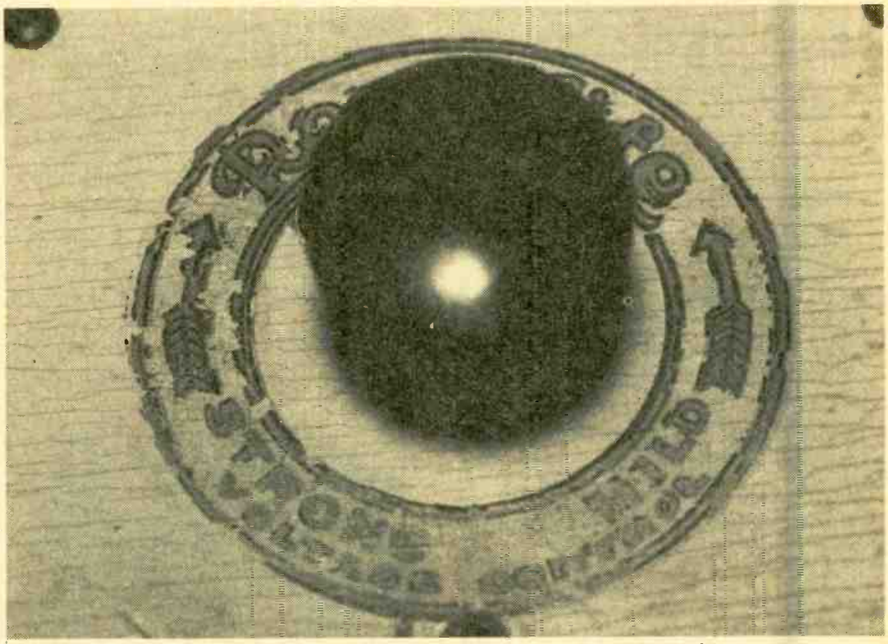
The coat hanger electrode provides an excellent way of illustrating what Benjamin Franklin called the "power of points." Place the coil on a wooden table top and at least one foot away from any conducting material. With the room lights out and the generator on, a small, flamelike discharge forms around the tip of the electrode. Little wonder why Franklin liked to think of high-voltage emanation as "electrical fire." The intensity of the discharge can be varied with the adjusting screw. Do not turn the screw all way to the left; this jams the contact points and stops the vibrator.

Now grasp a piece of metal, like a large nail, firmly with your fingers. Move it slowly towards the electrode and a thin, threadlike spark will jump from the wire to the nail. A Violet Ray Generator in good working condition should produce a spark at least one-half inch long.

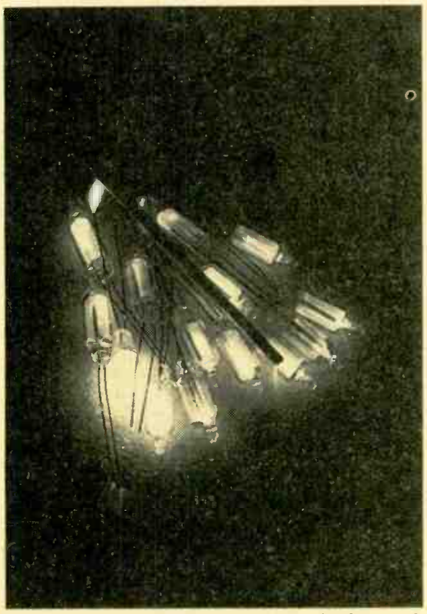
If you are holding the nail tight, you will feel nothing whatsoever. That is due to something known as the skin effect, or the tendency of RF currents to pass near the surface of a conductor. In this case the conductor is you. If you loosen your grip on the nail just a bit, you will begin to feel a tingle. This is because



The output of the Violet Ray Generator can be improved by carefully cleaning the contact points. Both the armature arm and the adjusting screw can be removed to make the job easier.



The RenuLife generator has an adjustment screw that sets the distance between the contact points. Before plugging in the unit for the first time, turn the screw several revolutions to the right.



Scatter some small neon lamps in front of the electrode. Now turn on the generator and turn off the room lights. High-voltage discharge descends from the wire and the neons flicker with a cold bright orange glow. Make sure to do this on a wooden, plastic, glass, or other non-conductive surface.

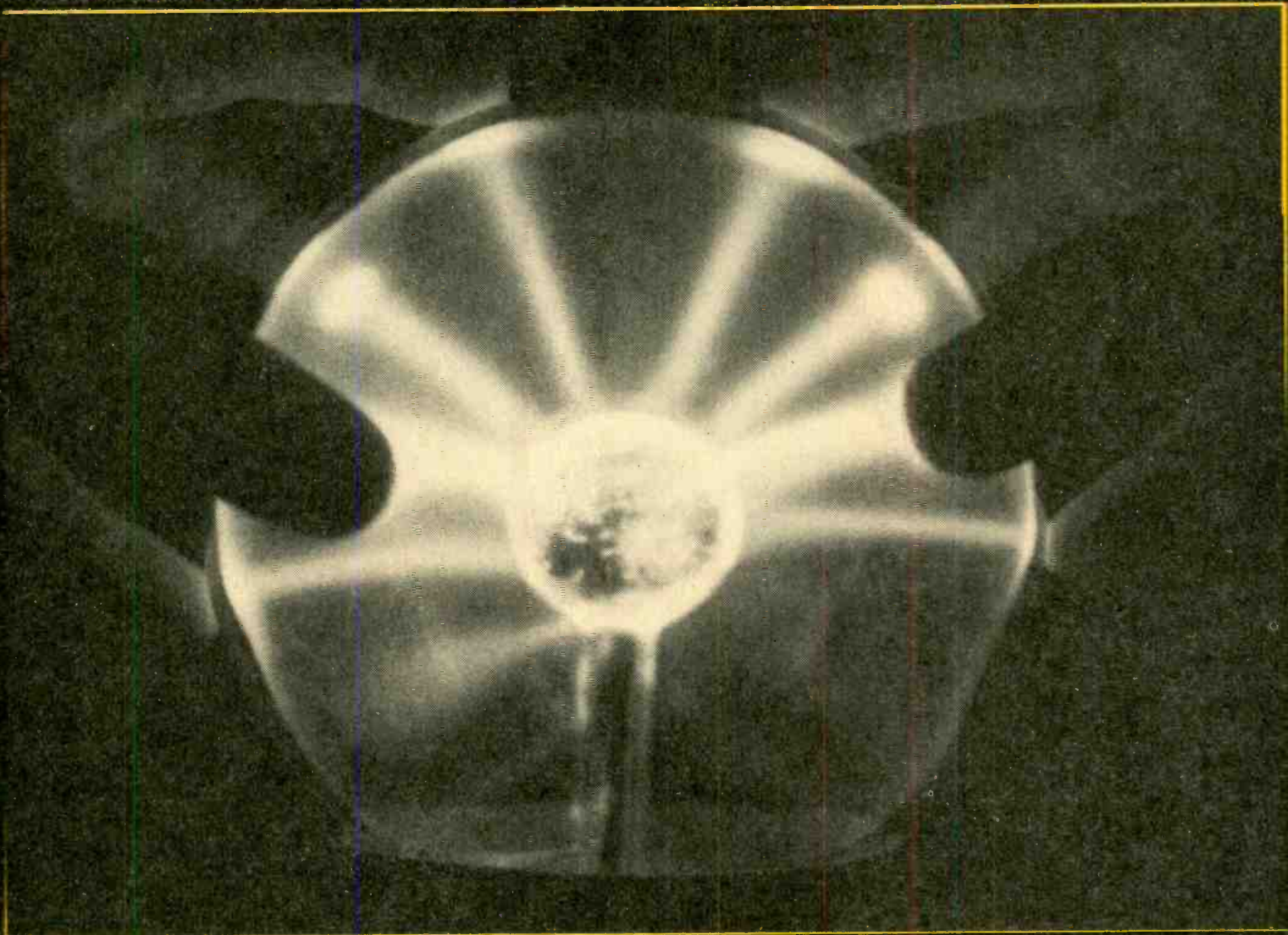
tiny sparks are jumping from the metal and piercing your epidermis. A large spark jumping to your body in this way can be fairly painful.

Inert gases ionize easily in the presence of Violet Ray currents. Just point the electrode at a neon bulb, a xenon flash lamp, or a conventional flourescent tube and it will light up. Do not expose any of these to a strong spark for more than a couple seconds. The heat can burn a hole in the glass and destroy the tube.

Everyday objects found around the home and workshop can also take part in other experiments with your Violet Ray Generator. High-frequency discharge inside an ordinary light bulb, for example, is simply spectacular. Large ones, small ones, round or tubular, clear or frosted, no two will look alike.

For further ideas, you can consult *The Inventions, Researches, and Writings of Nicola Tesla* (orig. 1894). The book was reprinted in 1977 and is available for $17.00 (ppd) from Omni Publications, PO Box 900566, Palmdale, CA 93590 (Tel. 805-274-2240). ■

Make A Custom



Plasma Display

Designing a power supply is the easy part—the real fun starts when you tackle the plasma globe itself!

BY RALPH HUBSCHER

The first time I ever laid my eyes on a Plasma Globe—in Disneyland in 1986—I was instantly fascinated. It was a small black box with a glass globe mounted on top. Bluish arcs emanated from a central electrode and moved outward erratically towards the glass walls. If a finger was held near the glass or if the glass was touched, the arcs intensified. It was beautiful and captivating.

I had been building Tesla transformers for years and I knew that similar discharges could be produced by holding transparent light bulbs near the high-voltage electrode of such a device or an induction coil. Anyone who has ever seen plucker-tube discharges is automatically reminded of plasma discharges of rare gases such as neon or xenon, which are equally spectacular.

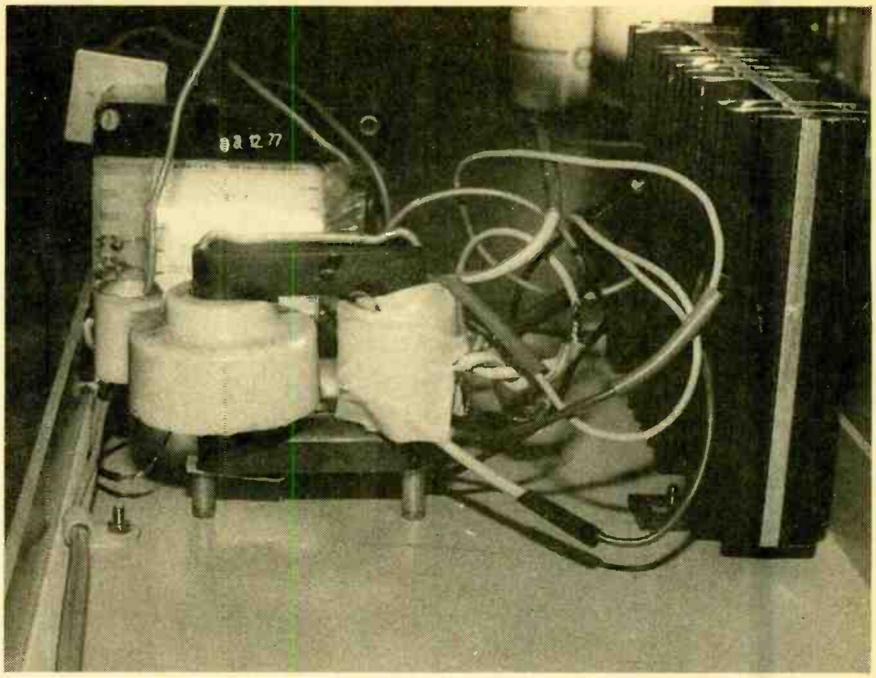
I was determined to build my own plasma display, and because of my experience with Tesla coils I knew where to start. Obviously, the globe was an evacuated vessel spiked with a trace of one of the above mentioned gases and agitated by a high-voltage current. Rare gases have an electron arrangement that facilitates gas discharges. A chassis connection is not necessary where such high-voltages are involved. The surroundings in this case are negative enough. If I could only shrink my Tesla transformers. I had never seen one this small before.

Searching for a Supply. Once I returned home to West Germany, I tried a number of high-voltage devices and their effects on 20-watt transparent light bulbs grounded with wire on one side. I found that

• An auto ignition coil driven by a transistor ignition and an electronic interrupter (variable across the frequency band) gave poor results.

• An SCR-driven high-voltage device used for Kirlian photography did not work any better.
• A photo-multiplier high-voltage power supply was tapped before the rectifier. It produced a ¾-inch arc in air but was a poor choice for the purpose intended.
• A discarded 27.12-MHz generator, once used for medical purposes, was repaired and tried. The output was tapped after the output amplifier tubes, but before the filter, so it probably put out frequencies in addition to the intended one, but all of them were in the high-frequency band. It worked fairly well.

Obviously, high-voltage alone is not sufficient to generate a plasma (make a gas glow). High frequency is also important. That's why the last power source, as well as Tesla transformers and induction coils worked well; they all can be classified as high-frequency devices.



Here's the author's high-voltage, high-frequency power supply. Note the large heat sink used for transistors Q1 and Q2.

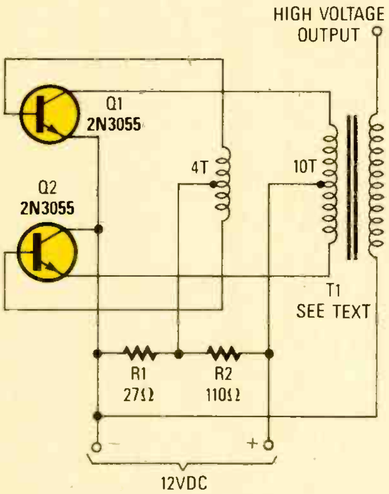


Fig. 1. A modified black-and-white TV flyback transformer is at the heart of the plasma-globe power supply. The transformer is driven by a blocking oscillator.

That led me to investigate the use of TV flyback transformers. Since those have a peak output frequency of 15,625 Hz, one might work well as a source of high-frequency high voltage.

There are many ways of exciting a flyback transformer, but none of them are downright easy. One is to drive the transformer with a square-wave oscillator built around a 741 op-amp or the popular 555 timer. However, I found that a blocking oscillator (Fig. 1) was about the best solution.

That brought me to the next problem. Old black-and-white TV sets produced their high voltage in flyback transformers whose outputs were rectified and then applied directly to the picture tube. Unfortunately, more modern sets, especially color ones, are equipped with flyback transformers that put out only a fraction of the voltage that the old black-and-white flybacks did. In such sets, the high-voltage DC is derived from voltage-doubling circuits. Such flybacks are of little or no use for driving plasma globes. The DC voltage will not cause the discharges, and the AC generated is too low in frequency to excite the gas. So when selecting a flyback, be sure you chose one that's the proper type.

The flyback generator shown in the schematic has a consumption of about 3.5 amperes at 12 VDC. Because of that, large heat sinks must be used on the transistors. **The generator should also be housed in a heavy plastic (or other non-conductive) case in order to eliminate the possibility that anyone might touch the chassis and high voltage at the same time.** Such an occurrence is quite unpleasant and dangerous. **Always treat high voltages with the utmost respect.**

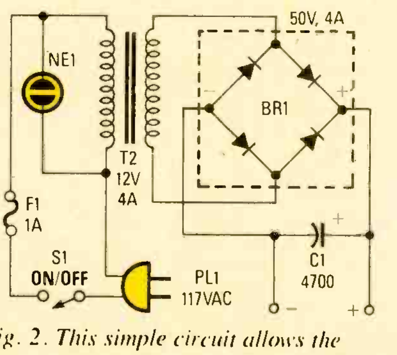


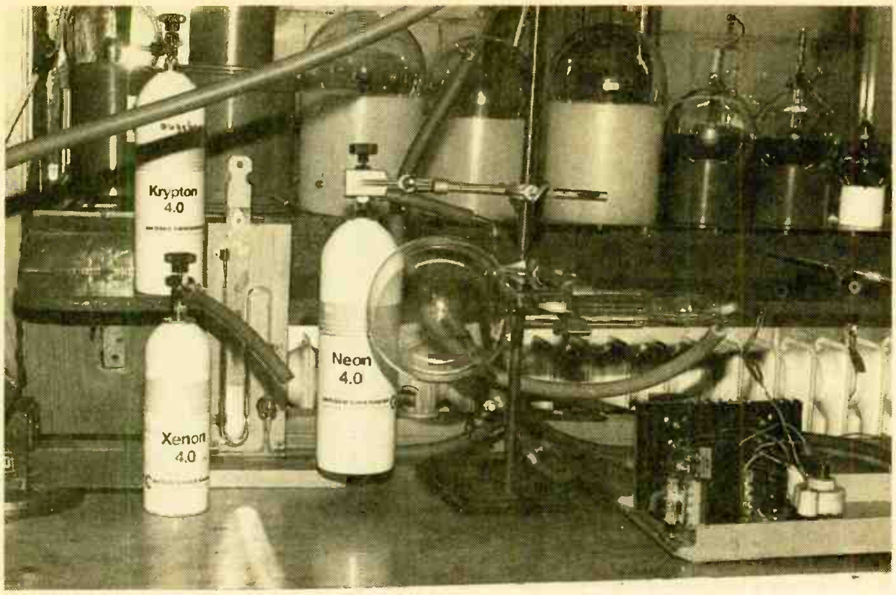
Fig. 2. This simple circuit allows the power supply to be operated from 117-volts AC.

However, housing the circuit in a small plastic case may result in overheating. A small fan or blower may be needed in some cases depending upon the nature of your salvaged flyback.

A 117-VAC/12-VDC power supply can be assembled easily so that the unit can be run on house current. A schematic for that power supply is shown in Fig. 2.

Modifying the Flyback. When you salvage black and white TV flybacks, clean them with a paint brush. Look for the tube filament winding—it is a one-turn well-insulated winding. Once you have located the winding, remove it; it is no longer needed.

Connect one lead of your multimeter to the flyback's high-voltage output and try the other lead on the remaining connections until you find the highest resistance reading (probably between 180 and 500 ohms); that is your negative connection. Next, look for some free space on the ferrite core and wrap five turns of #18 wire, bring out a loop of wire to use as a center tap, and wind



This set up was used to investigate the different displays produced by the rare gases. Note the array of home-made plasma globes located behind the set up.

another five turns in the same direction without overlaps. See Fig. 3. Secure the ten-turn winding with tape. A second winding will go over the one you have just completed. To create the second winding, wrap two turns of #18 wire, come out with a center tap, and complete the winding by making two more turns. The four-turn coil should be wrapped in the same direction as the ten-turn coil and, when it is completed, it should be secured with tape also.

Hook up the circuit as shown in Fig. 1. Plastic insulators must be used where the transistor leads pass through the heat sink and a mica disc is used in between the transistor and heat sink. Heat-conducting grease should be applied over and under the mica disc.

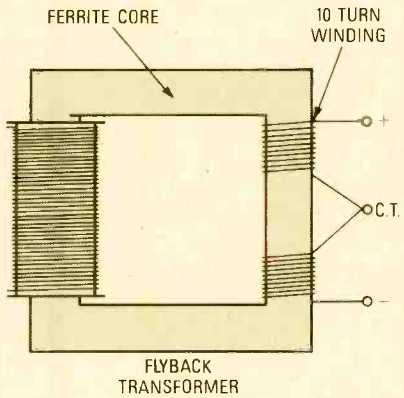


Fig. 3. To modify the flyback remove the filament winding and replace it with this 10-turn, center-tapped winding. A second, 4-turn winding will be placed over this 10-turn winding.

PARTS LIST FOR THE PLASMA GLOBE POWER SUPPLY

Q1, Q2—2N3055 NPN transistor
BR1—40-PIV, 5-amp bridge rectifier
R2—110-ohm, 5-watt resistor
R1—27-ohm, 5-watt resistor
C1—4700-μF, 25-VDC, electrolytic capacitor
T1—Ferrite-core flyback transformer, see text
T2—12-volt, 4-amp, transformer
F1—1-amp fuse
PL1—117 VAC line plug and cord assembly
S1—SPST (on/off) line-cord switch
NE1—NE-2 neon lamp with resistor, Radio Shack 272-1100 or equivalent
Heat sink (see text), mica disks and plastic insulators for Q1 and Q2, heat-conducting grease, plastic case, hardware, wire, solder, etc.

When you turn on the juice, you should get arcing from the high-voltage lead to a *well-insulated* screw driver. If you don't, turn off the power and reverse the connections of either the 10-turn or 4-turn coil (but not on both). If you still get no arc, something is not properly connected—probably the transistors or the chassis connection. If you encounter problems, double check everything.

Making the Display. Now that a source of high voltage was found, globe production was tackled. The easy way out is to use an ordinary light bulb. Of the light bulbs available on the market, 100-watt transparent "globe" bulbs were best. Their glass envelopes are most voluminous, which leaves some room between filament and wall for arcs to form. However, while the displays that bulb creates are impressive, I was not satisfied; I decided to experiment with making my own globes.

Before I continue, a word of caution is in order. **Evacuated glass containers must be handled with care. The danger of implosion is always present. Use glass vessels of appropriate thickness and design, and keep an appropriate distance between you and the container while air is being removed from it. If you are unsure of what you are doing, get experienced assistance.**

In an effort to save money in my initial efforts, cucumber and mayonnaise jars were used as globes (see Fig. 4). A glass petcock was cemented into the lid with epoxy resin. Electrodes were soldered onto the lids if they were steel, or cemented on with epoxy resin if the lids were aluminum. The lids themselves were cemented onto the jars with epoxy resin and allowed to set for 24 hours.

One-liter round-bottom flasks from a laboratory supply house were also tried. They were first closed with a rubber stopper into which a glass petcock

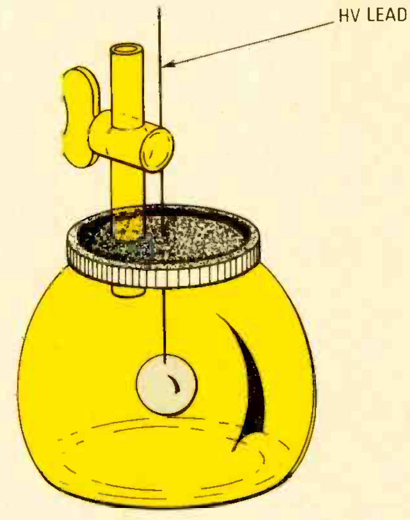


Fig. 4. The first attempts at globe making used mayonnaise jars as the containers.

with tubing and an electrode were well fitted.

Next, high voltage was applied to the electrodes while the air was evacuated from the jars and flasks by means of a simple one-stage diaphragm-type vacuum pump (see Fig. 5). As air was removed from the flask, arcing became increasingly pronounced and spread out to form an eerie glow and purple bands and waves formed.

When air pressure inside the container dropped to 3-4 mm Hg, a thorn-like purple corona discharge became visible around the electrode. That all became more intense when a ground connection—such as a human finger—approached or touched the glass globe.

I next used the set up shown in Fig. 6 to study the effects of rare gases on the display. Gas suppliers have laboratory-size lecture bottles of neon or xenon, or even smaller sample bottles under very light pressure. The latter are not very expensive for neon and quite sufficient. Only a small amount of gas is needed. When such small bottles are used, a pressure reduction valve is not necessary, either.

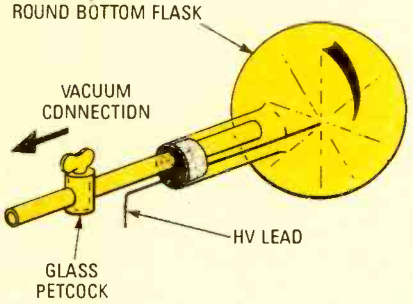


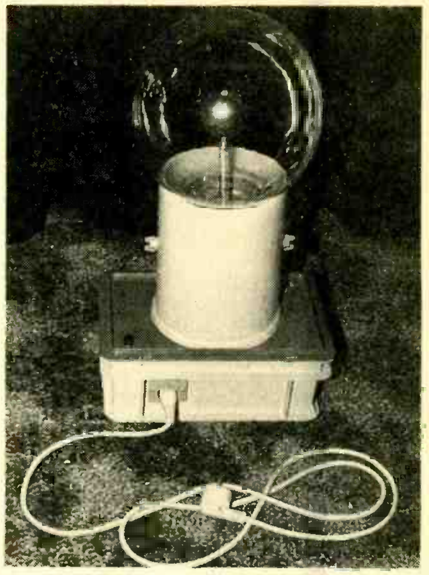
Fig. 5. A high voltage was applied to the electrode while air was evacuated using a simple one-stage vacuum pump.

In my experiments, I found that neon is the most reasonably priced rare gas that can be used. Its red plasma is spectacular and probably the best visible. It reacts at pressures of 70-180 mm Hg and at voltages that are lower than the other rare gases. Discharges are in almost straight lines.

Xenon is perhaps the most spectacular gas of the rare-gas series. Its plasma is bluish-white and lightning-like. It is unbelievably expensive even in small amounts. It reacts at roughly 70 mm Hg and discharges only with the best generators at the highest voltages. Discharges are erratic, bend at nearly right angles, and are snake-tongued. Neon-xenon blends make spectacular displays. The other rare gases I tried—helium, argon, and krypton—were unspectacular performers.

I also experimented with using different shaped electrodes. My first electrode was simply a stiff wire. A disc was used next and worked well insofar as it spread the emanations around better than a wire. Bell-shaped and ball-shaped electrodes were chosen as the best of all. They work about equally well because the top part of the globe is the most important part.

These methods were sufficient to study the effects of vacuum, different rare gases, and different electrodes on the discharge. The vacuum held for hours, days, sometimes months. But none of the jars mentioned, were vacuum-tight forever. Even epoxy resin or sealing wax were no guarantee that the vacuum would hold.



One of the author's many plasma displays. This one features a 6-liter flask and a metal ball-shaped electrode, and is filled with neon at a pressure of 70 mm Hg.

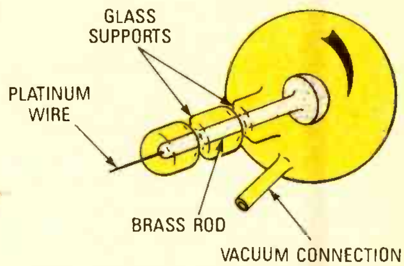


Fig. 7. A glass-blowers services were required to create a truly vacuum-tight enclosure. Here, a platinum wire melted into the glass serves as the high-voltage lead.

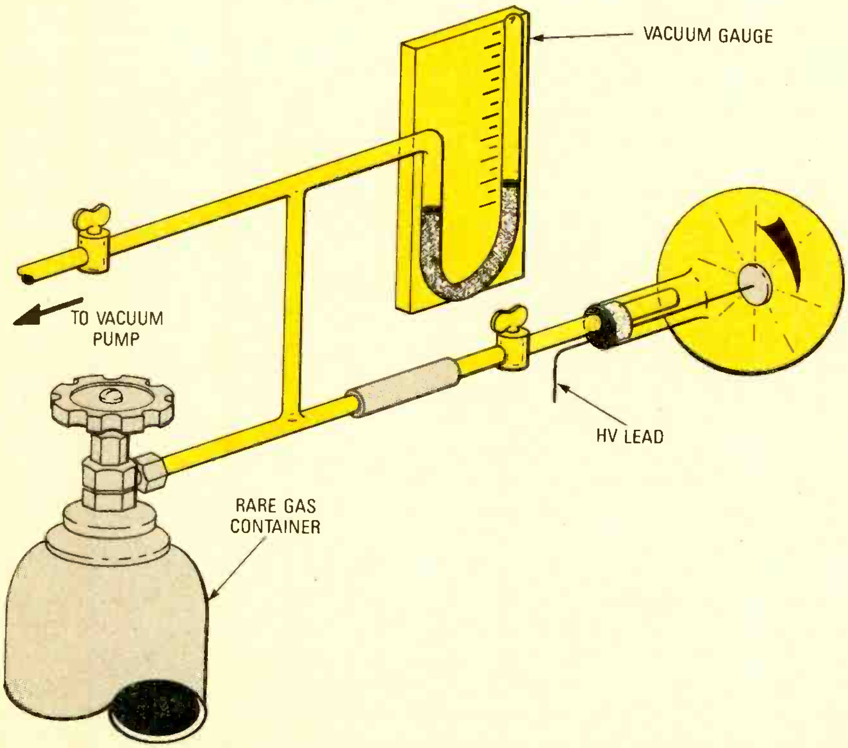


Fig. 6. Small amounts of rare gases were introduced into the plasma globe using this set up. A high voltage was then applied to study the effects of the gas.

In order to better hold the vacuum in the jars and globes, I decided to melt the electrodes into the glass and to blow on a vacuum connection. While a glass blower's charges are high, he is the only one who could tackle the job. See Fig. 7.

I quickly discovered that this approach added a few complications. For instance, steel or copper wires cannot be melted into glass. They will crack the glass on cooling since their coefficient of expansion is different from that of glass. Platinum's coefficient of cooling is close enough to that of glass to work. While platinum wire is very expensive, a small piece for use as an elec-

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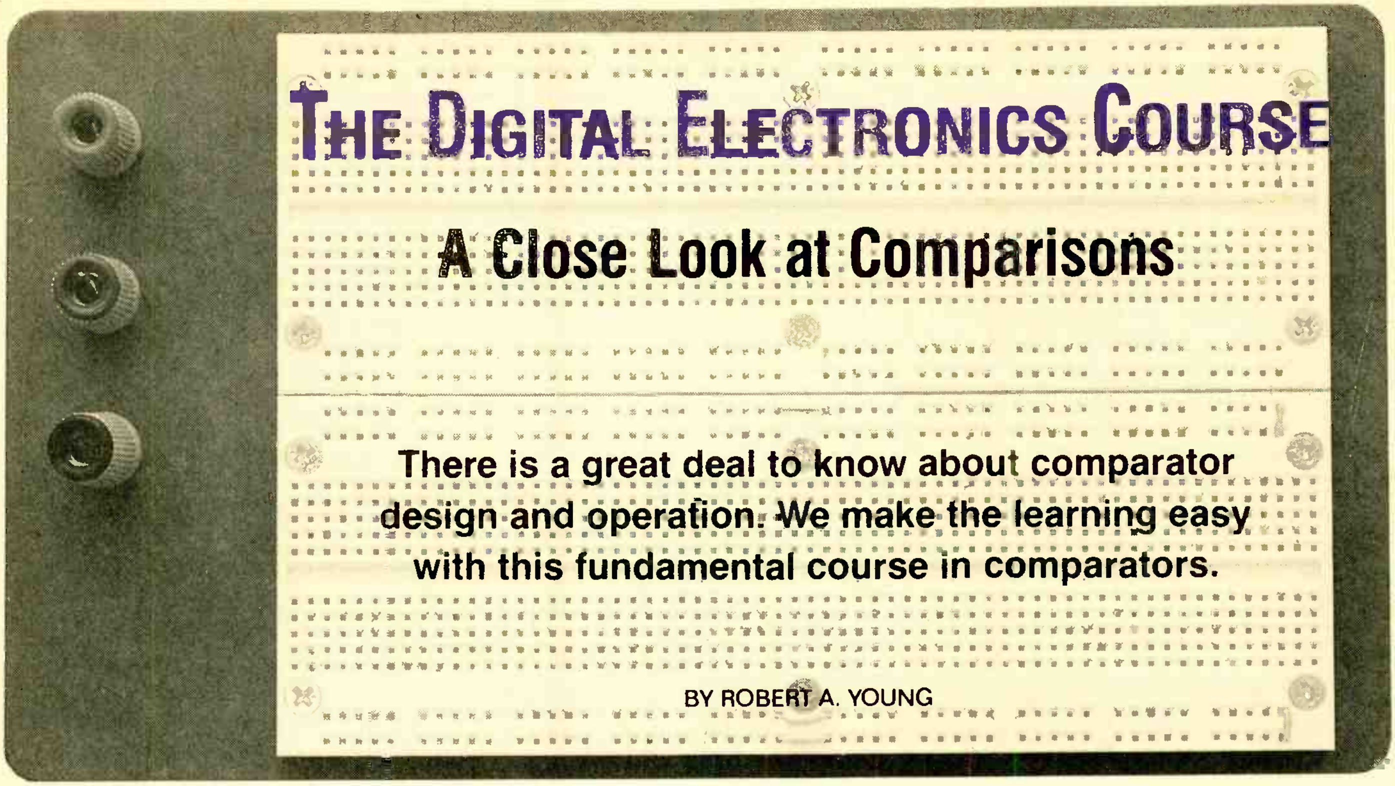

THE DIGITAL ELECTRONICS COURSE

A Close Look at Comparisons

There is a great deal to know about comparator design and operation. We make the learning easy with this fundamental course in comparators.

BY ROBERT A. YOUNG

The operational amplifier is a unique device in that it can be used to perform many functions in addition to amplification—hence the term operational. Generally speaking, operational amplifiers (more commonly referred to as op-amps) require both positive and negative power sources in order to operate.

However, there are some that operate from a single-ended supply. The supply voltages for an op-amp can range from 4 to about 18 volts. They have two inputs: the inverting input (denoted by −) and the non-inverting input (denoted by +).

Op-amps can be configured as differential (difference) amplifiers by applying two different signals to their positive and negative input terminals. The voltage difference (thus the term differential) between the two signals is amplified by a ratio determined by the feedback network connected between the amplifier's output and its negative input terminal. If that network is eliminated, the amplification is extremely large. In fact, the amplifier output will either be totally on, with the output equal to the positive-supply voltage, or off, with the output at the negative-supply or ground potential.

Our gratitude is extended to the EIA/CEG for the creation of this course, especially to the consultants who brought it to fruition: Dr. William Mast, Appalachian State University; Mr. Joseph Sloop, Surry Community College; Dr. Elmer Poe, Eastern Kentucky University.

However, in digital electronics we are not interested in the op-amp's amplifying abilities, but rather its output level under various input conditions. If the voltage at an op-amp's positive input terminal exceeds that at its negative input terminal by some small amount, its output goes high (all the way up to the power-supply voltage). But if the voltage at its negative input terminal exceeds that at its positive input terminal by some small amount, its output goes low (completely to ground). When used in that manner, the op-amp is called a comparator.

Comparators. A comparator is a special op-amp used to compare the voltage levels presented to its two inputs. Its output swings between fully on and fully off and so the op-amp operates open loop; *e.g.*, there is no negative feedback applied to its inverting input to moderate the output. Circuits optimized for comparator use, therefore, require none of the phase/frequency compensation needed for op-amp feedback stabilization.

In fact, compensation components (if used) would slow the response time of a comparator. Although in principle, an ordinary op-amp can be used as a comparator, using a compensated device would produce a response time of tens of thousands of microseconds, whereas devices optimized for comparator use have response times typically in the several-hundred nanosecond range.

Comparators are often used to interface with digital circuits (TTL, CMOS, etc.). Therefore using a standard op-amp—which is designed for linear operation (with say, ±10-volt swings)—would require some level shifting and/or clamping in order to drive a logic circuit.

Differential Input Comparators. A comparator circuit is one that provides an indication of the relative state of signals applied to its inputs. If one input is a reference voltage and the other is an unknown or "signal" voltage, the output of the comparator will indicate whether the unknown input is above or below the reference voltage. A basic op-amp comparator is shown in Fig. 1.

Let's assume that V_{ref} is a positive voltage applied to the inverting input of

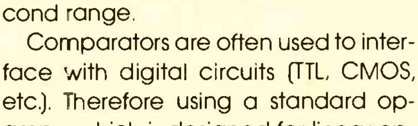

Fig 1. A basic op-amp comparator is shown here. Because the op-amp is operated in an open loop configuration, the input voltage difference required to toggle the output from one state to another is very small.

the op-amp and V_{in} is an unknown applied to the non-inverting input. When V_{in} is lower than the reference voltage, the output of the op-amp goes to negative saturation (in this case ground). As soon as V_{in} goes higher than V_{ref}, the output of the op-amp switches to the positive saturation limit (the supply voltage).

Because the op-amp is operated in an open-loop configuration, the input voltage difference required to toggle the output from one state to another is very small (a few hundred microvolts or less). That characteristic threshold is called the "offset" voltage of the op-amp (which can be as much ± 10 volts in some cases). Because of that, precision comparators should be nulled so that the input differential voltage is as close to zero as possible, and any source resistances in the input path should be selected to minimize the offset voltage.

Beyond the basic requirement of input voltage range, speed (which has two meanings for comparators) is the next consideration in selecting op-amps suitable for use as comparators. In comparators speed is related to both response time and slew rate. Response time is simply the total time required for an output change to occur once a change in the input (either positive or negative) has taken place. Slew rate indicates how quickly an output can change—which can be different for positive- and negative-going slopes.

Frequency compensation in a comparator is usually detrimental because it slows the open-loop speed of the op-amp: For example, with a slew rate of 0.5 volts per microsecond (V/µs), an op-amp needs 40 µs to swing from -10 volts to $+10$ volts because of its slew-rate limitation.

Elimination of frequency compensation also increases the high-frequency gain of the op-amp; thereby increasing the frequency range over which the comparator will have sufficient sensitivity (a high open-loop gain suggests that a small input voltage is required to cause a change in the output). Comparators are subject to wide differential input voltages since V_{ref} and V_{in} can be anywhere within the common-mode input range of the op-amp (± 10 volts). That requires a differential input voltage rating of at least ± 20 volts to accommodate the worst-case situation.

Inverting comparators may be needed in some cases—a configuration that may be obtained by reversing the inputs of the comparator so that V_{in} is connected to the inverting input of the comparator. In either case, the op-amp presents a high input impedance to V_{ref} and V_{in}.

Single-Ended Input Comparator. The differential input comparator described previously is the most general configuration and the most often used. Single-ended inputs are around, but both the signal and the reference voltages are fed to a common terminal, and the other input is grounded, as shown in Fig. 2.

Resistors R1 and R2 form a voltage divider between V_{in} and V_{ref} (which are of opposite polarities). The resistors along with V_{ref} define the level of V_{in} required to cause the junction of R1 and R2 to cross ground, thereby changing the state of the output.

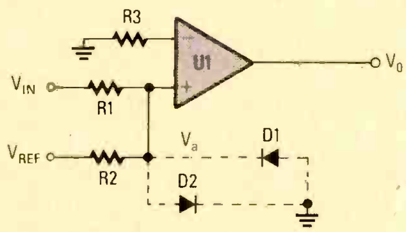

Fig. 2. In the single-ended input comparator both the signal and the reference voltages are fed to a common terminal, and the other input is grounded.

In practice, V_{ref} and R2 define the current in R2 for V_{tr} (the trip point); so R1 is selected for the desired trip level of V_{in}. Although non-inverting operation is shown, negative operation is possible by using the inverting input as in the previous example.

The circuit in Fig. 2 has the advantage of being non-critical as to the specific device used. The voltage between its two inputs will be smaller due to R1 and R2, so a smaller input-voltage rating is tolerable. The magnitude of V_{in} can be unrestricted because R1 can always be chosen to reduce the voltage of V_{in}.

It is also a good idea (though not necessary) to add a parallel clamping-diode circuit (as shown in Fig. 2) to govern V_a. The diodes don't affect the trip point because when V_a is 0, both diodes are biased off. The diodes can also be connected across the two inputs for differential clamping. Many op-amps have those diodes built into their input stages for protection.

Comparators With Hysteresis. The comparators discussed so far have been of the basic open-loop configuration, which amplify the difference between an input signal and a reference voltage. In situations where the input signal is a slowly varying voltage, that can be a disadvantage—particularly when used to drive logic circuits requiring fast trigger pulses—because the output would also change slowly.

One solution is the application of positive feedback to the non-inverting input of the unit, which would give a "snap action" to the output transition. Figure 3 shows an inverting differential-input comparator that has V_{ref} applied to the non-inverting input through R1.

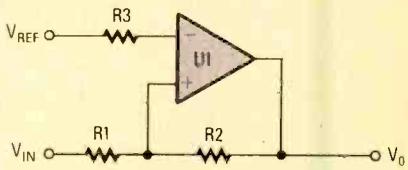

Fig. 3. In situations where the input signal is a slowly varying voltage, comparators with hysteresis—which would give a "snap action" to the output—are desirable.

Without R2, the circuit would perform similar to the circuit in Fig. 1. If V_{ref} (for example) were 1 volt, the output would toggle as V_{in} rises above or dips below 1 volt.

By adding R2, on the other hand, a positive feedback is developed, so that when the output is high, the fed-back signal is added to the reference voltage, producing a new reference voltage and trip level.

The feedback is regenerative, so the output quickly snaps back to the opposite state, regardless of the rate of change in V_{in}, providing a constant output-transition time.

Positive feedback introduces two new terms: We now have an upper threshold point and a lower threshold point rather than a single threshold. The difference between the two threshold points is the hysteresis, which is always centered around V_{ref} and is not always symmetrical. If the saturation voltages of the op-amp are not equal, the hysteresis region is not symmetrical.

Hysteresis is a useful feature in comparators, not only for reducing response time. For instance, if a low-level noise is superimposed on the input signal, an open-loop comparator will switch rapidly back and forth due to noise fluctuations as the input signal passes through the threshold region. In addition, some open-loop circuits may oscillate during transition due to stray capacitive feedback. One cure for those problems is a small amount of hysteresis, providing a "dead zone" within which the comparator does not respond. Often as little as 10 mV of hysteresis can eliminate such unwanted effects.

Single-Ended Comparators with Hysteresis. Single-ended comparators with hysteresis, as shown in Fig. 4, can also be used. In that circuit, U1 senses the difference between ground, applied to the inverting input, and the

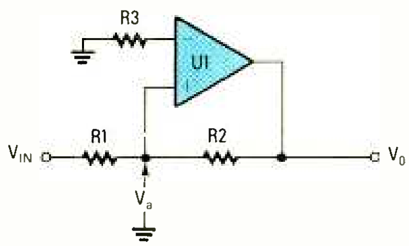

Fig. 4. Single-ended comparators with hysteresis are also possible.

voltage developed at the junction formed by R1, R2, and the non-inverting input of U1.

Assuming the output is negative, a positive V_{in} would cause the voltage at V_a to rise until it reaches zero volts. The output then snaps positive as a result of the feedback through R2. The voltage at V_a is now positive because the output of U1 is at positive saturation. When V_{in} goes negative, the voltage at V_a also decreases until it approaches zero.

When V_{in} has reached its lower trip point (often denoted LTP) its output snaps negative again, returning to its original state. The output saturation voltages, in conjunction with the R1/R2 network, sets the trip points of the circuit. The comparator circuit in Fig. 4 is useful, in that no separate reference is required and it can be assembled from an unprotected op-amp.

On the down side, however, the positive and negative output saturation voltages are not suitable references, because they tend to vary with loading, temperature, and from device to device. That's an undesirable characteristic since some op-amp outputs can swing from rail-to-rail.

Clamped-Feedback Comparators. Adding a Zener-diode clamping network in the positive feedback loop (as shown in Fig. 5) is one solution to variations in threshold voltage. In that circuit, back-to-back Zener diodes (D1 and D2)

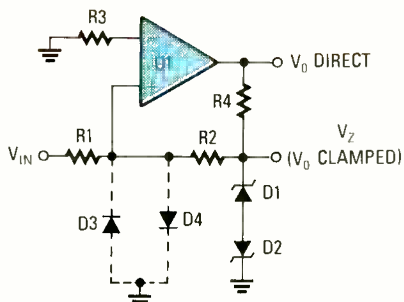

Fig. 5. Adding a Zener-diode clamping network in the positive feedback loop is one solution to the varying threshold-voltage problem.

are used to clamp the feedback portion of the output of U1 to V_Z (the Zener voltage).

The Zener diodes along with D3 and D4, provide temperature-stabilized thresholds. With equal resistances for R1 and R2, the circuit's input trip level will be equal to the V_Z reference point. Higher and lower input voltages are possible by changing the value of R1.

The circuit provides two outputs: V_o, which will vary between the positive and negative supply voltages, and V_Z (which is V_o clamped across D1 and D2). If input voltages exceeding the common-mode range of U1 are fed to the circuit, a pair of input-clamping diodes (D3 and D4 in Fig. 5) should be used.

Exercise. Figure 6 shows two op-amps, both configured as comparators. The voltages that are to be compared are derived from a typical resistive network (known as a voltage divider), consisting of R1 and R3 for the negative (inverting) input. The positive (non-inverting) inputs for U1-a and for

PARTS LIST FOR THE COMPARATOR EXERCISE

SEMICONDUCTORS

U1—LM324 quad comparator, integrated circuit

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)

R1, R2, R6—47,000-ohm

R3—12,000-ohm

R4, R5—Light-dependent resistor (see text)

ADDITIONAL PARTS AND MATERIALS

Breadboard, ohmmeter, logic probe, No. 22 wire.

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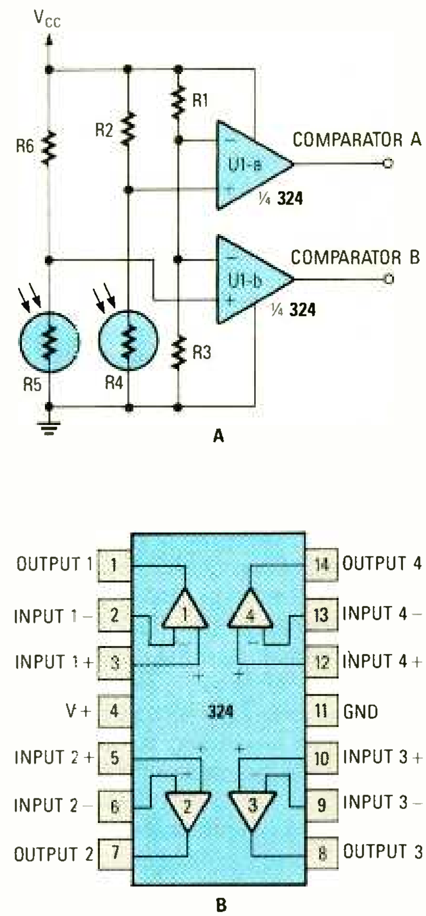
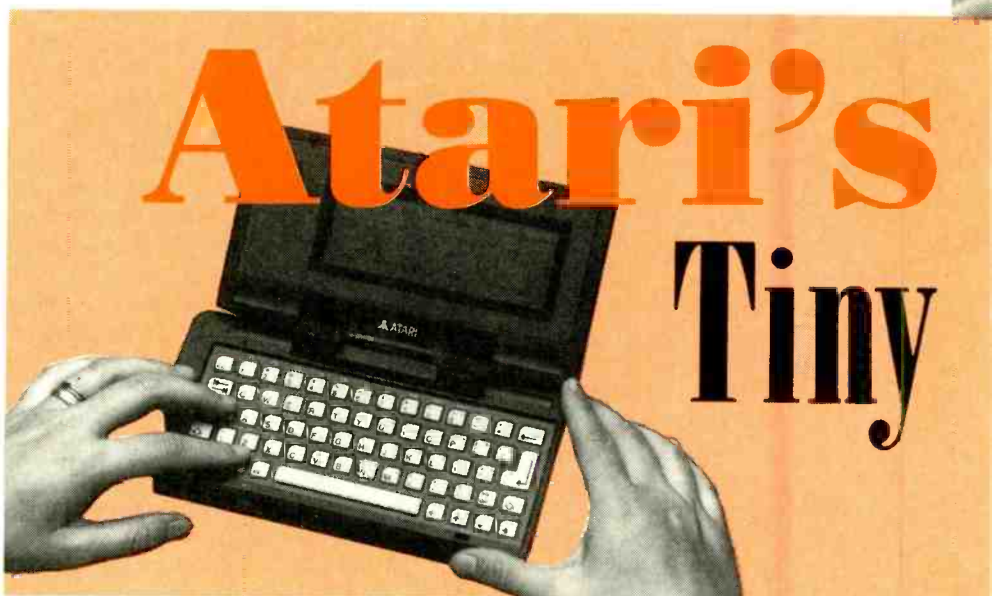


Fig. 6. In this circuit (A), the voltages that are to be compared are derived from typical voltage-divider networks: R1 and R3 for the inverting inputs; and the R2/R4 and R6/R5 combinations, for the non-inverting inputs. Shown in B is the pinout diagram for the 324 quad op-amp.

U1-b are derived from the R2/R4, and R6/R5 combinations, respectively.

In each case, the voltage-divider network connected to the non-inverting input contains a light-dependent resistor (LDR)—a resistive semiconductor whose resistivity varies inversely with light intensity—and a fixed resistor. For the sake of discussion let's assume that resistors R1 and R3 are equal. That means that the inverting input to both comparators is equal to one-half V_{CC}.

(Continued on page 99)



While you wait for your chief executive officer to call you into his office for that important meeting, you slip out your pocket personal computer and check the essential data stored in its memory. Yep, the all-important budget spreadsheet is there as well as the modified version you worked up. You also stored some important memos and letters for immediate reference if needed. In fact, you've cranked in a resume of your accomplishments within the company, and your salary history, should you get the chance to pitch for the raise that you so richly deserve.

The Palm-top Computer! Was that fantasy you just read? No! With the introduction of *Portfolio*, the world's first *palm-top* personal computer, Atari Computer (1196 Borregas Ave., Sunnyvale, CA 94088) has created a new category of personal computers. Portfolio establishes brand-new standards in small size, light weight, and minimum-power computing.

The Portfolio requires three standard "AA" alkaline batteries, yet it has the computer power to complete the spreadsheet, word processing, and other computational tasks required by today's business person, student, or fun-loving hacker. In fact, the 4.92-MHz system, which includes a built-in Lotus 1-2-3 file-compatible spreadsheet program, word processing software, calculator software, appointment book package, and phone/address directory as well as an operating system using MS-DOS 2.11-compatible commands, is comparable in power to an IBM PC.

What's Inside. Packed inside Atari's Portfolio are the Intel 80C88 static CMOS microprocessor, CMOS RAM, and other CMOS components, as well as a compact LCD readout. The low power consumption of those components, combined with special system software, enables users to run the system for six to eight weeks of "normal" use, with just three standard "AA" alkaline batteries.

The system software itself provides several power-conserving features. For example, while a program is waiting for the user to use the keyboard, Portfolio automatically switches into a stand-by mode. The stand-by mode actually stops the microprocessor clock. The feature is transparent to the user, because the screen does not go blank and there is no delay when the user resumes work.

The energy-saving system also conserves its battery life by turning off automatically if no entry has been made for two to four minutes. However, data is not lost and the user need only press any key to continue any work in progress.

Users are also warned if Portfolio's batteries are running low. A built-in circuit senses when battery voltage is low and indicates the status by putting a message on the screen before it automatically shuts the system off. Users who turn on the machine will get a "Low Batteries" message and the machine will again turn itself off. If the user changes the batteries within a few weeks, the data in the internal memory can be salvaged.

Keeping the Weight Down. Creative component packaging and new fabrication technology was a major factor in determining the compact size of Atari's Portfolio. Rather than use standard integrated circuits that are packaged in full-size, dual in-line packages; Portfolio uses miniature, surface-mounted components, which are mounted on both sides of the circuit board.

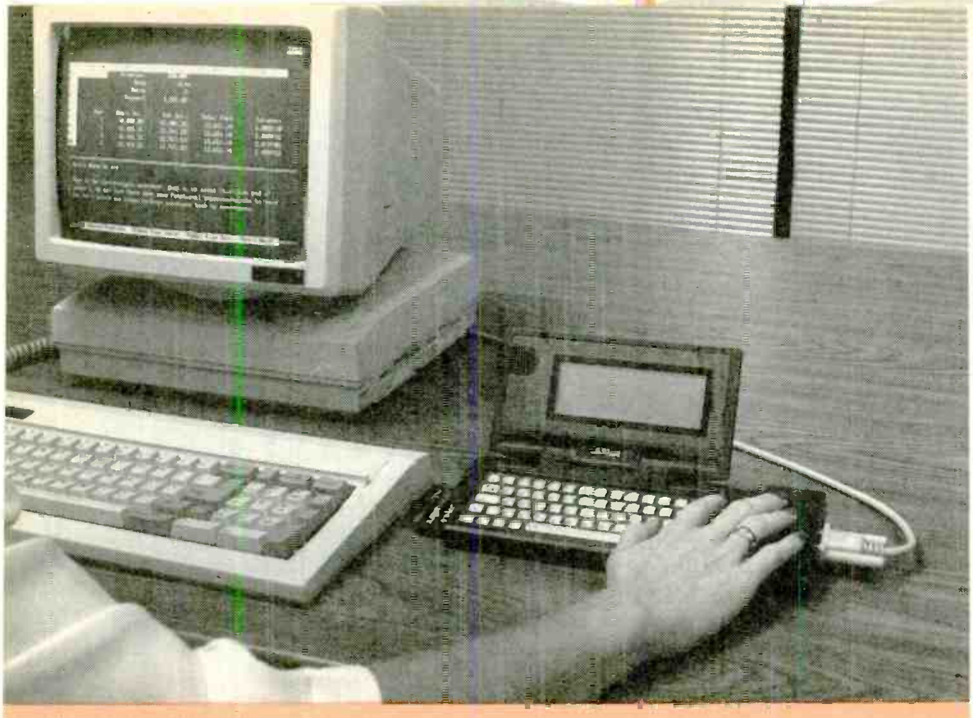
Until now, it would have been virtually impossible to create such a small system with reasonable computing power because the technology just wasn't available. For example, Portfolio has a powerful ASIC (Application Specific Integrated-Circuit) chip which combines most of the system-integration features that, as recently as two years ago, would have used multiple, bulky chips.

To further help reduce Portfolio's size, a card drive and solid-state memory cards were substituted for a floppy drive and disks. That significantly reduced the necessary size, weight, cost and power consumption for the system.

The 40-column by 8-line LCD screen may be an unattractive feature in the eyes of some users; however, that design has also enabled Atari Computer's engineering team to minimize the size and power consumption of Portfolio. Rather than doubling the size of the system with a full-screen display, an added window function allows the user to saunter throughout a virtual 80-column × 25-line display. That "virtual screen" is used when running certain Portfolio-compatible MS-DOS programs that have been downloaded onto the system.

Portfolio's design is similar to a flat jewel box. The keyboard is on the bottom half of the system and the display is on the top half. They are joined by a hinge that enables users to adjust the angle of the LCD screen for optimal viewing.

Keyboard Considerations. As Portfolio developed into a palm-top computer, its small size created some keyboard-size problems. For instance, in an attempt to do touch typing, the reviewer's four fingers on the left hand



It's here! A one-pound personal computer that runs DOS-type software and can even fit in your pocket!

Marvel

BY JULIAN MARTIN

covered the A, S, D, F, and G keys—that's one key too many! The right hand had a similar experience. It was obvious that touch typing wouldn't be useful with the Portfolio. Children and adults with small hands may be able to manage it, though.

Portfolio's keyboard was made to provide users with the look and feel to which they are accustomed from full-size computers. The keyboard has a 63-key configuration with positive-action keys that fill the entire lower surface (7.8-in. × 4.1-in.) of the case. That means that when a user strikes a character, their tactile sense allows them to easily feel when the keystroke is complete. There is also an audible key click (that can be disabled) as second reassurance to users that they have entered data. Rather than add feet to the system to optimize the viewing and typing angle by pitching the entire unit, Portfolio designers chose to tilt the top of each key upward. The keyboard is not a cheap "chiclet" fabrication, but a craftsmanship-award winner.

The keyboard design eliminated the keys for the numeric keypad as we know it; but, a special key combination activates an "embedded" numeric keypad. So, accountants, engineers, students, and income-tax sufferers can still manipulate numbers as they do on full-size machines.

Memories, Memories. The solid-state memory cards, which are about as thick as two credit cards, are used in the same way as floppy disks. The cards can store data files or application programs, have no moving parts, are fully encased with plastic, and are more rugged and easier to store than floppies. The memory cards are available in 32K, 64K, and 128K capacities.

Independent software suppliers working closely with Atari will soon make available masked ROM cards. The cards will offer utilities and accounting and sales-support software; each card is capable of permanently storing up to 128K of software.

Internal Software. Portfolio is bundled with five software packages, including:

Spreadsheet—This Lotus 1-2-3 file-compatible spreadsheet offers users 127 columns by 255 lines. The Portfolio spreadsheet permits most Lotus 2.X commands and functions except database management and graphics.

Text Editor—This basic word processor includes automatic carriage return and word wrap, as well as search-and-replace and cut-and-paste functions.

Calculator—The calculator has five-number memory, percentage calculations, and four numeric formats: general, fixed, scientific, and engineering. In addition, there are three functions: factoral, power, and root. The calculator also includes an editable "tape" of previous calculations with spreadsheet-like recalculation—a terrific feature for income-tax form preparation.

Diary—The personal diary includes a calendar and appointment book with programmable reminder alarms. Repeating alarms can be set to go off every day, week, month, or year—never forget a birthday or anniversary again.

Address Book—Names, phone numbers, and addresses are managed with an alphabetical index. Users may find entries alphabetically, by scrolling, or by searching for a word or phrase. You can retrieve telephone numbers visually or let Atari's Portfolio do the dialing. (The reviewer used the automatic dialer to contact his mutual-fund electronic operator for pricing information—Portfolio dialed the 800 number and provided 18 additional identification digits in two groups to get the financial data.)

Operating System—Atari's Portfolio operating system uses MS-DOS 2.11-compatible commands. That enables MS-DOS software developers to easily adapt "well-behaved" PC programs to the unique features of Portfolio, such as the 40-column by 8-line LCD. The equivalent of MS-DOS .EXE and .COM files may be stored in Program Cards instead of floppy disks, or executed directly when specially compiled.

Portfolio also includes an internal file transfer function, which, when combined with the optional Smart Parallel Interface, enables users to upload or download data files from their IBM-compatible personal computers. For moving data within or between applications, Portfolio includes a cut-and-paste function. For example, spreadsheet data can be incorporated in a business memo.

Portfolio is a multi-lingual system. In fact, Portfolio is provided with one of seven different keyboard configurations during assembly. Each system includes one predominant language for menus and messages and two additional languages. Users can switch between languages with a few keystrokes. The three language formats are: English/French/German, English/Spanish/Italian, and English/Swedish/Danish.

Sophisticated micro-miniaturization technology was used to make the Atari a one-pound unit, which is slightly smaller than a video-tape cassette. The thin memory card snaps into a side port. Note the piano-key-like contacts at the bottom of the card.

Options. Atari's Portfolio has a 60-pin bus connector for use with proprietary peripheral devices. It can be connected to any peripheral that uses the industry-standard RS-232C serial interface. The Smart Parallel Interface supports standard Centronics parallel devices, such as printers.

Some of the optional Portfolio peripherals are:

Smart Parallel Interface—The $4.95 Smart Parallel Interface can be used with Portfolio's internal File-Transfer program and PC File-Transfer software to exchange files between the palm-top system and an IBM PC or compatible computer. For example, users can download Lotus 1-2-3 spreadsheet templates created on their desktop PC and use them on their Portfolio. It can also be used to connect the system directly to a parallel printer.

Serial Interface—The $7.95 Serial Interface can be used to connect Portfolio to peripherals such as modems, printers, or bar-code readers. With suitable software, the serial interface can be connected to the serial interface of another computer so that Portfolio can act as an intelligent terminal.

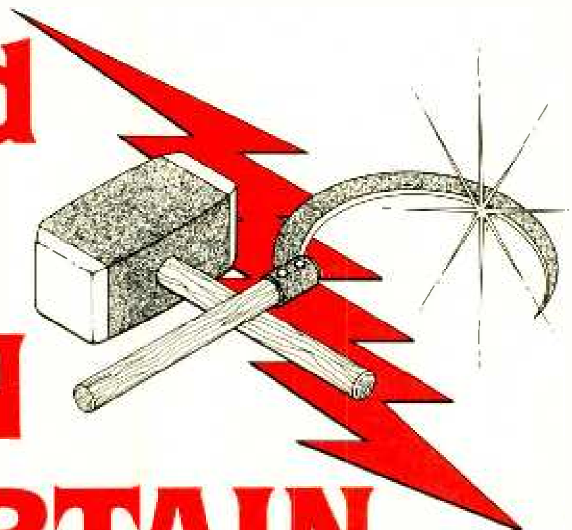
Memory Expander Plus—The $229.95 Memory Expander Plus contains 256K of RAM that can extend the internal 128K RAM in the main unit and/or increase the size of the internal RAM disk. Two memory expanders can be attached to Portfolio to extend the internal RAM to 640K. The memory expander retains data stored when Portfolio is turned off and extends the bus so that additional peripherals can be attached. The memory expander contains a second "card drive" that accepts a memory or program card so users can run external programs and store data on a card at the same time, or both drives can be used to copy cards quickly.

AC Adaptor—Portfolio's $9.95 AC Adaptor is useful to users who want to conserve their batteries during long periods of operation. When the adaptor is connected, batteries are not required to power the system or peripherals.

PC Card Drive—Users who frequently transfer files between Portfolio and their desktop PC will want to consider adding the $99.95 PC Memory Card Drive to their desktop system. The card drive allows users to read and write memory cards with their IBM-compatible PC at high speeds. It also eases the process of downloading MS-DOS files from your personal computer onto Memory Cards for Portfolio.

The one-pound Portfolio palm-top personal computer is the most complete portable personal computer system available today; it is the smallest, full-featured personal computer ever designed. But even if it were several pounds heavier, it would be the most competitive system available for portable computer users in terms of price verses performance. Portfolio is available from Atari Computer's leading authorized dealers for $399.95 and from Atari direct at 1-800-443-8020. For more information contact the company directly, or circle No. 118 on the Free Information Card. ■

Electronics Hobbyists Behind the IRON CURTAIN



Clandestine meetings in dark hallways, scouting through trash, and manipulating personal connections sounds normal for a hardened gum-shoe, but a typical electronics hobbyist?

BY ANTON A. ANTOKKIN

It is a cold winter day on Gorky Street—one of the central arteries of Moscow running to Red Square. Brown slush makes slurping noises under my feet as I walk up to the gray granite building. I feel a bit nervous, though not nearly as nervous as the first time I came here. After all, if I am caught, I can spend a few months in jail.

My right hand is wrapped around the handle of an ugly lime-colored suitcase; my fingers getting tired from the heavy load. On the first floor of the building red plastic letters over a shop-window read: "*Magazin Peeoner*," which means "The store of young pioneers." Inside, there are wood, paint, tools, model railroads, and electronics departments, outside however, is the black market for electronics parts.

I walk up to a heavy-set man with an expensive briefcase, standing next to an entrance. We study each other's faces for some time.

"What have you got?" he finally utters, nodding at my suitcase.

"Everything you want," I reply nonchalantly, "computer boards, MIG-35 insides, a bunch of Japanese IC amps, two-color LED's—lots of stuff."

The businessman's eyes light up, he cautiously looks around and whispers: "Trade or sell?"

"Trade." I say.

He says, "Let's go around the corner. Act normal."

Being a serious electronics buff in the Soviet Union is not easy. It's nothing like it is in the States; It requires considerable money, connections, and a lot of inventiveness. It's not a hobby for a quiet introvert. In the Soviet Union it has more in common with something like stamp collecting, than anything else. You search for that one part for weeks, making phone calls, visiting black marketeers, and staking out dumpsters. When you finally get that 1000-pF, 5-volt capacitor, there is a sense of joy, comparable only to the feeling of a stamp collector who acquires a 1938 Swiss stamp with the price printed upside down.

Building the project is only a part of the hobby. Finding the part and building your collection is just as much a pastime as soldering and testing. That might seem inconceivable to a hobbyist here, in the States. But imagine; what would you do if Radio Shack discontinued its parts, mail order was outlawed, and you didn't want to take apart your grandfather's AM radio?

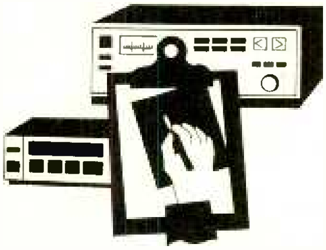
Gold from Trash. Mixing and matching parts is fine if you only want to build one-evening multivibrators that scream, bark, and meow. But if you decide to put together a receiver or an amplifier, substitution will not get you very far. But, of course, that doesn't mean it's time to put on your darkest sunglasses and head for the underground electronics bazaar: a *real* hobbyist will first search an institutional trash can—the black market is only a last resort.

I started out in electronics at the age of five, collecting tubes and burned-out potentiometers behind a TV repair shop near my house. Every Tuesday and Friday evening, a janitor emptied a bucketful of electronic rubbish, surplus parts, lunch leftovers, and, oftentimes, empty bottles of vodka into a dumpster next to the back door of the shop. A group of local hobbyists, ranging in age from five to fifty, would watch him from the stake out in a nearby park with rapt attention.

In a matter of minutes the dumpster was toppled on its side, and the hunt began. Shortly, all that was left were lunch leftovers and broken vodka bottles. Almost everything was a good find: tubes, transistors, and electrolytics could be tested; yokes and transformers were good sources of wire, and can be re-spooled; chassis can be refitted; circuit boards could be rewired; and switches could be cleaned and rebuilt.

I would check out the trash every week, often with a few friends, at a number of "hot spots" around Moscow. Unfortunately, oftentimes the people who disposed of electronic parts, were also quite aware of their value. The best was taken home for their children, or for

(Continued on page 102)



Product Test Reports

By Len Feldman

INSTANT REPLAY VT-498EM VIDEO CASSETTE RECORDER

Have you ever borrowed or received a video tape from a friend overseas, popped it into your VCR, and then been frustrated when all you could see on your TV screen were blurred, wildly fluctuating wavy lines? Unfortunately for world standardization, TV broadcasting "grew like Topsy" after World War II, with different parts of the world adopting different transmission and reception standards. The U.S., Canada, Japan, and most of South America use a system known as NTSC. Much of Western Europe uses one or more variations of a system known as PAL, while France, parts of Africa, the Middle East, and the USSR use a system called SECAM. While multi-system TV sets have been available to world travelers for some time, it took a company called Instant Replay (2951 S. Bayshore Drive, Miami, FL, 33133) to come up with a VCR that not only can receive programs broadcast in NTSC, PAL, or SECAM, but can also record and play back such programs correctly. With it, you can play a PAL or SECAM tape on an NTSC (U.S. System) TV monitor. Abroad, if you have this VCR with you, you can play an NTSC-recorded tape on a PAL (European System) TV/Monitor.

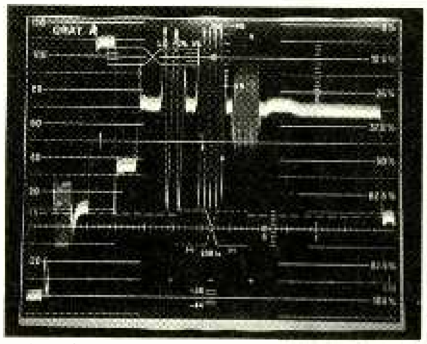
The VCR is configured for the VHS format. It uses four heads for improved performance at all tape speeds. Multiple RF converters are built in for the various transmission standards. The unit comes with a full-function remote control that lets you program the timer for up to eight recording events over a one-year period. The remote also handles the usual VCR operations such as play, stop, pause, etc. The real-time clock can be set from the remote and, once set, will show you the day of the week for any day over the next 99 years!

The VCR's tuner section will memorize up to 79 TV-channel frequencies. Other timer features include instant or "one-touch" recording for periods of up to four hours (in 30 minute increments), as well as simplified timer recording (over a period of the next 24 hours).

Various automatic-operation modes are incorporated, such as automatic play (when a cassette is inserted), repeat playback, automatic power-on, automatic shutoff after rewind, automatic speed selection during playback, and even automatic color-system selection. The "World Traveler," as this VCR is called, also incorporates an RGB output and its own PAL/SECAM color-level control right on the front of the unit.

The usual special effects common to single-system VCR's are available with this unit, too, such as still-frame viewing, and fast scanning in either direction.

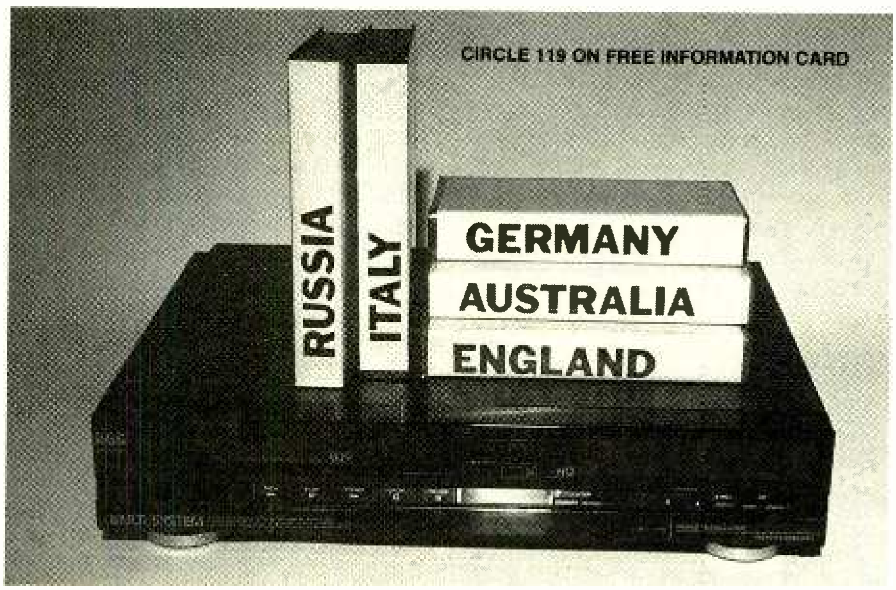
Controls. A POWER switch at the left end of the front panel, adjacent to the cassette slot, activates the unit. COLOR MODE indicators that show the type of color-TV system being recorded or played back are nearby, while further to the right is a display area that shows time and day of the week, tape counter numerals, and channel indication. The usual array of tape transport buttons (REWIND/VISUAL SEARCH, PLAY, FAST FORWARD/VISUAL SEARCH, STOP and PAUSE) are below the cassette slot. To their right are COUNTER RESET and COUNTER MEMORY (rewind) buttons, "Up" and "Down" TV-CHANNEL SELECT buttons, a RECORD button and a pair of buttons needed for instant recording.



A low-frequency video-burst signal was used to evaluate playback video-response. The test results in the PAL mode at SP speed are shown here.

Opening a hinged flap near the bottom of the front panel discloses an array of secondary controls, many of which are unique to this type of multi-system VCR. One nice little feature we discovered here is the imprinting of the control functions on the inside of the flap (which, when opened, is positioned on a horizontal plane) as well as on the vertical surface behind the hinged flap. A small matter, you might think, but for those of us who hate to stoop down to the ground to read the nomenclature, it is a convenient and thoughtful addition that didn't cost the manufacturer very much to incorporate.

Controls here include a picture SHARPNESS knob, a TRACKING control, con-



Instant Replay's VT-498EM NTSC/PAL/SECAM VHS VCR.

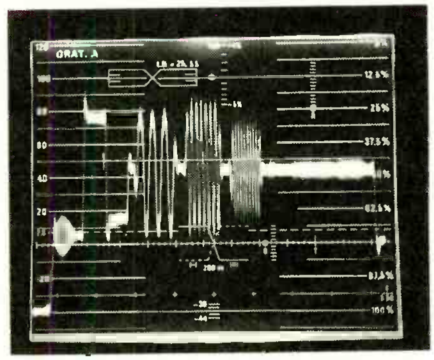
TEST RESULTS—INSTANT REPLAY VT-498EM VCR

Unlike the case with audio products, video products seldom have many meaningful published specifications associated with them. Thus, APEL's results are tabulated without any reference to manufacturer's specifications, simply because few of APEL's measurements are normally reported by this or any other manufacturer. As **Popular Electronics** publishes more and more reports, you will be able to make meaningful comparisons between competing products.

Specification	APEL Measured
Video Section	
Video Output	1.0 Volts, p-p
Maximum Record/Play Time (NTSC & PAL/Secam)	8 hours/4 hours
Frequency response, PAL (Video Output)	
SP Playback	−4.33 db @ 2.0 MHz
LP Playback	−4.86 dB @ 2.0 MHz
Frequency response, NTSC (Video Output)	
SP Playback	−3.37 dB @ 2.0 MHz
LP Playback	−4.86 dB @ 2.0 MHz
Signal-to-Noise Ratios	
Red-Field Chroma, PAL (Video Output)	
SP (AM/PM)	33.1/36.3 dB
LP (AM/PM)	32.9/36.2 dB
Red-Field Chroma, NTSC (Video Output)	
SP (AM/PM)	50.6/44.8 dB
LP (AM/PM)	44.5/38.9 dB
Luminance, PAL (Video Output)	
SP (100/50/10 IRE)	22.6/25.2/31.9 dB
LP (100 IRE)	22.7 dB
Luminance, NTSC (Video Output)	
SP (100/50/10 IRE)	46.1/47.1/47.5 dB
LP (100/50/10 IRE)	41.6/41.8/42.2 dB
Audio Section (NTSC Rec/Play)	
Output Level for Referenced Input	
SP	0.33 volts
LP	0.30 volts
THD at Referenced Output	
SP	1.6%
LP	1.8%
Frequency Response (for −3 dB)	
SP	90 Hz to 12.0 kHz
LP	64 Hz to 5.2 kHz
Signal-to-Noise, Record/Play	
SP	46.3 dB
LP	47.3 dB
Harmonic Distortion @ −10 dB (SP/LP)	
100 Hz	0.62/1.00%
1 kHz	0.60/1.00%
Additional Data	
Power Requirements	38.0 Watts
Fast-Rewind Time (T-120 tape)	4 min. 42 sec.
Fast-Forward Time (T-120 tape)	4 min. 41 sec.
Dimensions (H × W × D, inches)	$3\frac{9}{16} \times 17\frac{1}{16} \times 14\frac{3}{4}$
Weight (lbs.)	16.0
Suggested Retail Price	$1995.00

trols associated with automatic or manual selection of the type of color system desired (NTSC, PAL, or SECAM), BUZZER and EDIT switches (the buzzer, if turned on, acknowledges every touch of a control with a distinctive beep), controls needed for setting the clock and for timer programming, a RECORDING SPEED selector (playback speed control is, of course, automatic), and a SIMULCAST switch that allows you to record video from the tuner while audio (usually stereo) is recorded via the external audio-input jack, usually from an FM broadcast.

The rear panel of the VT-498EM VCR is equipped with the usual ANTENNA-input and RF-output connectors, AUDIO and VIDEO input and output jacks, a VERTICAL SYNCHRONIZATION control, a selector switch that needs to be set according to the type or format of TV set connected to the VCR, and a switch and control that allow you to adjust the RF modulators to match your TV set's tuning exactly.



At the SP speed, the playback video-response in the NTSC mode was a shade better.

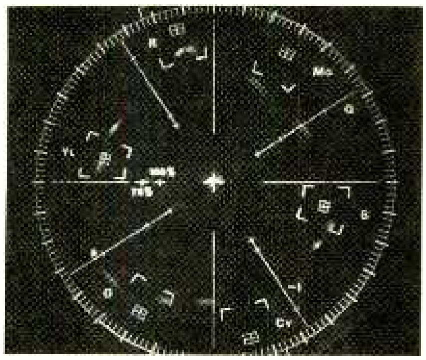
The remote control duplicates many of the major control functions found on the front panel. Furthermore, because it is equipped with numeric buttons, it allows instant access to any channel. In addition, it has an LCD screen of its own so that timer programming can be done from the remote as well as from the front panel.

About APEL. Performance of video products tested for **Popular Electronics** is measured and tested by Advanced Product Evaluation Laboratories (APEL), under the direction of Mr. Frank Barr. Mr. Barr has been in the business of independently evaluating consumer-electronics products for more than two decades, and his laboratory is one of the best equipped video-testing laboratories in the country. After APEL amasses data concerning a video product, that data, along with the product, is sent to my laboratory (Leonard Feldman Electronic Labs) where we put the product through its paces, analyze the data supplied by APEL, and produce the final report you are reading now. Some of APEL's measurements may appear to be too technical for casual readers. For that reason, the actual numerical test results are summarized elsewhere in this report, while their significance is reported here.

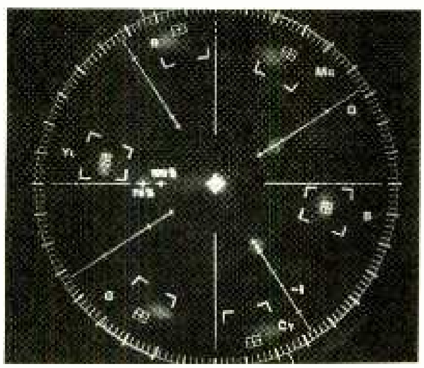
The Test Results. Since APEL is based in the U.S. and generally is involved only with NTSC video equipment, it was necessary for the lab to produce a special PAL test tape. That was done using a Tektronix PAL generator and a Magni Computer generator. Instant Replay supplied APEL with a couple of pre-recorded PAL and SECAM program tapes. The lab reports (and we can confirm, having viewed those tapes) that playback quality was very good—better than the PAL signal-to-noise measurements would indicate.

APEL tested the video section first as a PAL player and then as an NTSC record/play unit. Using a video-burst signal, video frequency-response was about what you would expect from any high-quality VHS VCR. At the SP speed, video response was a shade better using the NTSC format, than it was in the PAL mode, but at the slower, LP speed (LP, not EP, is the slowest speed available on most European VCR's), results were about the same in both PAL and NTSC.

Both chroma (color) and luminance (brightness) signal-to-noise ratios using the PAL tapes were rather poor compared with the results obtained in the NTSC mode, but as already pointed out, those figures were somewhat deceptive when it came to playing back tapes in the PAL mode. As is usual, signal-to-noise was poorer for either mode when measured at the slower LP tape speed than it was in the SP speed.



This vectorscope measurement of NTSC record/play tapes shows that color phase (accuracy) and intensity was near perfect.



In the case of the PAL tests, the vectorscope indicated a double set of vectors; one correct, one somewhat displaced. Since the effect was not viewed when observing the actual color bars on the monitor, APEL believes the odd display was caused by the difference between U.S. AC frequency and the PAL line-repetition rate.

APEL measured color accuracy and the degree of color saturation using a piece of test equipment known as a *vectorscope*, which measures the phase and intensity of the signals associated with standard color bars, as recorded on and played back from the tape. Ideally, the vectors produced should produce spots of light on the vectorscope display that fall precisely on the cross-hairs used to designate the various colors in the color-bar patterns, such as R (for Red), Cy (for Cyan), Yl (for Yellow), B (for Blue), and G (for Green). In the case of NTSC record/play tapes, both intensity and color accuracy were virtually perfect. In the case of the PAL tests, double sets of vectors seemed to appear on the vectorscope display; one set falling where it should, the other somewhat displaced from the first set. APEL did not observe that phenomenon when viewing the actual color bars on a TV monitor. They therefore feel that the odd display may have been caused by the fact that the U.S. power-line frequency is 60 Hz, whereas the PAL field repetition rate is 50 Hz, to correspond with power line frequencies in most of Europe.

Audio performance of the VCR was measured in the NTSC mode only. Since the VCR uses only a conventional linear audio track recorded by means of a stationary tape head, very little difference in audio performance might be expected between NTSC, PAL, or SECAM modes.

The tape speed is the single greatest governing factor when it comes to audio frequency-response, and SP tape speed does not vary that much between the color-TV operating modes (33.35 millimeters/second for NTSC, and 23.39 mm/s for PAL and SECAM.) While audio signal-to-noise ratios were not much better than what you can expect from an inexpensive hand-held audio-cassette recorder, frequency response extended to well beyond 10 kHz when the higher SP tape speed was used. Of course, at the slower LP speed, audio response suffered as it always does when linear edge-track audio recording is used on VCR's. At that speed, audio-frequency response extended only to about 5 kHz, which is actually slightly better than the average for VHS VCR's operated at that speed and in the conventional recording mode.

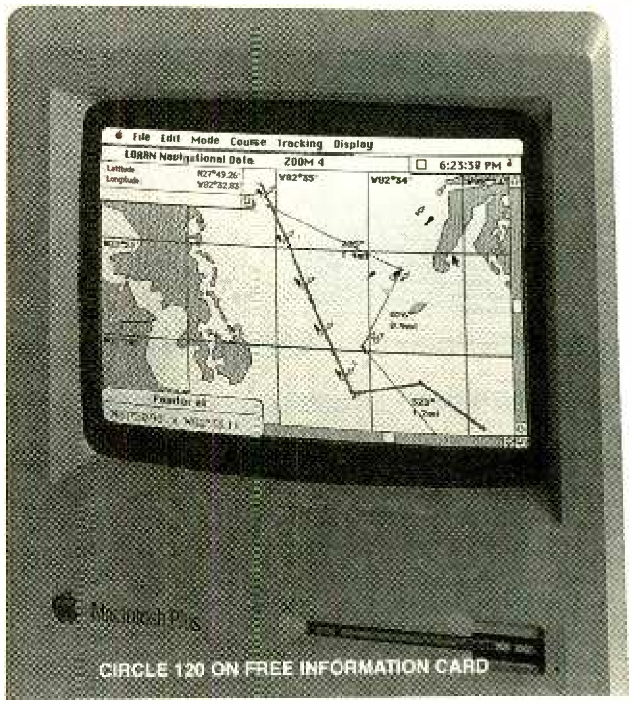
Hands-On Tests. Of course, we were not able to record programming of our own in anything but the U.S. NTSC system. We did, however, play the tapes supplied by Instant Replay and found that there was little need for control adjustment and the "transcoding" (as the manufacturer calls the process of making PAL or SECAM tapes compatible with NTSC video monitors) was well done, with no vertical jitter and well stabilized horizontal synchronization.

The tapes that we did record from over-the-air broadcasts using the NTSC format played back with about the same picture definition or resolution as we normally get from a dedicated VHS NTSC VCR. One point worth mentioning is the fact that the VCR also has provision for operation at most of the world's line voltages. It comes from the factory adjusted for the highest line voltage, as a safety measure. When operated in the U.S. the setting of a switch (located on the underside of the unit) should be changed. And, of course, should you take the unit with you overseas, you must set the switch to a higher setting if the country you visit uses 210 to 240 volts as a standard supply voltage.

At a suggested retail price of $1995.00, the VT-498EM "World Traveler" VCR is not for everyone. But, for the frequent traveler, or for anyone who receives "home movie" video tapes from friends or relatives living in other parts of the world and hasn't been able to view them without paying a steep fee for having a professional studio convert the tapes to NTSC format, the "World Traveler" VCR may be just what's needed. For more information contact the manufacturer, or circle no. 119 on the Free Information Card. ■

"It keeps spitting out the tapes? Maybe it just has better taste in movies."

Popular Electronics
HANDS-ON REPORT



OCEAN PRODUCTS NAVplus NAVIGATION SOFTWARE

If Christopher Columbus had the NAVplus system on-board when he reached the shores of America, he would have known exactly where he was.

For centuries, navigating the world's waterways has been as much of an art as it was a science. While it's true that modern technology has yielded navigational aids that have made course-plotting a lot more precise (such as "Loran," which we'll discuss later), one still has to painstakingly plot Loran readouts onto an actual chart.

To remedy that problem, today's technology has also provided us with the extremely rugged, relatively low-cost, and easily portable Macintosh computer. The Macintosh has a high-resolution display—perfect for nautical charts—and a mouse that makes selecting various points of interest extremely easy. It is for those reasons that the NAVplus charting and navigation software package was targetted for use on a Macintosh plus or better. An IBM version of the package is also in the works as of this writing.

Loran. Before we discuss the NAVplus system, let's first explain what Loran is, and how it's used. Loran is similar to radar in that it measures distance by noting radio-wave travel time. The basic difference between them is that Loran simultaneously uses several transmitter sites to accurately pinpoint a position.

Take a look at Fig. 1. For simplicity's sake, the figure contains only two transmitter sites. First, a "master station" sends out a radio signal that is picked-up by a Loran receiver on-board the ship. The signal is also detected by a "slave station," which sends out its own signal a short time after it receives the master-station signal. The on-board Loran receiver then picks-up the slave's signal and measures the time delay between the two signals and converts that to map coordinates.

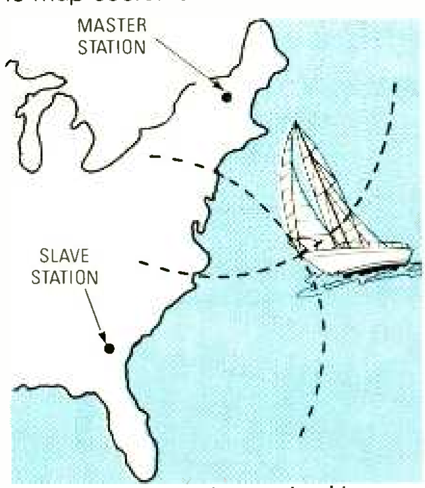


Fig. 1. A Loran receiver on the ship receives a pulse from the master station and then one from the slave station. The time difference between the two signals can be converted to map coordinates.

Actually, if only one master-slave pair is used as shown, the system couldn't tell if you were in the Atlantic to the right of the stations or somewhere in Idaho to the left. That problem is overcome by the use of multiple master-slave pairs. After all the data is converted to coordinates, it is then the job of the navigator to transfer those coordinates onto an actual chart.

By the way, other navigational systems (*i.e.* such as SAT NAV and GPS) also exist. They're not exactly Loran, but they operate in a similar manner. SAT NAV (Satellite Navigation) is a system that uses several satellites around the world to get a positional fix. The satellites, however, are not fixed in relation to the Earth's surface, so it is only good for periodic position updates. The GPS (Global Positioning System) uses several geo-synchronous, or fixed-to-Earth satellites, and provides a highly accurate, continuous means of determining your position. Because of the addition of more and more satellites, GPS coverage is constantly expanding and may eventually make Loran obsolete.

Most receivers designed for Loran, SAT NAV, or GPS have a standard marine output signal, NMEA 0183, which can be fed into a printer or modem port from a receiver via a cable.

(Continued on page 106)

Antique Radio

By Marc Ellis

BROTHER PAT'S MARVELOUS MUSEUM OF TUBES

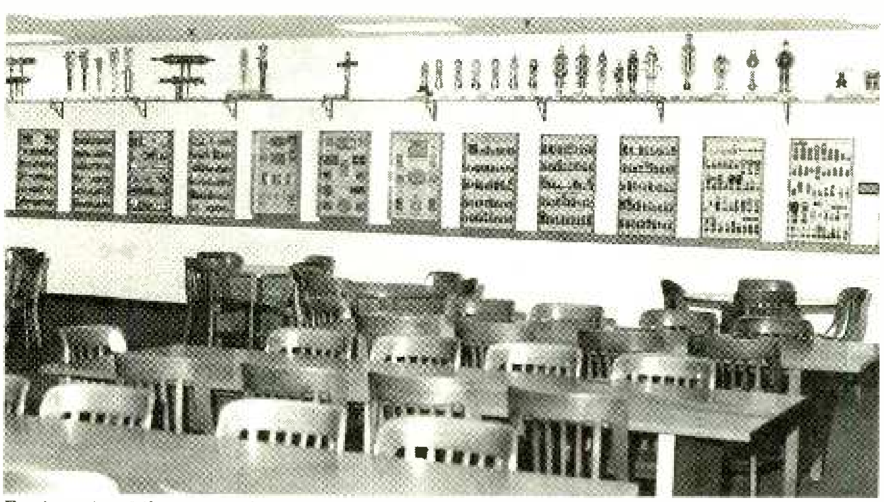
Tucked away in a college library in the heart of the Bronx, a New York City borough, is a "must see" exhibit for anyone interested in the history of vacuum tubes. It's a collection of almost 4,000 tubes and related artifacts, representing every phase of U.S. vacuum-tube evolution from the earliest to the most recent types manufactured. The permanent exhibit, mounted along the walls of Manhattan College's Engineering Library reading room, is the brainchild of Brother Patrick Dowd, F.S.C., science teacher at Paramus (New Jersey) Catholic Boys High School, who spent 16 years creating it.

Though considered by experts to be the most comprehensive permanent display of its kind anywhere in the world, the museum is as unpretentious as Brother Pat himself. If you're sightseeing in the New York City area, don't look for it in a visitor's guide. In fact, the museum doesn't even have a formal name. In the simple photocopied brochure that serves as its catalogue, this world-class exhibit is variously called "The History of the Vacuum Tube," or "the vacuum tube exhibit at the Manhattan College Engineering Library."

How It All Started. This incredible collection had its beginnings in the mid 1970's. The diamond anniversary of Marconi's 1901 Atlantic-spanning radio experiment was approaching, and the principal of Paramus Catholic Boy's High School wanted to put together a commemorative exhibit. Because of Brother Patrick's interest in amateur radio, he was recruited for the job of putting together a display of vacuum tubes.

As a licensed radio ham, Brother Pat was an intelligent user of tubes, but he knew little about their rich and interesting history. However, learning as he went along, he solicited donations from members of his ham-radio club (the North Jersey DX Association), other old-time radio amateurs, manufacturers, and dealers in second-hand tubes. The response was overwhelming, and over the next few years literally thousands of tubes poured in.

As he became more knowledgeable, he refined his hoard by purchasing at flea markets and estate sales, and by trading with other collectors. Eventually, the collection transcended its original purpose and came to include a large number of rare and historically significant pieces. That was when Brother Pat determined that he should try to find a permanent home for the tubes.



Engineering Library Reading Room at Manhattan College doubles as home for Brother Pat's tube museum. Industrial and transmitting tubes too large to fit on panels are mounted on shelves above.

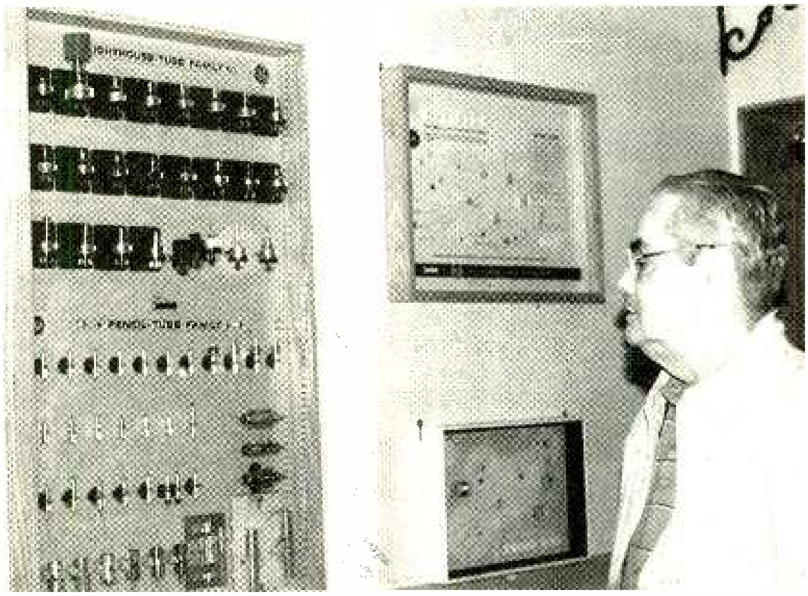
One of the difficulties that he had experienced when he first began to research the history of vacuum tubes was the lack of any public display of tubes anywhere in the New York City metropolitan area. Brother Pat was hoping to correct that condition. His first step was to mount the collection, in related groups, on attractive display panels.

Brother Pat (right) discusses the collection with Bruce Kelley (left), Curator of the Antique Wireless Association Museum in East Bloomfield, NY, and Rick Barry (center), Manhattan College's Engineering librarian. Panels in background show over 100 brands and variants of the famous 201/201-A tube.

Manhattan College Comes Through. The mounting project was started in the summer of 1978, and a permanent home for the collection was located by the following spring. New York City's Manhattan College was just completing a new reading room for its engineering library. Not only would the library be a very appropriate locale for the tubes, but the reading-room walls offered plenty of room for hanging the display panels. The deal was made, and the first 24 panels were completed and installed in time for the room's September, 1979 dedication ceremonies.

The final four panels were added last summer, bringing the total to 76. Brother Pat considers himself most fortunate, because the available wall space held out until the addition of the last panel. What's he going to do for an encore? He's not saying—but, as curator of the collection, Brother Pat has a lot to do just updating the displays to include the new "finds" and additional information that continue to turn up.

Objectives and Organization. When the exhibit was first being installed at



Panel containing early "lighthouse" and "pencil" tubes (left) gets once-over from Brother Pat. Small panels at right were made by RCA, and illustrate assembly of Nuvistor tubes.

Manhattan College, the objective was simply to put together a permanent display showing the history of the vacuum tube. However, as more and more tubes were acquired, the goals slowly broadened. Today, the objectives call for not only illustrating vacuum-tube history, but also displaying types demonstrating all uses of the vacuum tube—including receiving, transmitting, industrial, and special purpose.

As the collection expanded, says Brother Pat, so did its status in people's minds. In the beginning, he and his principal thought of it as a display. When it was first moved to Manhattan College, folks began to think of it as an exhibit. Today, there's no doubt that it's a full-fledged museum.

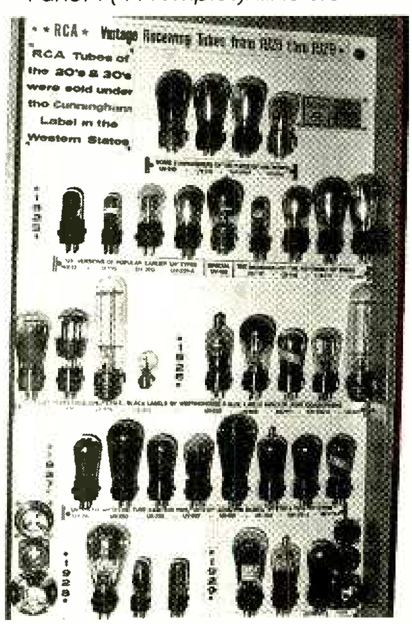
Because of space limitations, the collection is mainly devoted to the history and role of the vacuum tube in America. However, foreign tubes are shown wherever their inclusion is necessary in telling the complete story of the vacuum tube—or where they found widespread use in this country.

The tubes range in size from the smallest triode ever made (⅛ × ½ inches) to a 5-foot, 100-kW, transmitting model. The larger transmitting and industrial tubes are located on special shelves above the panels. The museum currently displays about a hundred of those larger tubes, with more to be added in the near future.

The tubes are arranged in organized groups on the glass-enclosed oak panels. Depending on the point to be made, the samples on a particular panel might be mounted by type, time period, function, manufacturer, etc. Individual panels, or groups of panels, are devoted to receiving tubes; transmitting tubes; special-purpose tubes such as rectifiers, magic-eye indicators, and voltage regulators; TV image tubes; X-ray tubes; industrial types; radar types; and others.

Exhibit Highlights. Of course, there's no way to do justice to this unique and extensive collection in the limited space available. But here are a few things that caught my eye as I scanned the descriptions of the panels in Brother Pat's exhibit catalogue:

"Panel 1 (44 samples). ...Picture of the 'Edison Effect' Bulb; Samples of Pre-patent DeForest Audion; Fleming Valve; DeForest Spericals; Weagant Valves; Early Tubulars; Popular WWI Vacuum Tubes—France, England, Germany and America; Early Post-WWI Marconi/Deforest/Moorhead; DeForest 'Singer' Type Rectifier & Amplifier—(1906-1920)."



Here is a close-up of Panel 4, which features RCA receiving tubes dating from 1925-1929.

"Panel 2 (53 samples). Western Electric Early spherical and tubular tubes (1914-1929)."

"Panel 3 (37 samples). RCA Receiving Tube Releases—(1920–1924) + Later Variants."

"Panel 4 (42 samples). RCA Receiving Tube Releases—(1925–1929) + Some Forerunners."

"Panel 5 (56 samples) and Panel 6 (60 samples). Some of the Many Faces of the 201/201-A—perhaps the most popular vacuum tube ever made. (1920's)."

"Panel 18 (42 samples). G.E.'s Prototype All-Metal Receiving Tubes + RCA's first production samples of these tubes—(1933–mid 1938)."

"Panel 21-b (25 samples). Birth and Development of the Electron Ray (Magic-Eye) Tube—'35 & After."

"Panels 23 through 34 (336 samples). Devoted to the Transmitting and Industrial tubes (1920's to WWII & after) of the following companies: G.E., Westinghouse, RCA, Western Electric, Deforest, Sylvania, Hytron, Taylor, Raytheon, Heinz & Kaufman, United Electronics, Amperex & Eimac."

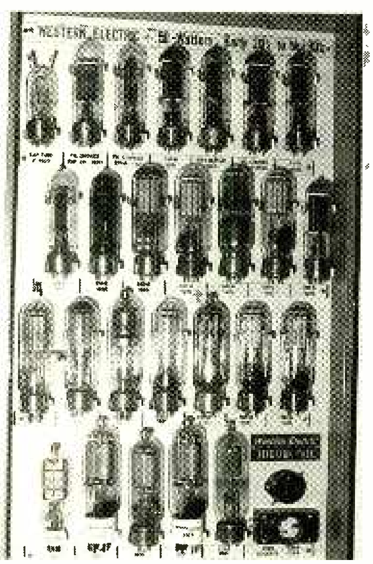
The list of large tubes shelved above the panel displays includes several types of more-than-passing interest, and among them are several vacuum tubes whose individual histories are known. Here are a few of the tubes that seemed especially noteworthy to me: Western Electric Type 340-A used in a *circa* 1930 AT&T 60-kilowatt Transatlantic Telephone Station; 1926-vintage RCA UV-851 transmitting tube used at Radio Station WOR; Westinghouse Type AW-200/899 50-kilowatt transmitting tube used atop the Empire State Building in the RCA/NBC experimental TV station W2XBS from July, 1936 to World War II; Westinghouse WL-530 & WL-531, the power-amplifier and rectifier types used in the Pearl Harbor radar (December 7th, 1941).

More on the Exhibits. I've shared with you some of the things that I personally thought were especially interesting about the museum, but now let's give Brother Pat the floor! In corresponding with me as this article was being developed, he made several points about the collection that I'll pass along here.

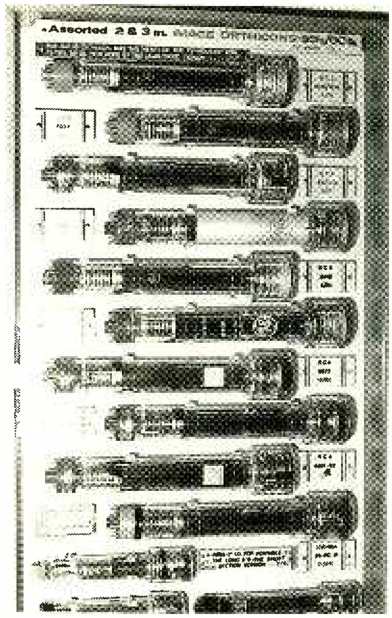
In the summer of 1975, while researching the panels devoted to metal tubes, Pat got to know the personnel at RCA's Harrison, NJ plant. Those contacts stood him in good stead when, in January 1976, RCA announced that their tube plants would be closed. During the last months at Harrison, he was allowed to photograph the tube manufacturing processes and to collect many tools and devices for his own museum (panels 59 and 68) and that of the Antique Wireless Association in East Bloomfield, NY. He was also able to obtain—for the Antique Wireless Association—all of RCA's tube records and manufacturing specifications.

More RCA artifacts found their way into Brother Pat's museum through his friendship with George M. Rose, the retired head of RCA's receiving tube advanced research and development group. George invented the glass-button-stem and hard-wire-pin construction style that made possible the miniature and micro tubes. He developed the acorn, pencil, and Nuvistor tubes, to mention only a few of his many contributions. George had preserved the developmental samples of most of his projects, and those precious artifacts are now mounted in panels 9, 10, and 11.

Twelve panels of the exhibit (numbered 40 through 51) make up a unique display tracing the development of the image tubes used in TV cameras. Beginning with the Zworykin Iconoscope and Farnsworth Image Dis-



Western Electric 50-watt transmitting and industrial tubes of the 20's and 30's are shown on Panel 24.



Panel 46 highlights Image Orthicon tubes used in studio TV cameras during the 50's and 60's.

sector tubes of the early 1930's, the series of panels covers every step in the evolution of image-forming devices through the development of the solid-state studio-quality imaging devices that appeared on the scene in the mid 1980's.

Additional donations to the museum are always welcome. If you have a vacuum tube or related item of historical significance, and would like to see it preserved and made accessible to the general public, Brother Pat would like to hear from you. Write Brother Patrick Dowd, F.S.C., 425 Paramus Rd., Paramus, NJ 07652.

Besides acting as museum curator and holding down his regular job at the high school, Pat also finds time to serve as the contributing editor on vacuum tubes for *The Old Timer's Bulletin* of the Antique Wireless Association. He regularly writes articles about vintage tubes for the *Bulletin*, and has received two separate awards from the Association for his outstanding contributions to vacuum-tube history. He is also an active radio amateur (W2GK).

The Antique Wireless Association is a non-profit group dedicated to the preservation of the history and artifacts of wireless communications and electronics. If you'd like to find out more about the Association and its extremely interesting quarterly publication, you might like to write Lauren Peckham, President, Antique Wireless Association, 101 Ormiston Rd., RR1, Box 676, Breesport, NY 14816.

Visiting the Museum. When you're in the New York City area, make a point of dropping in on the museum. You should find it well worth your time! The Manhattan College Engineering Building is located just off the main campus in the Bronx. It's on Corlear Ave. (a short block west of Broadway) between 238th and 240th Streets.

If you're driving, a parking lot is located just south of the building—on the 238th Street side. If you're coming by subway from Manhattan, take the IRT Van Cortlandt Park train to the 238th Street stop. Walk one block west to Corlear Avenue. The best access to the museum is not via the main door, but through the side entrance facing the parking lot.

Just before making your trek to the museum, it probably would be a good idea to call the Manhattan College Engineering Library (212-920-0165) and determine the hours that the reading room will be open. Once in the reading room, you'll be free to wander through the many displays at your own pace. There are no guides, but Brother Pat's handouts and the explanatory notes on the display panels themselves will tell you everything you need to know. Plan on spending at least a couple of hours at the museum if you'd like to do it full justice.

Bye For This Month! In March, we'll return to the saga of the Pilot A.C. Super Wasp. The power supply for the Wasp (as outlined in the January column) is now under construction, and we should be able to try the set out in time to report on the results next month. See you then, and in the meantime don't forget to let me hear from you! Write *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

Computer Bits

By Jeff Holtzman

VITRAX IX MICROCONTROLLER

Before IBM introduced the PC and subsequent members of that now-ubiquitous family, owning a personal computer was a technical challenge. Rather than bookshelves filled with pre-packaged software, a microcomputer owner was likely to own a bench full of test equipment and components. Of course no one wants to turn back the clock and give up the progress that's been made in software. On the other hand, there are still people who hunger for greater technical understanding, as well as the ability to tinker with hardware. If that sounds like you (or if you're a professional engineer looking for an inexpensive yet powerful controller), you should check out the Vitrax IX Microcontroller20 (VIM).

The VIM is a small (4.5 × 6.5 inch) card built around a Hitachi 64180 (Z80-compatible) microprocessor running at 6 MHz. For a base price of about $170, you get an 8K BASIC interpreter, 2K of RAM, and a built-in EPROM programmer. Just add a single-voltage power supply and a dumb terminal or a PC running terminal-emulation software and you're ready to play.

Capabilities. The VIM has a lot of options that make it really flexible. You can power it with either a regulated five-volt 200-mA source, or 8-volts unregulated; the VIM generates the negative RS-232 voltages on-board. However, you'll need a 12.5- or 21-volt source to use the EPROM programmer.

The board includes circuitry for two RS-232 channels and 24 bits of parallel I/O. Normally, you'll use one of the serial ports to communicate with the VIM via a terminal; you're free to use the other as desired. The terminal channel is self-configuring (*i.e.*, it automatically senses the correct baud rate after you press the <RETURN> key a few times). All 24 parallel lines (implemented as a standard Intel 8255) are brought to a connector; a subset of those lines is also brought to a second connector you can use as a printer port for program listings.

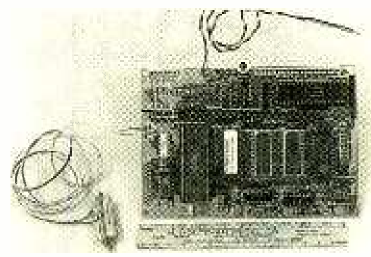
The board includes space for a real-time clock chip and an 8-channel A/D converter; external options include an I/O expander/isolator, cartridge memory system for remote data acquisition, D/A converter, power supplies, cables, memory IC's, etc.

The VIM comes with four memory sockets. The first is occupied by the BASIC interpreter; the second provides space for user programs in EPROM (16K maximum); the third is the EPROM programmer; and the fourth accepts a CMOS RAM IC (2K, 8K, or 32K, jumper selectable).

For speed-critical applications that require machine-language code, Sintec (the VIM's supplier) provides a system-monitor EPROM that allows you to examine and change memory, set and remove software breakpoints, configure the second RS-232 port, etc.

In addition, Sintec has a free terminal emulator that allows you to edit, load, and save VIM BASIC program files on a PC. And a $60 program called B-link allows you to create "structured" BASIC programs (without line numbers); B-link also compresses files, "pretty-prints" them, etc.

The Kit. The PC board is laid out well, is double-sided with plated-through holes, and contains silk-screened markings for all components. The kit comes with only one socket for the 64180; you'll probably want to add a 40-pin socket for the 8255 and 28-pin sockets for the memory IC's. You'll also need some connectors, a momentary-contact reset switch, and a source of DC power.



The Vitrax IX Microcontroller is built around a 6-MHz 64180 microprocessor and contains an 8K BASIC interpreter, as much as 32K of RAM, and a built-in EPROM programmer.

An unregulated 20-volt DC wall transformer will serve fine, as the board has space for a 7805 (however, that regulator is not included with the basic kit).

It took me about three hours to solder everything to the board, and another hour to get it up and running, due to RS-232 interface problems. I had no problems thereafter.

The ROM BASIC is fairly powerful, as shown in Table 1. Variable names consist of one or two characters; as many as 286 string and numeric variables can be defined. Numbers are stored in floating-point format; values may range from 2E – 20 to 5E + 18. VIM BASIC allows you to CALL machine-language routines, to PEEK and POKE memory lo-

(Continued on page 97)

Table 1—BASIC Language

Function	Command/Statement/Function/Operator
Arithmetic	ABS, EXP, INT, LN, LOG, SGN, SQR, +, –, *, /, ^
Branching	GOSUB, GOTO, IF . . THEN
EPROM Programming	COPY, EPROM, LOAD
Execution	CALL, CONT, CNTL-C, RUN, STOP, XEQ
Format/configuration	DATA, DIM, DIS, ENA, NEW, NEW*, RESTORE
Input	INP, INPUT, INPUT$, INPUT LINE, LET, PEEK, READ, ON INTERRUPT (OI)
Looping	FOR . . NEXT
Miscellaneous	FRE, RANDOMIZE, RND
Output	OUT, POKE
Print and list	CNTL-P, LIST, LPRINT, PRINT, !, REM, '
String handling	ASC, CHR$, INPUT$, INPUT LINE, INSTR, LEFT$, LEN, MID$, NUM$, STRING$, VAL, +
Trigonometric	ATN, SIN, COS
Logical operators	& (AND), @ (OR), % (XOR)

Circuit Circus

By Charles D. Rakes

UNUSUAL CIRCUITS, AND DESIGN AIDS

This month I would like to share a number of simple, but useful circuits, that might just make your next construction project or equipment repair job a wee bit easier.

Diode Matching Circuit. Our first test circuit came about when a number of matched silicon signal diodes were needed for a balanced modulator project. Since I wanted to match the diodes to within a few millivolts, the old "quick and dirty" method of using an ohmmeter to match the forward conduction of each unit was out. A 9-volt battery, two precision resistors, and a digital voltmeter, connected as shown in Fig. 1, proved to be a simple answer.

The two 2.2k resistors (R1 and R2) must be a matched pair—remember that at the rated value, a 5% unit can be off by as much as +/− 110 ohms. Their actual resistance isn't critical as long as they are of equal value.

Finding two 2.2k resistors of the same value isn't too difficult. Take at least a dozen 2.2k units and carefully read each value using a digital ohmmeter. Pair the two closest values for R1 and R2. With any luck at all you should be able to find at least one set of twins without going through too many resistors.

Using the diode matching circuit is easy. Connect a diode to each pair of test terminals and set the DVM, if it's not an autoranging meter, to it's most sensitive DC-voltage range. The meter reading will indicate the difference in the forward voltage-drop of the two diodes in millivolts. Note: Each diode must be allowed to return to room temperature after handling before a reading is taken. To prove a point grab either diode and watch the meter change as the temperature rises.

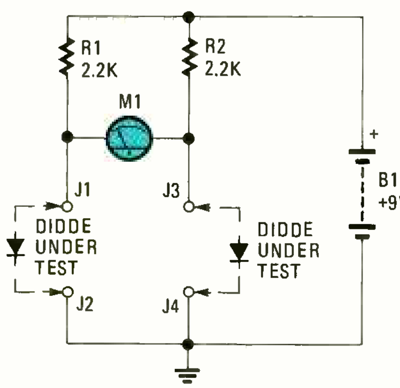


Fig. 1. This circuit can be used to match diodes for use in circuits where such a balance is necessary—a balanced modulator for instance. The Diode Matching Circuit will indicate the forward voltage drop of the two diodes in millivolts.

PARTS LIST FOR THE DIODE MATCHING CIRCUIT

B1—9-volt transistor-radio battery
R1, R2—2200-ohm, ¼-watt, 5% resistor (see text)
Digital voltmeter (see text)
Battery holder, alligator clips, wire, solder, etc.

Modified Matching Circuit. If a more-dynamic testing approach is desired, try the diode matching circuit shown in Fig. 2. The basic circuit is similar to the previous one; the main difference being the addition of a variable resistor, R4, which allows you to vary the current through the diodes.

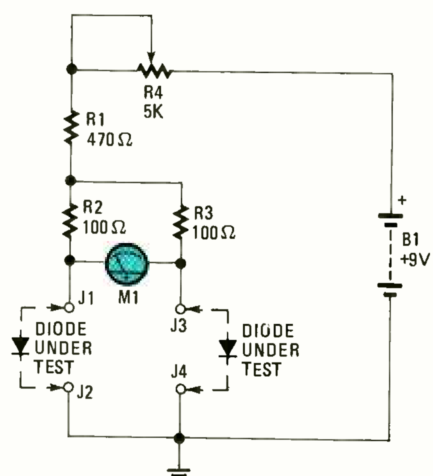


Fig. 2. If a more-dynamic testing approach is desired, try this modified version of the previous matching circuit. The main difference between the two circuits is the addition of a variable resistor, R4, which allows you to vary the current through the diodes.

That lets you compare the two diode's forward voltage-drop as the current flow is varied from less than 1 mA to over 7 mA. If the voltage changes very little over the current range, the two diodes are well matched in their forward voltage curve. Resistors R1 and R2 must be matched in the same manner as in the first circuit.

PARTS LIST FOR THE MODIFIED MATCHING CIRCUIT

B1—9-volt transistor-radio battery
R1—470-ohm, ¼-watt, 5% resistor
R2, R3—100-ohm, ¼-watt, 5% resistor, see text
R4—5,000-ohm, potentiometer
Battery holder, alligator clips, wire, solder, etc.

Oscilloscope-Based Matching Circuit. Our last diode-matching circuit, see Fig. 3, allows you to look at the forward conduction curve of both diodes simultaneously on an oscilloscope. A 6-volt transformer (T1) and diode D1 sup-

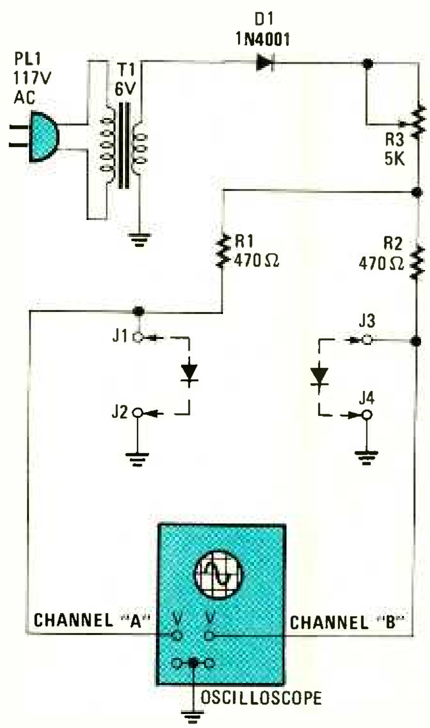


Fig. 3. The Oscilloscope-Based Matching Circuit allows you to look at the forward conduction curve of both diodes simultaneously on an oscilloscope.

PARTS LIST FOR THE OSCILLOSCOPE-BASED MATCHING CIRCUIT

D1—1N4001 1-amp, 50-PIV, rectifier diode
R1, R2—470-ohm, ¼-watt, 5% resistor
R3—5000-ohm potentiometer
T1—6.3-volt, 300-mA, step-down power transformer
Test terminals, scope, power cord, wire, solder, etc.

plies a pulsed positive voltage to the two diodes through a 5000-ohm potentiometer and two matched 470-ohm resistors.

The scope must have dual vertical inputs to connect to each of the diodes under test. The scope's vertical amplifiers can be used in either the alternate or chopped mode to display both waveforms together.

Here's how to set the scope up for the dual-waveform circuit. Set the gain of both vertical amplifiers to 0.2 volts per division. Place the vertical-mode switch to either the chopped or alternate setting. Set the horizontal sweep to 2 milliseconds-per-division. Set the scope's trigger to produce a horizontal line and adjust the trace of each vertical input to overlap and form a single line at the screen's center.

Connect the scope to the test circuit, re-adjust the trigger for a stable display, and if the diodes are alike the two waveforms will appear as a single trace. Resistor R3 sets the diode's forward current and can be adjusted during testing.

Crystal Tester. The next tester came about when our faithful old 75A-4 Collins amateur receiver failed to operate on the 20-meter band. A quick check of the receiver's schematic suggested that the crystal for the 20-meter band was sound asleep in its socket. Naturally our shop's crystal checker was nowhere to be found; so the circuit in Fig. 4 was quickly whipped together.

In that circuit, transistor Q1 is connected in a Pierce-oscillator configuration with the crystal supplying the feedback from Q1's collector to its base to produce and sustain oscillation. Actually that is what happens if the crystal under test happens to be good. A small variable capacitor, C4, allows the checker to cover a wide frequency range. Diodes D1 and D2 convert the RF to DC, lighting LED1 to indicate that the crystal is oscillating.

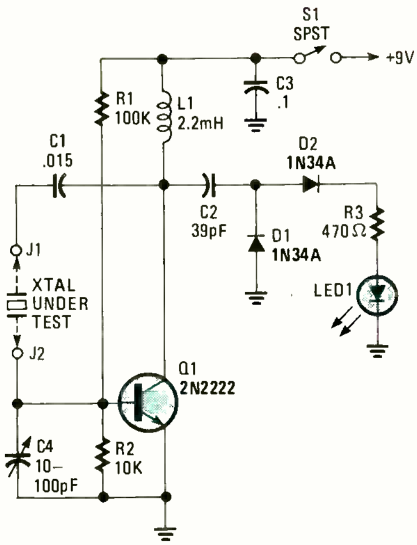


Fig. 4. In the Crystal Tester circuit, transistor Q1 is connected in a Pierce oscillator configuration with the crystal under test supplying the feedback from Q1's collector to its base to produce and sustain oscillation. If the circuit oscillates, the crystal under test is good.

PARTS LIST FOR THE CRYSTAL TESTER

Q1—2N2222 general-purpose NPN silicon transistor
D1, D2—1N34A general-purpose germanium diode
LED1—Jumbo light-emitting diode (any color)
R1—100,000-ohm, ¼-watt, 5% resistor
R2—10,000-ohm, ¼-watt, 5% resistor
R3—470-ohm, ¼-watt, 5% resistor
C1—0.015-µF, 100-WVDC, ceramic-disc capacitor
C2—39-pF, ceramic-disc, capacitor
C3—0.1-µF, 100-WVDC, ceramic-disc capacitor
C4—10-to-100-pF (or similar) tuning capacitor
L1—2.2-mH RF choke
S1—SPST toggle switch
Perfboard materials, alligator clips, battery and battery holder, wire, solder, hardware, etc.

The checker can be built breadboard style on perfboard and housed in a small plastic cabinet. Since there's such a wide range of crystal sizes used in electronics, two small mini alligator clips will serve fine as a universal crystal socket.

Using the crystal checker is simple. Connect the crystal to the tester and rotate capacitor C4, starting at its minimum capacitance value, until the LED lights. The circuit can also be used to check a number of the ceramic- and piezo-filter devices.

Magnetically Tunable Tone Generator. The next two circuits both use a permanent magnet to vary the inductance of a coil. The inductance value of a coil wound on a ferrite core is primarily determined by the number of turns of wire and the permeability of the core material. If a permanent magnet is moved toward a ferrite core, the permeability of the core will vary in relationship to the strength of the magnetic field and the inductance of a coil wound on the core will change accordingly.

The circuit in Fig. 5 uses an external horseshoe magnet to vary the frequency of an audio-tone generator. The tuning range of that circuit is about 2-to-1. Inductors L1 and L2 are wound on a ferrite core measuring ¼ inch in diameter and 4 inches in length. About any similar size ferrite rod will work in this circuit. A good source of ferrite material

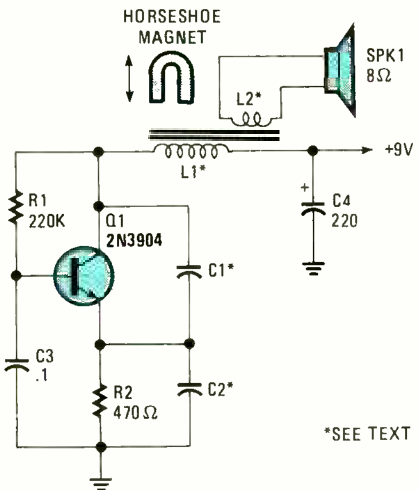


Fig. 5. This tunable tone generator uses a horseshoe magnet to vary the inductance of L1, thereby altering the output frequency of the circuit.

PARTS LIST FOR THE MAGNETICALLY TUNABLE TONE GENERATOR

Q1—2N3904, general-purpose NPN silicon transistor
R1—220,000-ohm, ¼-watt, 5% resistor
R2—470-ohm, ¼-watt, 5% resistor
C1, C2—See text
C3—0.1-µF, 100-WVDC, ceramic-disc capacitor
C4—220-µF, 25-WVDC, electrolytic capacitor
L1, L2—See text
SPKR1—4-inch, 8-ohm speaker
Perfboard materials, horseshoe magnet (with 1 to 2-inch pole spacing), 9-volt transistor-radio battery and battery holder, wire, solder, hardware, etc.

is Amidon Associates (12033 Otsego St., North Hollywood, CA 91607).

Inductor L1 consists of 70 feet of #26 copper wire wound on the ferrite rod from end to end. Inductor L2 is formed by winding 20 turns of #26 wire over the center of L1.

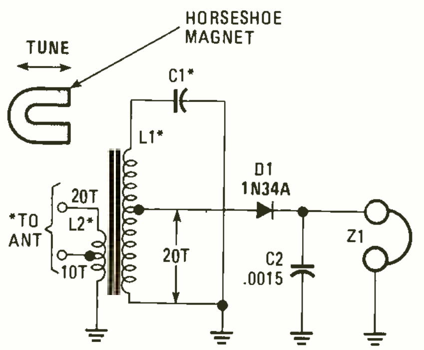
When a 1-µF, 100-WVDC Mylar capacitor is used for C1 and C2, the oscillator's frequency is near 1500 Hz. The frequency will increase to about 3400 Hz with the magnet touching the coil in a parallel position. The first effect of the magnet is noted at a distance of about 2½ inches.

The circuit can be used as a CW (code) oscillator and tuned for just the right sound with the magnet, or housed in a non-metallic cabinet and turned over to the kids as a fun noise maker.

By changing the values of C1, C2, and L1, the circuit in Fig. 5 can be turned into a variable-frequency RF generator. When a 2- by ½-inch, flat-bar, ferrite AM-broadcast antenna coil is used for L1 and two 680-pF capacitors are used for C1 and C2, the oscillator will tune from about 600 kHz to over 1.5 MHz with the same horseshoe magnet.

Magnetically Tuned Crystal Radio. Our next magnetically tuned circuit is by far the simplest of the lot and could be that first build-it-yourself project you've been looking for.

The crystal-radio circuit in Fig. 6 replaces the hard-to-locate broadcast tuning capacitor with a fixed capacitor and a horseshoe magnet. Just about any ferrite AM-broadcast antenna coil with a length of 2 inches or more will work in the circuit. Any small horse shoe magnet with a 1- to 2-inch gap between poles will do fine for tuning. The stronger the magnet the greater the tuning range.



*SEE TEXT

Fig. 6. In this unusual tunable crystal radio, the hard-to-locate broadcast-band tuning capacitor is replaced by a fixed capacitor and a horseshoe magnet.

PARTS LIST FOR THE MAGNETICALLY TUNED CRYSTAL RADIO

L1, L2—See text
C1—See text
D1—1N34A general-purpose germanium diode
C2—.0015-µF, 100-WVDC, Mylar or similar capacitor
Z1—2000-ohm (or similar) high-impedance headphones
Perfboard materials, horseshoe magnet (with 1 to 2-inch pole spacing), #26 coil wire, battery and battery holder, wire, solder, small knob, etc.

Take the selected ferrite coil and unwind twenty turns from either end and make a tap at that point and rewind the wire back in place. Over the same end of the coil (end where tap was made) wind 20 turns of #26 wire with a tap at the tenth turn. That winding will serve as the antenna and ground input for the receiver.

The receiver can be built breadboard style on a piece of wood or any non-metallic material. Use two plastic cable-mounting clips to secure the ferrite core solidly to the breadboard's base. Position the magnet, as shown in the schematic diagram, with each pole aimed at opposite ends of the ferrite core and at equal distances. If the magnet has a hole through the curved portion, a small knob can be attached to allow easier tuning of the circuit. Let the magnet lay flat on the breadboard's base and slide back and forth parallel to the coil.

Checking out the crystal set is easy. If a long wire antenna (50 or more feet) is available connect it to the tenth turn on L2; but if only a short wire is handy, connect it to the end of L2 farthest from ground. The receiver will perform best when the circuit ground is connected to a good earth ground.

It's unlikely that the receiver will tune the entire broadcast band with a single-value tuning capacitor, so try a 150 to 250 pF unit for C1, and see how much of the band can be covered. Without the influence of the magnet, the value of C1 will set the receiver to its lowest tuned frequency. As the magnet moves closer to the ferrite material, the frequency of the tuned circuit will increase toward the upper end of the broadcast band.

Well that's about all the space we have for this month, but be sure to join us next time when we'll present another batch of entertaining circuits. ■

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CARL BARONE,
NRI PROGRAMMER/ANALYST

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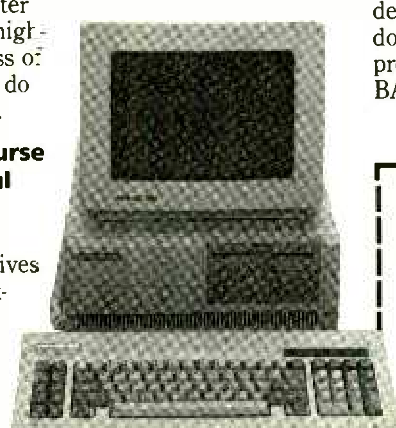

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DX Listening

By Don Jensen

A NEW TRANSMITTER FOR NEW ZEALAND

It has been a long time coming, but New Zealand has finally committed itself to a new and powerful shortwave station.

The new *Radio New Zealand* will be broadcasting from a 100-kilowatt shortwave transmitter at Rangitaki, a site on the Pacific nation's North Island.

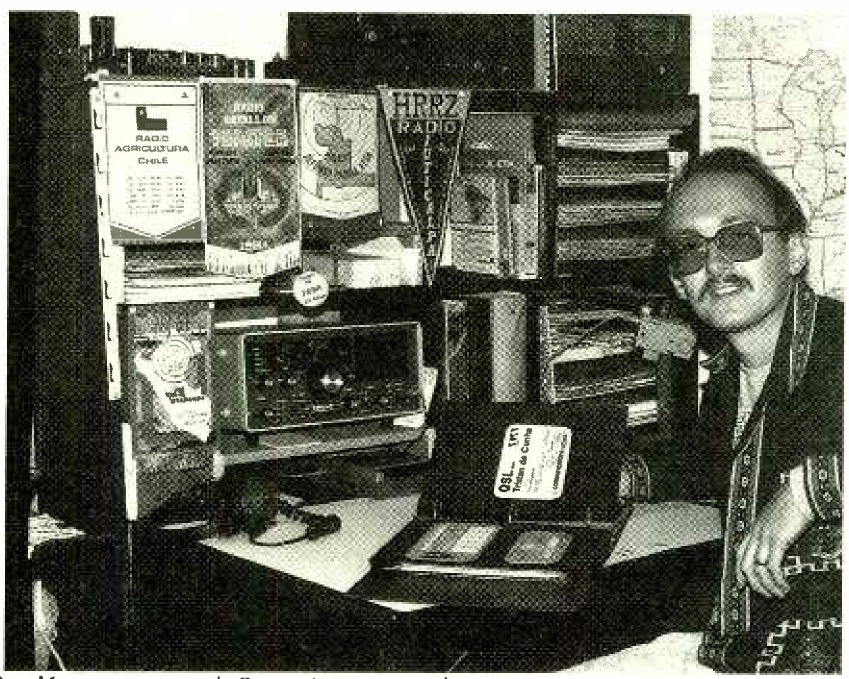
As longtime readers will recall, I've mentioned Radio New Zealand's shoestring SW operations on several occasions in the past few years. While other Pacific rim nations—Japan, China, the Koreas, Australia—project powerful shortwave signals throughout Oceania, New Zealand made do with a pair of hopelessly underpowered seven-and-a-half-kilowatt, World War II vintage transmitters.

Despite the official policy of projecting a New Zealand presence in the Pacific from Papua, New Guinea to the Cook Islands, government after government since 1948 have left the broadcasting organization to scrimp along with inadequate funding. In fact, in 1982, Radio New Zealand shortwave nearly vanished from the air when the then-government chopped a $200,000 a year subsidy. By pinching pennies, the shortwave service stayed on the air, but barely.

The government, however, was acutely embarrassed several years ago, when during internal disturbances in Fiji—an island nation that New Zealand has long considered in its sphere of influence—listeners there had to rely on *Radio Australia* shortwave for newscasts. New Zealand's shortwave signal was simply not reliable in the crisis.

Now though, NZ Foreign Affairs Minister Russell Marshall notes, "We are now putting our money where our diplomatic mouth is...at last!" The foreign ministry will come up with the money, $3.2 million, for the new transmitting equipment and will also provide $1 million in annual operating expenses. Radio New Zealand will continue to provide the programming. They have always been a particular favorite of SWL's, mostly because of their low key Pacific-oriented English language programming.

The news from New Zealand does not say when the new 100-kilowatt station will go on the air, but it probably will be within a year. In the meantime, though Radio New Zealand isn't the easiest shortwave station to hear in North America, you may have success if you try tuning 9,850 or 11,780 kHz during the early morning, 0900–1200 UTC time period. Weekends you may find RNZ around 0500–0730 UTC on 17,705 kHz.



Don Moore gets around. Currently teaching college in Big Rapids, MI. Don has traveled extensively in Central and South America in recent years, visiting many of the stations he has heard with his FRG7 shortwave receiver. Note the attractive station pennants he has picked up in his journeys.

Feedback. Comments, questions about SWL'ing and your logging of shortwave stations you've heard are always wanted. Write to me, Don Jensen, in care of *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Comment comes in two varieties—favorable and not-so-favorable. Some of the mail that comes across the desk here is in the latter category.

Example: A letter from Milwaukee, WI, listener Richard Mielke.

"I have been an SWL for 26 years and am an old **Popular Electronics** reader. I must say that the columns have done me almost no good. Listening to shortwave varies so much from area to area. Time and frequency information in magazines does not indicate that some programs are for the east coast, some for the west coast.

"I think that in putting your column together, care should be exercised as far as being accurate on time. You should know which months schedules change, when summertime hours start, and not have to say that the stations often change without notice.

"Many listeners could probably be helped by just having them write a short note to any station they want to hear and ask for a schedule. I have found they are all willing to tell you where and when to tune them.

"Lists of loggings and suggested schedules should be based on using a simple receiver. Not many people have receivers with filters, notches, or computers to fish a signal out of many on the bands. Listening conditions have deteriorated over the years, with many sta-

*CREDITS—John Campbell, England; Al Gastle, Ontario, Canada; Richard D'Angelo, PA; William Sparks, CA; Ontario DX Association, P.O. Box 161, Station A, Willowdale, Ontario M2N 5S8, Canada) tions added to crowded bands, with higher power, sloppy control of signals, and lack of consideration for other stations."

Richard ends his letter with a "welcome back" to **Popular Electronics** and his hope "that *DX Listening* improves."

I appreciate the comments, Richard. Constructive criticism helps us improve and we all want that! In putting together a magazine column, there is one basic problem that no one has yet figured out a way to lick. It is that it takes quite a while to put each issue together, from the early editorial planning until the magazine turns up on the newsstand. Therefore, this column is being written a number of months before you read it.

Things change much more quickly on the shortwave bands. Hence, sometimes a station will have moved to another frequency between the time the information is typed in the column manuscript and the time you read it.

I do take care in selecting the frequencies and times noted in the "Down the Dial" portion of the column, but sometimes, unavoidably, the frequencies will be different by the time you get your issue of **Popular Electronics**. Usually, you will find the major international broadcasters on other frequencies, often in the same band, if you tune around a bit.

Major SW stations do make wholesale frequency changes not just at summertime but four times a year, usually the first Sunday in March, May, September, and November. But individual frequency changes can occur at any time a station feels the need to shift frequency to better serve listeners in a particular part of the world.

You're correct, Richard, that getting on a station's schedule mailing list is a very good way of getting advanced information as the station makes its frequency decisions.

Another consideration some readers fail to appreciate is that there is no typical reader of this column. Some of you are beginners at shortwave listening, with but the simplest of listening equipment. Others are more experienced SWL's and have somewhat more sophisticated receivers. Thus the stations listed in this column range from the easy-to-hear to the rather difficult. Some may not, as Richard suggests, be audible on the west coast of North America at the time they can be heard on the east coast.

What I try to do is offer just a sampling; hopefully a bit of something for everyone. Don't expect to be able to tune every station, every time, on the frequency and hour listed. You may hear it at another time, on another frequency.

Experienced listeners like Richard usually belong to DX clubs whose monthly (sometimes twice-a-month) newsletters can include much more current and complete schedule and frequency information. And with club members all over the world reporting, it is normally easy to determine when you, wherever you live, should be able to hear a particular SW station. Check recent *DX Listening* columns for information on joining those shortwave clubs.

And, yes, Richard, the SW bands are crowded with high-powered stations that many times do interfere with one another, probably to a greater extent than when you began listening 26 years ago. That, unfortunately, is life on the SW bands in the 1990's. Surely, though, it need not sour anyone on SWL'ing. There is plenty—in fact, more than ever—to hear and better, and in some cases cheaper SW receivers on the market today than there were when both of us began listening years ago!

Down The Dial. Let's focus on some of the Pacific area stations, besides Radio New Zealand, which are being reported by SWL's:

Cook Islands—11,760 kHz. *Radio Cook Islands* recently was reorganized, according to a visitor to Rarotoga, the tiny nation's capital. It's schedule is 1600 to 1000 UTC (Universal Coordinated Time is equivalent to EST + 5 hours; CST + 6; MST + 7; and PST + 8). Several of our reporters note, however, that the best time may be between 0700 and 0930 UTC.

Tahiti—15,170 kHz. *Radiodiffusion Francaise D'Outre Mer* (RFO), the French-operated shortwave station at Papeete uses this frequency, plus 6,135, 9,750, and 11,825 kHz. It can be a tough logging but try to catch it around 0300–0430 UTC.

New Caledonia—7,170 kHz. Another French RFO station broadcasts from Noumea. Tune around 0700 UTC and later.

Tonga—5,025 kHz. Station 3AZ is the newest of the shortwave voices in the Pacific and certainly the hardest to hear in most of North America. Try around 0700–1000 UTC ■

Ham Radio

By Joseph J. Carr, K4IPV

IS YOUR HOBBY HAZARDOUS TO YOUR HEALTH?

The signal from an amateur-radio transmitter is an electromagnetic wave that is identical to ultraviolet (UV) light, X-rays, and gamma rays, but it has a different frequency and wavelength.

There is no controversy about UV, X-rays, and gamma rays—all are dangerous. There is also no controversy when it comes to microwave radiation. Stories of microwave hazards abound among electronics workers—and cardiac pacemaker wearers are especially at risk.

But prior to about 10 years ago, RF radiation below the microwave region was thought to be essentially harmless. Oh, sure, a few cranks on the fringe claimed that problems existed, but they were not the "experts." Some early studies on the subject were highly flawed, so they produced inconclusive results. Now, however, a different picture is emerging, and some of the best biomedical experts in the country are concerned about the negative effects of low-frequency radiation including 60-Hz from the power lines.

How much is too much? At one time the standard for permissible exposure was 10 mW/cm^2 for continuous periods of six minutes. In more recent times, the ANSI (American National Standards Institute) standard (see Fig. 1) has been adopted by many organizations. That standard takes note of the fact that VHF/UHF seems somewhat more dangerous than lower frequencies (probably due to resonance effects).

The standard in the 30- to 300-MHz VHF region is 1 mW/cm^2. At UHF (300 to 1500 MHz) the standard calls for a maximum exposure of $f/300$, where f is the frequency in MHz. That translates to 1 mW/cm^2 at 300 MHz, and 5 mW/cm^2 at 1500 MHz and higher.

In the HF (shortwave) spectrum used by most hams, the ANSI limit is $900/f^2$ mW/cm^2, where f is once again the frequency in MHz. Thus, the standard is 100 mW/cm^2 at the low end of 80 meters and 1 mW/cm^2 at 10 meters. The standard at frequencies below 3 MHz is 100 mW/cm^2.

The standard was based on the observation that bioeffects started to take place at a specific absorption rate (SAR) of 4 watts per kilogram of body weight; once a suitable safety factor was added, the allowed SAR was set at 0.4 watts per kilogram of body weight. The current standard updates the old 10 mW/cm^2 standard by taking frequency into account, and is for exposures of six minutes or more. It is probable that the standard will be revised again later this year.

It is not yet clear which amateur-transmitter and antenna installations are likely to exceed the permissible dosage rates. In order to be certain about the field strength at any given installation, calibrated field-strength measurements must be made. The instrument required for that type of measurement is expensive, although not so much so that larger ham organizations cannot afford it. At least one amateur operator has spent his own funds to obtain such an instrument. In addition, it is possible that some enterprising souls will make the investment and go into the business of making measurements for hire.

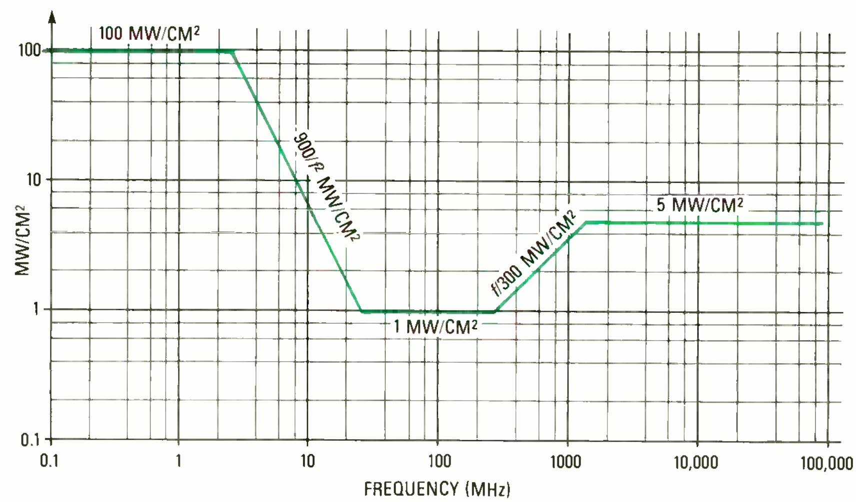


Fig. 1. The ANSI standard allows greater RF-exposure levels at lower frequencies and is for exposure times of six minutes or more.

What to Do. Although detailed measurements may not be available to you, there are some guidelines that you might want to follow in normal amateur-radio operations:

First, limit transmitter RF-output power to what is actually needed to make communications. All modern transceivers have a control that allows you to crank down the power level; either the AUDIO or MIC control when operating SSB phone or the CARRIER control when operating CW (Morse code).

Although I personally don't believe that my 100-watt HF transceiver is dangerous, I'm only going to turn on the kilowatt linear-amp when it is needed... and then only at whatever power level is needed to actually make good contact. Incidentally, that is not only possibly healthier, if you'll check FCC regulations you'll see that it is also the law! And if everyone followed that law, the QRM (man-made interference) levels on the bands would drop tremendously!

Second, limit the time of transmission, especially in the VHF/UHF region. That is also good practice for ordinary operation, never mind the health benefits. Time and again operating experts (especially big-gun DX'ers) tell us that we get the most out of our rigs by listening more than transmitting. Although police and commercial users of mobile and hand-held radios tend to make short transmissions, hams tend to rag-chew on and on, and are therefore subject to greater exposure.

Third, don't use a high power linear-amp on VHF/UHF bands unless there is a

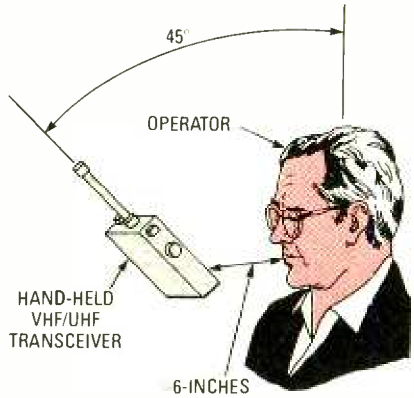


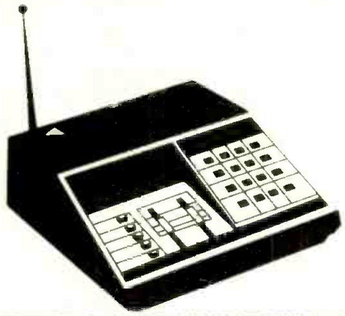
Fig. 2. When operating a handheld VHF/UHF transceiver, keep the unit at least six inches from your face and cocked at a 45° angle.

good reason to do so. According to one source, the high-powered 2-meter 150-watt mobile "brick" in the trunk, feeding an antenna on the trunk lip, will produce dangerous radiation levels for passengers in the back seat. Children are especially at risk (because of their lower body weight), and they are the very ones placed in the back seat of most family automobiles. To protect them, lower the power level and move that antenna to the roof of the car.

Some readers may make the argument that they "need" 150-watts on 2-meters mobile in order to "get into the repeater solid." That, I trust, means "full quieting" and more from 50 *klicks* out. But in truth, one does not need full quieting for effective communications. Repeaters tend to be very sensitive receivers, so they can be triggered within sensible range with a lot less power.

Fourth, when operating a VHF or UHF handheld transceiver, be sure to keep it at least six inches away from your face, and keep it cocked at a 45° angle (see Fig. 2). That's the advice given by a major supplier of commercial and police hand-held units to its customers, but it also applies to amateur 2-meter (and up) hand-held rigs as well. It seems that placing a 1-watt to 5-watt hand-held unit "rubber ducky" antenna close to your head does a good job of irradiating the temporal lobe of your brain. That problem is greatly reduced by correct operating procedures.

There is no reasonable doubt that RF radiation is at least a potential hazard. To deny or ignore that potential would be foolhardy, especially since most of the danger can be avoided by following correct operating procedures and common sense. ■



Scanner Scene

By Marc Saxon

PRO-2005: A NEW-AND-IMPROVED PRO-2004

There's no getting away from the fact that the most talked about scanner of 1989 was the 300-channel *Realistic PRO-2004* from Radio Shack. With the exception of some UHF-TV channel-spectrum and the 800-MHz cellular bands, it covered from 25 to 1300 MHz. With a few very minor modifications, users could quickly increase the number of channels in the PRO-2004 to 400, and also restore the missing 800-MHz-band coverage.

The PRO-2004, however, has been removed from the market and replaced by the new *PRO-2005*. Like its predecessor, this scanner costs about $400 ($419.95 to be precise). The question of the winter has been, "What's the difference between the two units?" Other than a significantly redesigned exterior, the biggest difference seems to be that the PRO-2005 comes all set up with 400-channel capability. Although it doesn't come-off-the-shelf with the ability to receive the cellular channels, I understand that they can be made to work in a manner essentially the same as the earlier model.

From an external point of view, the former set's sloping front panel has been replaced by one that is vertical; however, front "legs" beneath the set allow the user to angle the front of the PRO-2005 upward if desired for a better view of the LCD readout. The keyboard has also been changed, with the previous flat piece of plastic replaced with "real" individual pushbuttons.

Realistic's new PRO-2005 offers all the "pro's" of its predecessor, the PRO-2004, plus 400-channel capability built-in to a redesigned exterior.

If you thought the PRO-2004 was fantastic, this newer edition will equally impress you. On the other hand, if you are using a PRO-2004 and have it modified for 400-channel operation, there isn't sufficient cause to dump the older set and replace it with the current model. Still, if you have neither of the two models and are seeking the unit that many serious monitors swear by, then you'll certainly want to put the new Realistic PRO-2005 at the top of your shopping list. We like it a lot!

By the way, I can still supply information on how to increase your PRO-2004 to 400-channels, and also how to activate the missing 800-MHz frequencies in those scanners. We recently received information on how to restore the missing 800-MHz-band frequencies in the *Bearcat BC-760XLT*, and can also supply that (although Uniden does not recommend doing such modifications to any of their scanners). Any of these modifications can be obtained from this column upon request (specify which you want) along with a stamped, self-addressed return envelope. Send for them at the address at the end of this month's column. And, yes, we can still supply cellular-restoration data for the Realistic *PRO-34* handheld scanner.

Hey, Taxi! An interesting question was posed by Harry Waggenheim of California. Harry notes that in all commercial two-way services where repeaters aren't used, the base stations and mobile units operate in simplex mode; that is, with the bases and mobiles on one frequency. The one notable exception is the Taxicab Radio Service, where base stations operate in the 152.27- to 152.45-MHz band, while the mobiles operate on frequencies in the 157.53- to 157.71-MHz band. He was curious about why that service was set up in such a manner.

My first guess would be that it reduces the amount of stations using the often-crowded dispatch channels. Second, unlike many other users of two-way radio, mobile units seldom need to hear one another in order to coordinate their activities.

I posed the question to the owner of

a fleet of taxis, and, while he agreed with my guesses, he pointed out that the owners simply didn't want the drivers tying up the channels chit-chatting with one another about "nonsense"—making arrangements for coffee breaks, etc. Moreover, he pointed out that the owners most especially did not want the passengers subjected to a constant stream of such idle chatter along with the mix of colorful and salty language often used by drivers.

In fact, he told me that many customers don't like hearing the two-way at all while they're riding and request that his drivers turn off the two-way radio. Some people feel it interferes with their conversation with other passengers, and others just find it generally annoying to be held captive in a taxi while a disembodied voice barks commands to various vehicles.

So, in the case of taxicabs, the radio service was somewhat custom-tailored to suit their rather unique needs. But remember that there are also UHF taxi channels where, in some cases, repeaters are in use. Apparently in major metro areas (where UHF taxi channels are most used) the cash customers are treated to all of the chatter, which is a trade-off for the safety, security, and anti-crime benefits of the drivers being able to contact one another in a hurry.

QSL's? Readers constantly ask if it's possible to verify (QSL) stations monitored on their scanners. In many instances it is; however, don't expect to dash off a reception report and get a fancy QSL card back.

Two-way communications stations aren't broadcasters. They don't seek an audience, and very often don't appreciate having one. That means they don't have QSL cards to send out, and might be just as annoyed to find that you asked for one as they were to learn that you were listening in.

Therefore, a reception report should mention only that communications between specified units occurred at certain times, but shouldn't mention the details of what those communications contained. If you prepare a postpaid return QSL card for the station to just sign and return to you, you could get lucky. You might (as others have) eventually develop a rather successful technique that will bring you a good percentage of returns from most categories of stations—except possibly some federal-agency operations in the law-enforcement and security fields. ■

COMPUTER BITS

(Continued from page 85)

VENDOR INFORMATION

Vitrax IX Microcontroller ($169.50 for basic kit)
Sintec Company
P.O. Box 410
28 8th Street
Frenchtown, NJ 08825
Tel. 800-526-5960
201-996-4093
CIRCLE 117 ON FREE INFORMATION CARD

cations, to read and write I/O ports, and to process interrupts (the VIM has four hardware-interrupt inputs).

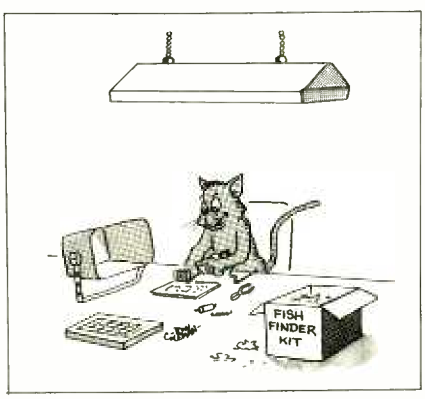
After you write and debug your program, you can burn it into an EPROM, after which the VIM will automatically execute that code each time it boots. This means that when your program is finished, you won't need to connect a terminal to run it.

The VIM comes with detailed instructions on kit construction, how it works, the BASIC interpreter, use of terminal and printer ports, and more. Supplements include copies of manufacturers' data sheets for the IC's.

My only complaints are that I wish the VIM could burn EEPROM's and that it had a C language interface, but those are small points. All in all, the Vitrax IX Microcontroller is perfect for industrial control, science projects, and just plain tinkering.

Let 'em know you read about it here.

Contest Update. No, we have not forgotten about the Pascal Program Writing contest. When the contest was announced back in August, we promised to announce the winners in this issue. Unfortunately, due to publishing schedules, this column had to be written before the contest deadline had passed. So, in fairness to everyone, we've decided to hold off the announcement until next month. Be sure to check in with us then. ■



DIGITAL COURSE

(Continued from page 93)

Let's further assume that R2 and R6 have a resistance equal to the dark rating of the LDR's (0.5 megohms). That means that under no-light conditions, the same voltage level is applied to both inputs of each comparator. Now recall that we stated earlier that if the signal applied to one input exceeds that applied to the other, the output of that device toggles to one of the extremes (high or low), depending upon which input of the comparator is at the higher potential.

With the scenario just outlined, the output of each comparator is at ground potential. (That's not really true, but it is convenient for the sake of discussion). If you were to shine a light on R5, its resistance would decrease, causing most of the supply voltage across that leg of the circuit to be dropped across R5. That means that the voltage at the non-inverting input of comparator U1-b is at a lower potential than the inverting input, which would cause the output of U1-b to go negative.

Since no light has been focused on R4, the two inputs to U1-a remain equal, and therefore that unit does not produce an output. If you did shine a light on R4, the output of U1-a would also go negative.

Now let's set up the circuit shown in Fig. 6, and check out the operation of the two comparators. Plug in your own values for R1–R3, and R6, making R1 and R3 equal and the resistors connected to the LDR's equal to the LDR's full-light resistance (about 100 ohms). Apply power to the circuit with the power supply featured earlier in this series, and note the output condition of each comparator, using a multimeter.

Now cover one of the LDR's so that no light radiates on it, and observe the change in output states. Reverse the positions of one LDR and its associated series-connected resistor, and repeat the experiment. Try connecting the R1/R3 junction to the positive input of one comparator, and the LDR/fixed-resistor combination to the negative input of that comparator. Again repeat the experiment. Note all observations.

What conclusion can be drawn from the data collected? How can the circuit in Fig. 6 be used in circuits of your own design? Try experimenting with the knowledge that you've gained, and see what you can come up with. ■

THINK TANK

(Continued from page 29)

under test, and then apply the probe to the output of each stage. When you lose the signal, that's where your problem lies.

I built the circuit into a small plastic toothbrush holder and used a nail for the probe. The unit stays in my tool box, and I find frequent use for it. I realize that there isn't too much to say about it, but it's really just that simple. Still, it's got to be worth a Fips Book, right?

—Thomas Schloeder, Van Nuys, CA

Okay Tom. You're right, it's simple and concise, and also is very useful. The only thing I can suggest by way of improvement, would be the addition of a small SPST switch in series with the battery. While current drain is minimal, I'd like to be able to turn the battery off when it isn't in use.

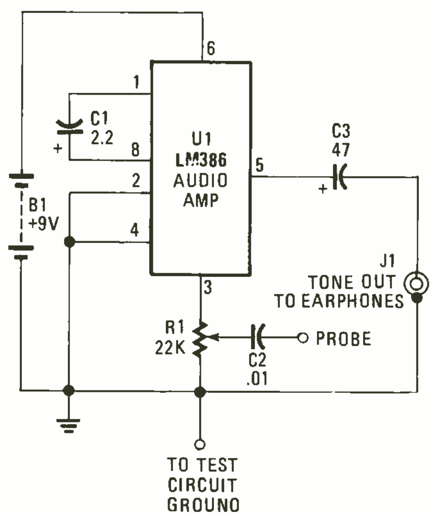


Fig. 8. The Signal Tracer circuit presented here is essentially a variable-gain amplifier.

Turn On (and Off). Byron, I've been meaning to submit this night-light circuit for some time, and when I read that you're running out of Fips Books, I decided to do it now. I originally built this circuit (see Fig. 9.) several years ago and it has provided excellent service ever since. It can be permanently installed, and requires very little in the way of operating power.

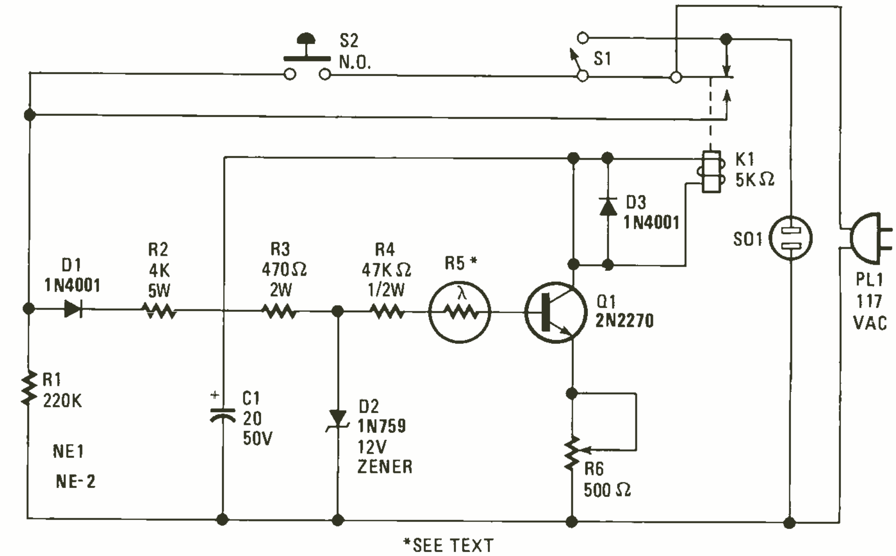


Fig. 9. This circuit is little more than a light-dependent switch circuit that's used to trigger a relay, which in turn feeds AC power to the device connected to the socket (SO1).

You can use the lamp normally by closing S1. A voltage divider (formed of R2 and R3) along with Zener diode D2 are used to obtain the voltage required. The Zener provides a stable base voltage for transistor Q1, which should be set to trigger at dusk.

I hope that circuit qualifies for a book?

—Robert N. Jennings, Woodlynne, NJ

It's on the way, Bob. We sure could have used a bit more in the way of descriptive text, but I'm hoping that other, more windy contributors will take up some of the slack!

Okay guys, that should fill all the empty space for this month. But next month, there will be another batch of empty pages. You can help us...and yourself...by sending in those circuits. Just mail 'em to *Think Tank*, **Popular Electronics,** 500-B BiCounty Blvd, Farmingdale, NY 11735. ■

SONIC EMULATOR

(Continued from page 34)

channel's V/DIV selector switch to 20 mV/div. Input the signal source to either the left or right input, and set the PHASE control (R16) to 12 o'clock. Slowly adjust the BIAS control (R11) until a replica of the input waveform appears on the scope trace. The PHASE control (R16) will interact with that adjustment, but there will be an optimum position where the delay-line window will stay biased throughout the rotation of the PHASE control.

If you own an AM/FM-cassette car or home stereo with line outputs and a power amp, or stereo (or any installation with phono jacks and available power), then hookup is a matter of placing this device in the tape or CD loop. The effect can also be recorded for playback on any other system simply by inserting it ahead of the recorder input. Note that there is no power switch *per se*; a switched B+ line from an in-dash tape deck or power amp is the intended hookup.

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IRON CURTAIN

(Continued from page 77)

black-market re-sale, a good source of secondary salary.

An Edge. Often one has to turn to friends and relatives for parts. My grandfather worked at a facility that *did not have a name*, yet occupied about five street blocks near the center of Moscow. He told me that they were designing airplane turbines. It was clear enough that those were not civilian airplanes. Every month I would make my grandfather a list of the parts I needed, always ending it with a phrase: "And whatever else that looks good." A few weeks later he would come home with a long-awaited cardboard box wrapped in newspaper containing all sorts of goodies. I was considered very lucky by my fellow electronics buffs.

Military institutions in the Soviet Union are well funded, and the boxes I got were living proof. I acquired rugged 24-volt power supplies, mercury switches embedded in a web of chips and resistors, alphanumeric displays, and non-polarized electrolytics, which were impossible to find anywhere else.

Once I came across a small lead box which was soldered all around, except for a 12-pin connector in one side. There was a radiation danger symbol on it. Hack-sawing the top off revealed a mass of dirty-yellow paraffin. I melted it off and discovered a number of sealed black boxes that looked like relays. All had cryptic English abbreviations on them. To this day I wonder what it was; whether it was actually radioactive, or if it was simply a cover-up for stolen Western technology.

Another connection I had was a distant uncle named Boris, who never ever mentioned his type of employment. Later I found out, from another uncle, that Boris worked for KGB's Department of State Communications. That department is responsible for all the communication equipment used by government agencies. He managed to carry out more than 50 IC's for my projects, most of them were made by Motorola or NEC. Boris was naturally quite reluctant about stealing electronics from the KGB, and it took some family pressure to make him do it.

Entering the Black Market. Of course, my friends helped me with my hobby, too. When I was about fifteen years old, I got hold of two circuit diagrams: one of a ping-pong style video game, and the second of a 100-watt amplifier. The diagrams were hand-drawn, and lent to me for only one day. Judging from the condition of the paper, they had gone through hundreds of hands already. Determined to build them, I re-copied them on a large sheet of drawing paper.

By then my grandfather retired, and Boris was *transferred* out of Moscow! The TV repair shop, and the hobby shop were of no help either. Besides, the projects required crystals, chips, and speakers, so it became necessary to visit the Black Market. Here in America I could just get in the car, drive three miles to a Radio Shack, and buy everything I need; in Russia that was not an option.

Supply and Demand. Do not get me wrong, there are parts inside the electronics shops in the USSR, and they are usually *less* expensive than those in the US, however, while it is common to see a counter full of 1-, 2-, and 5-ohm 1-watt resistors, (each for five kopecks—about two cents), any value above 100-ohms would be a find. That is a common problem with all Soviet consumer goods as well as electronic components. Not enough popular parts are manufactured. Also, most of the parts will simply never make it to the store. They either go to the KGB, Defense Department, or to research institutes, or are stolen for black market re-sale.

While the supply of electronic parts for retail purposes is small, the demand is great. Hobby electronics is more popular in the Soviet Union than it is in the US. There are official district clubs, unofficial groups, and, of course, individual experimenters. Despite the deficit of literature, the scope of projects is as broad as you will find in the pages of American electronics magazines.

The government's rationale for restricting the free flow of electronics information is the same as it is for restricting the sales of shortwave receivers, and making computers and photocopy machines unavailable. The well-known truth, that knowledge, or information, equals power, was troubling for the government. So today, with the advent of *Perestroika* and *Glastnost*, electronics buffs in the USSR are getting a break. The black market, for example, has been legalized to some extent. That means more project books on the shelf, more parts at the counter, and, perhaps, no more dumpster-scouting. ■

POWER SUPPLY CIRCUITS

(Continued from page 41)

below 1.25 VDC due to the minimum voltage required across R1 to maintain the LM317's bias. The filter capacitors are shown with typical values. They will filter out higher frequency noise and transients that might disturb the operation of the load.

The LM317, which is similar in appearance to a power transistor, comes in in a TO-3 case, and is designed to sustain up to 1.5 amps of load current. Use a heat sink with the LM317, or mount the component's case to the metal chassis of the supply (insulate the case from the chassis). Be very careful when mounting the TO-3 case since it acts as a terminal for the device. If the case should short to the chassis, the DC output voltage will be shorted and blow the AC input fuse, if any.

Conclusion. Power supplies convert AC line voltage to some desired value of DC voltage. Although supplies vary in size, shape, efficiency, weight, and output, there are sections common to every supply. An unregulated supply needs a transformer to generate a secondary AC voltage, a rectifier to change AC into pulsating DC, and a filter to remove the pulsations from the DC. That is the simplest and least expensive supply, but the DC output will vary with the load and AC input. A regulator will reduce the efficiency of the supply (regulation disipates some energy), but the DC output is very stable even with changes in load and AC input voltage, and regulated DC is virtually free of ripple.

Take every precaution to protect electronic components from heat and accidental short circuits. Heat sinks carry excess heat away from regulators to keep them cooler. Fuses protect the supply and the load from shorts and current surges. Use "slo-blo" fuses when the supply drives heavy loads like motors, relays, and heaters. A fast-acting fuse should be used to protect sensitive electronics that can not tolerate any sort of surge. With some practice, using and building power supplies will be easy and straightforward. ■

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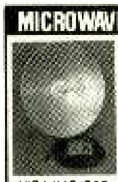

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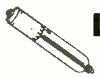

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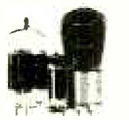

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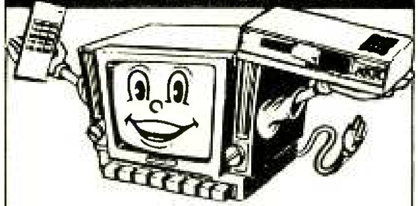

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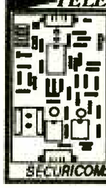

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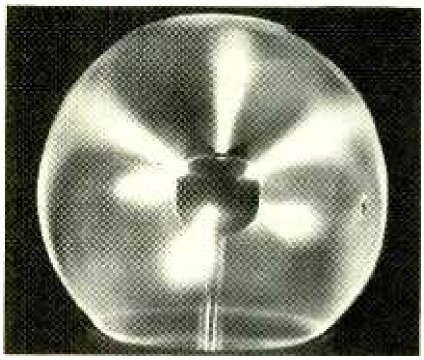
PLASMA DISPLAY

(Continued from page 68)

trical connection won't set you back too much.

Once the glass blower was done, the flasks were evacuated as far as possible (roughly 2 mm of Hg remaining), heated with a hot-hair blower to remove impurities from the inside walls, and filled with neon or xenon to approximately 70 mm Hg. The glass tubing was then melted off with a propane-oxygen torch. The flasks were truly vacuum-tight.

Finally, I hit upon the design shown in Fig. 8. In it, a second, small globe is



The display generated by the neon-filled 6-liter globe is quite impressive.

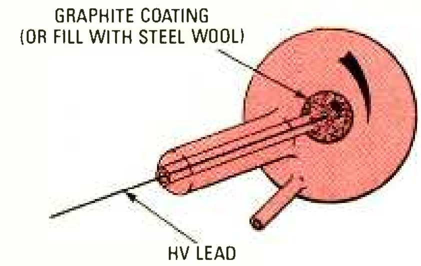


Fig. 8. This design proved to be the best of all. A second globe was blown within the first and was either coated with graphite or filled with fine steel wool.

blown inside the first; a narrow channel links the inside of the small globe to the outside world. That design allowed me to eliminate the internal electrode. Instead, the inside of the inner globe was coated with graphite and the graphite was dried on, or filled with steel wool, and a wire was placed into it. That serves as the electrode and works fine through the glass wall.

Different sized round-bottom flasks can be used for your globes. I tried 1-, 2-, and 6-liter flasks. For the type of globe shown in Fig. 8, the 2-liter size worked well and was not too expensive.

Other Considerations. Discharges in the globes can be influenced by changing the ground situation in respect to the globe. Any grounded object coming close has an influence. Changing the supply voltage also has an influence. A dimmer can be used to diminish the discharges. A normal dimmer, however, is not meant to regulate inductive loads such such as the plasma globe power-supply (flyback) transformer. It will probably work for a while and then burn out, because the return current from the transformer will eventually destroy the SCR. You may be able to solve the problem with a diode across the transformer.

That brings you up to date on my experiments. That doesn't mean that I am done, however. I plan to continue my experiments, and I encourage you to do the same. But remember: **The voltages involved in these units are dangerous and must be treated with respect. Furthermore, manufacturing the display globes is a tricky and hazardous operation that must be done with care. Before you perform any of these experiments, consider your personal safety first and foremost. If you are unsure of what you are doing, seek out someone with appropriate experience to help you.** ■

NAVplus

(Continued from page 81)

NAVplus. Charting coordinates from a Loran receiver onto a map is a chore that is impractical, if not impossible, to do on a "continuous" basis. And that's where NAVplus comes in; NAVplus is a software package that turns a Macintosh computer into a nautical chart.

The system requires a Macintosh plus or higher, and a mouse—no keyboard is required. The NAVplus program comes with an operating manual and one "charting area" (*e.g.* a region of interest encoded on a diskette)—additional areas are available. Charting areas come in two sizes: *offshore* and *detailed*. Offshore charts cover a broad area such as an entire coastline, and contain less detailed information about things such as ports and harbors than a detailed chart would. All charts have the same numbers and markings as government charts.

Operating NavPlus. After inserting the program disk into a Macintosh connected to a Loran receiver, some general information appears on the screen. Using the mouse to select the OK option, a menu appears on the screen. Under the FILE icon, you would then select OPEN CHART and insert the charting-area disk. Almost instantly, the chart appears on the screen, complete with navigational-aids (symbols and data) and a flashing indicator for your vessel's current position. By placing the pointer on any of the special symbols and pressing a mouse button, a box pops up with a complete description of the symbol. Selecting LEGEND at the top of the screen provides you with a complete list of navigational symbols.

One of NAVplus' best features is the ability to zoom into or out of any selected area. Any area can be zoomed-into multiple times—the more you zoom-in, the more details and aids appear.

To plot a course you select NEW COURSE and place the pointer at the start of the course and "click" the mouse—that becomes your first "waypoint." You continue to plot waypoints along the route to your destination, being careful to mind the navigational aids. You then store the course and get under way. The pointer continuously displays your actual position along with the plotted course, allowing you to follow it closely. On your return trip you can either plot a new course, plot your actual original course in reverse, or simply follow your originally stored course in reverse.

As proof of the capabilities of NAVplus, the NAVplus system was used aboard the *Gentry Eagle*—a 110-foot speedboat that successfully broke the speed record for trans-Atlantic crossing this past July. The new record of 62 hours, 7 minutes easily shattered the 1986 *Virgin Atlantic II* record of 80 hours, 31 minutes. The *Gentry* team averaged 55.61 mph over the 3,248-mile trip.

NAVplus has many more capabilities than the surface we've scratched has revealed. And even though you have to have a Macintosh on your boat to use NAVplus, you'll definitely find other uses for the Macintosh while you're at sea. (Who out there just said "play games?")

The NAVplus program, operating manual, and one charting area are available for $599.95. Additional charting areas are $199.95 each, and an interface cable is $19.95. For more information contact Ocean Products Corporation, 8 Bayberry Lane, New Fairfield, CT 06812 1-203-746-1175. Circle no. 120 on the Free Information Card. ■

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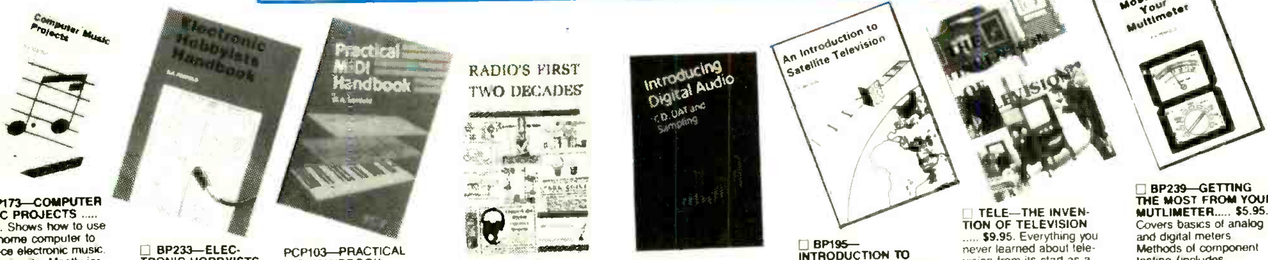

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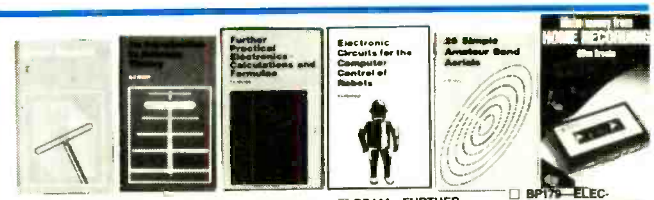

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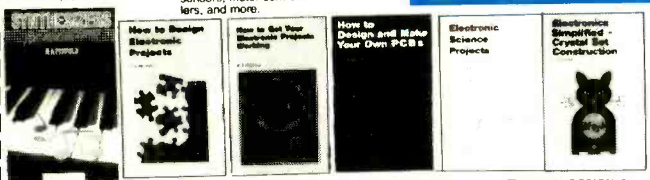

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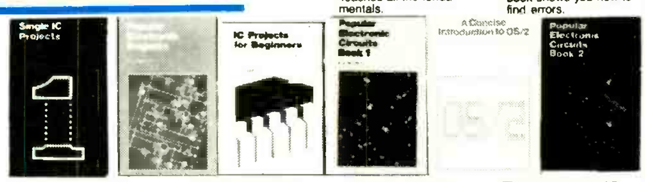

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The *Bearcat* 145XL is a 16 channel, programmable scanner covering ten frequency bands. The unit features a built-in delay function that adds a three second delay on all channels to prevent missed transmissions. A mobile version called the **BC560XLT-T** featuring priority, weather search, channel lockout and more is available for $94.95. CEI's package price includes mobile mounting bracket and mobile power cord.

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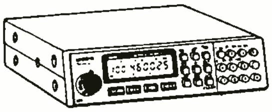
List price $499.95/**CE price $239.95/SPECIAL**
10 Meter Mobile Transceiver • Digital VFO Full Band Coverage • All-Mode Operation Backlit liquid crystal display • Auto Squelch RIT • Preprogrammed 10 KHz. Channels
Frequency Coverage: 28.0000 MHz. to 29.6999 MHz.

The *President* HR2510 Mobile 10 Meter Transceiver made by Uniden, has everything you need for amateur radio communications. Up to 25 Watt PEP USB/LSB and 25 Watt CW mode. Noise Blanker. PA mode. Digital VFO. Built-in S/RF/MOD/SWR meter. Channel switch on the microphone, and much more! The HR2510 lets you operate AM, FM, USB, LSB or CW. The digitally synthesized frequency control gives you maximum stability and you may choose either pre-programmed 10 KHz. channel steps, or use the built-in VFO for steps down to 100 Hz. There's also RIT (Receiver Incremental Tuning) to give you perfectly tuned signals. With receive scanning, you can scan 50 channels in any one of four band segments to find out where the action is. Order your HR2510 from CEI today.

NEW! President® HR2600-T

List price $599.95/**CE price $299.95/SPECIAL**
10 Meter Mobile Transceiver • New Features

The new *President* HR2600 Mobile 10 Meter Transceiver is similar to the *Uniden* HR2510 but now has repeater offsets (100 KHz.) and CTCSS encode.



BC760XLT
800 MHz. mobile scanner SPECIAL!

CIRCLE 6 ON FREE INFORMATION CARD

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★★★ Extended Service Contract ★★★

If you purchase a scanner, CB, radar detector or cordless phone from any store in the U.S. or Canada within the last 30 days, you can get up to three years of extended service contract from Warrantech. This service extension plan begins *after* the manufacturer's warranty expires. Warrantech will perform all necessary labor and will not charge for return shipping. Extended service contracts are not refundable and apply only to the original purchaser. A two year extended contract on a mobile or base scanner is $29.99 and three years is $39.99. For handheld scanners, 2 years is $59.99 and 3 years is $79.99. For radar detectors, two years is $29.99. For CB radios, 2 years is $39.99. For cordless phones, 3 years is $34.99. Order your extended service contract today.

OTHER RADIOS AND ACCESSORIES

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BC175XLT-T *Bearcat* 16 channel scanner $156.95
R2066-T *Regency* 60 channel scanner $149.95
R1099-T *Regency* 45 channel scanner $109.95
TS2-T *Regency* 75 channel scanner $269.95
UC102-T *Regency* VHF 2 ch. 1 Watt transceiver... $114.95
BPS5-T *Regency* 16 amp reg. power supply $179.95
BP205-T1 Ni-Cad batt. pack for BC200/BC100XLT... $39.95
B8-T 1.2 V AA Ni-Cad batteries (set of eight) $17.95
FBE-T Frequency Directory for Eastern U.S.A. $14.95
FBW-T Frequency Directory for Western U.S.A. $14.95
RFD1-T Great Lakes Frequency Directory $14.95
RFD2-T New England Frequency Directory $14.95
RFD3-T Mid Atlantic Frequency Directory $14.95
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TIC-T Techniques for Intercepting Communications ... $14.95
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EEC-T Embassy & Espionage Communications.... $14.95
CIE-T Covert Intelligence, Elect. Eavesdropping ... $14.95
MFF-T Midwest Federal Frequency directory $14.95
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A70-T Base station scanner antenna $35.95
A1300-T 25 MHz.-1.3 GHz Discone antenna..... $109.95
USAMM-T Mag mount VHF ant. w/ 12' cable $39.95
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