

1. INTRODUCTION - This report summarizes the results of a survey regarding the use of simulators as tools for research, design, and development in aerospace activities.

Questionnaires distributed to 168 companies resulted in 70 replies. The information received and as presented in this report comprises voluntary and unaided responses. No attempt was made to draw inferences or to seek clarification or expansion of the data. The analysis performed was for compilation rather than interpretation or comparison.

It is fully recognized that some simulators which fall in the category of this report may not have been included because of (1) failure to respond to questionnaires; and (2) knowledge of their existence was unavailable.

This report contains no classified material.

2. PURPOSE - The purpose of this report is to:
- Compile a technical catalog of existing simulator capabilities.
 - Establish an engineering base from which modifications of existing equipment can be determined to extend the present state-of-the-art.
 - Catalog the climate of future generation simulators that will be required through 1970.

CANCELLED

PREPARED BY SAE COMMITTEE AGE-3, TRAINING

(The AGE-3 Committee extends its appreciation to the Human Factors Group of Ling Temco Vought whose assistance made this report possible.)

SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

A DESIGN TOOL (RESEARCH AND DEVELOPMENT) SIMULATOR SURVEY REPORT

TABLE OF CONTENTS

Introduction	
Respondents	1
Abbreviations	3
Do you Own or Manufacture One or More Design Tool (R&D) Simulators?	4
1.0 Normal Uses of Simulators	5
2.0 Mission Phases Capable of Simulating	6
3.0 Computer Hardware Required	7
3.1 Analog Hardware - Numbers in Use	8
3.2 Digital Hardware - Types of Memory Storage	9
3.2 Digital Hardware - Continued	10
3.3 Conversion Equipment Used	11
4.0 Cockpit or Crew Station Motion	12
4.1 Physical Motion Produced by Moving Base - Angular	13
4.1 Physical Motion Produced by Moving Base - Translation	14
4.2 Wash-out Effects Used	15
4.3 Suggested Areas for Fixed and Moving Base R & D	16
5.1 Computer Capability for Motion Simulation - Angular	17
5.1 Computer Capability for Motion Simulation - Translation	18
5.2 Computer Techniques Which are Unique or Unusual	19
5.3A Instrumentation of Simulator - Pilot or Operator Display	20
5.3B Unmodified Standard Instruments	21
5.3C Modified Standard Instruments	22
5.3D Prototype or Specially Constructed Instruments	23
5.4 "Repeater" Instruments Available for Instructor	24
5.5 Instrument or Display Areas Needing R & D	25
6.1 Basic External Display	26
6.2 Presentation of External Display	27
6.3 Angular Motion of Visual Attachments	28
6.3 Motion of Visual Attachments - Translation	29

6.4	Distance - Pilot's Eyes to Screen	30
6.5	Curvature of Screen	31
6.6	Height and Width of Screen	32
6.7	Size of Visual Field	33
6.8	Suggested Areas for Visual R & D	34
7.1	Controls	35
7.2	Pilot Position	35
8.1	Applied Stresses - Physiological	36
8.1	Applied Physiological Stresses - Continued	37
8.1	Applied Physiological Stresses - Continued	38
8.1	Physiological - Acceleration on Operator (Kinesethetic Cues)	39
8.2	Applied Stresses - Psychological	40
8.3	Applied Stresses - Simulated	41
8.4	Suggested Stress Areas Needing R & D	42

RESPONDENTS

1. A.C.F. Industries, Electronics Div., Riverdale, Md., Space Vehicle Research Tool
2. Aircraft Armaments, Inc., Cockeysville, Md., Air Traffic Control Simulator
3. Aircraft Armaments, Inc., Cockeysville, Md., Model 1806 Three-axis Flight Simulator
4. Aviation Medical Acceleration Lab, NADC, Johnsville, Pa., Human Centrifuge
5. Bell Helicopter Co., & Franklin Inst., Fort Worth, Texas, Bell Helicopter Dynamic Simulator
6. Belock Instrument Corp., College Point, New York, 10 Models Represented
7. Bendix Computer Div., Bendix Corp., Los Angeles, Calif., Three-Dimensional Flight Simulator
8. Boeing Co., Wichita, Kans., Aerial Refueling Simulator
9. Boeing Co., Wichita, Kans., ECM Operator Station Simulator
10. Boeing Co., Wichita, Kans., Human Vibrator Simulator
11. Boeing Co., Wichita, Kans., Low Level Flight Simulator
12. Boeing Co., Wichita, Kans., Radar Navigation Station Simulator
13. Boeing Co., Seattle, Wash., Operational Mock-up
14. Boeing Co., Vertol Div., Morton, Pa.
15. Bausch & Lomb, Inc., Rochester, New York
16. Curtiss-Wright Electronics Div., East Patterson, N.J., 45 Models Represented
17. Electronic Assoc., Goodyear, Berkeley, and Astro., Hybrid
18. GAEC & NADC Airborne Instrument Lab., Johnstown, Pa., A2F-1 Weapons Systems Mission Simulator
19. GAEC & Project Cyclone - Reeves Inst. Co., New York City, N.Y. Apollo Re-entry Simulator
20. Goodyear Aircraft Corp., Akron, Ohio, Device 2F51, P6M-2 Operational Flight Trainer
21. Grumman Aircraft Engineering Corp., Bethpage, N.Y., Inertial Simulator
22. Grumman Aircraft Engineering Corp., Bethpage, N.Y., Grumman Research Vehicle Simulator
23. Lear Incorporated, Grand Rapids, Michigan
24. Link Div., General Precision, Inc., Binghamton, N.Y. DC-8
25. Martin Co., Orlando, Florida
26. Minneapolis Honeywell (Aero Div.), Minneapolis, Minn., Spacecraft Simulator Platform
27. Minneapolis Honeywell Regulator Co., Minneapolis, Minn., F104 Flight Simulator
28. NASA, Langley AFB, Va., Inertial Simulator
29. NASA, Langley AFB, Va., Lunar Landing Simulator
30. NASA, Langley AFB, Va., Fixed Base Simulator for Lunar Vehicle
31. NASA, Langley AFB, Va., Normal Acceleration & Pitch Simulator
32. NASA, Langley AFB, Va., Pilot Controlled Rendezvous Simulator
33. NASA, Langley AFB, Va., Re-entry Simulator
34. NASA, Langley AFB, Va., Fixed Base Simulator for Re-entry Studies
35. NASA, Langley AFB, Va., Fixed Base Orbital Rendezvous & Docking Simulator

36. NASA, Langley AFB, Va., Fixed Base Supersonic Aircraft Simulator
37. NASA, Langley AFB, Va., Three-Axis Cockpit Simulator
38. NASA, Langley AFB, Va., Three-Axis Air-Bearing Simulator for Spinning Vehicles
39. North American Aviation, Columbus, Ohio, Dynamic Flight Simulator
40. North American Aviation, Columbus, Ohio, Visual Flight Simulator
41. Northrup Corp., Norair Div., Hawthorne, Calif., Anthropometric Pre-Mockup
42. Northrup Corp., Norair Div., Hawthorne, Calif., One Man Rotational Space Flight Simulator
43. Northrup Corp., Norair Div., Hawthorne, Calif., Space Stability Simulator
44. Northrup Corp., Norair Div., Hawthorne, Calif., T-38/N-156 Cockpit Simulator
45. Northrup Corp., Norair Div., Hawthorne, Calif., T-38 Flight Control Test Stand
46. Northrup Corp., Norair Div., Hawthorne, Calif., T-38 Spin Test Centrifuge Cockpit Simulator
47. Northrup Corp., Norair Div., Hawthorne, Calif., Two-Axis Moving Base Simulator
48. Reflectone Electronics, Inc., Stamford, Conn., 20-L-10A Contact Analog Research Tool
49. Sikorsky Aircraft, Stratford, Conn., Sikorsky Aircraft Flight Simulator
50. Sylvania Electronics Systems, Needham, Mass., Universal Digital Operational Flight Trainer Tool
51. Vard Div. of Royal Industries, Pasadena, Calif., Three-Axis Flight Simulator
52. Vought Astronautics Div., Chance Vought Corp., Dallas, Texas, Automatic Controls Evaluation Simulator (ACES)
53. Vought Astronautics Div., Chance Vought Corp., Dallas, Texas, Manned Aero-Space Flight Simulator

LATE RESPONDENTS

54. Boeing Company, Seattle, Wash., Guidance and Control Development Model
55. Boeing Company, Aero-Space Div., Seattle, Wash., Dyna-Soar Glider 6⁰ of Freedom Developmental Simulator
56. General Dynamics/Electric Boat, Groton, Conn., Electric Boat Submarine Simulator
57. General Electric (S.T.C.), Valley Forge, Pa.
58. Martin Company, Denver, Colo.
59. North American Aviation, Los Angeles, Calif., B-70 Simulator
60. North American Aviation, Los Angeles, Calif., Flexible Cockpit Simulator (2)
61. North American Aviation, Los Angeles, Calif., Vertical Motion Device
62. Ryan Aeronautical Co., San Diego, Calif., Flight Simulation Visual Display Device
63. Sylvania Electronic Systems, East Needham, Mass., UDOFT
64. Winder Aircraft Corp., Dunnellon, Fla.

- 65. Vought Astronautics Div., Chance Vought Corp., Dallas, Tex., Frictionless Platform
- 66. Vought Aeronautics and Missiles Div., Chance Vought Corp., Dallas, Tex., General Purpose Fixed Base Simulator
- 67. Vought Aeronautics and Missiles Div., Chance Vought Corp., Dallas, Tex., Manned Aerospace Flight Simulator

ABBREVIATIONS

A/C - Alternating current	K or Kt - Knots
Accel - Acceleration	Long - Longitudinal
Alt - Altitude	Lt - Left
Anal - Analysis	M - 1000
Arr or Arrange - Arrangement	Max - Maximum
Avoid - Avoidance	MC - Megacycle
Char - Characteristics	Mi - Miles
Class - Classified	MS - Milliseconds
Clear - Clearance	Mult - Multiplier
Comm - Communication	No. - Number
Comp - Compass	Pos'n - Position
Config - Configuration	Press - Pressure
Cont - Continuous or Control	Qual - Qualification
CPS or Cyc/sec - Cycle per second	Quant or Qty - Quantity
CRT - Cathode ray tube	R or Rad - Radius
D/C - Direct current	R & D - Research and Development
Deg - Degrees	Resp - Respondent
Deg/sec or D/sec - Degrees per second	RPM - Rounds per minute
Dev - Develop or Development	Rt - Right
Dur - Duration	Sec - Seconds
EGT - Exhaust gas temperature	Shipbd - Shipboard
El - Electronic	STOL - Short take-off and landing
Env - Environment	TAS - True airspeed
Eval - Evaluation	TOT - Turbine outlet temperature
Flt - Flight	Traj - Trajectory
Func - Functional	Trng - Training
Fwd - Forward	TV - Television
Gen - Generator	U/L - Unlimited
Hyd - Hydraulic	Var - Variable
IAS - Indicated airspeed	Vs - Versus
Ind - Indicator	VTOL - Vertical take-off and landing
Inst - Instrument	

[illegible]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	52
--	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----

[illegible]

3.0 COMPUTER HARDWARE REQUIRED

PERCENT

RESP	ANALOG	DIGITAL
1	25	75
2	85	15
3	100	
4	90	10
5		
6	100	
7	70	
8	100	
9		
10		
11	100	
12		
13	100	
14	100	
15		
16	100	
17	90	20
18	80	60
19	100	
20	100	
21		
22	100	
23	100	
24	100	
25	100	
26		
27	90	
28		
29	100	
30	100	
31	100	
32	100	
33	100	
34	100	
35	100	
36	100	
37	100	
38		
39	100	
40	100	
41		
42		
43		
44		
45	100	
46		
47	100	
48	100	
49	100	
50		100
51		
52		
53	82	18

54	100	0
55	100	0
56	100	0
57	100	0
58	100	
59	90	10
60	08	10
61	80	10
62	100	
63		100
64		
65		
66	82	18
67	82	18
RESP	ANALOG	DIGITAL

3.1 ANALOG HARDWARE - NUMBERS IN USE

REF	AMPLIFIERS		NON-LINEAR EQUIPMENT			
	A/C	D/C	SERVO	RESOLVERS	FUNC. GEN.	EL. MULT.
1	66	26	59	19	350	8
2	360	6	700	120	4	8
3	12	39	6	6	4	4
4	6	306	5	6	9	9
6	360		6	80	4	10
6	36	19	29	22	16	8
7	16	63	3	15		18
8		280	12	4	4	4
6						
10						
11		106	6	2	2	2
12						
18		369	7		172	68
19		78	5	2		
16						
16	555	300	169	35	395	
17		555	35	24	59	52
15		488	55	13	6	0
19	5	535	36	6	6	5
20	225	0	100	15	80	0
21						
22		158	18	5	19	5
23		165	11	8	4	4
24	12	544	99	40	194	
26		389	5	8	20	60
26						
27		46	2			
26						
29		19	1			
25		136	16	7	6	41
31						
32		136	6	6		12
33		148	5	5	6	15
24	9	109	2	7	6	30
26		155	6	6	5	34
25		121	2	2	0	15
37						
38						
39		119	16	7	16	15
40		285	30	7	30	15
41						
42			8			
45						
44						
45		156	8	2	4	2
46						
47		146	19	3	3	8
48	4		4	1	5	5
48		260	11	12	59	62
55						
81	3	3	5	5	1	5
62						
53		504	66	27	45	20
94		323			27	139
56		475	12	24	156	146
36	10	60	9			
57		131	7	3	9	4
58						
59	9	1280	100	46	235	58
69	5	1285	168	45	235	85
61	0	1285	195	40	239	85
82		360	10	2	15-20 25-15	5
83		9	25			
42						
05						
63		964	98	27	46	20
67		604	50	27	45	29
REF	A/C	D/C	SERVO	RESOLVERS	FUNC. GEN.	EL. MULT.
AMPLIFIERS		NON-LINEAR EQUIPMENT				



32 DIGITAL HARDWARE

TYPE OF MEMORY STORAGE

HEAP CODE NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	148
--------------	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-----

3.2 DIGITAL HARDWARE - CONTINUED

STORAGE CAPACITY

RESP	NO. OF WORDS	SIZE OF WORDS	ACCESS TIME	REPEAT RATE
1	PROPRIETARY	PROPRIETARY	PROPRIETARY	PROPRIETARY
2	10,555	15 BITS	15 MS	
3				
4				
5	2,080		2.4 MS	
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17	144	6 BIT	8 US	VARIABLE
18	(1)	(1)	(1)	CLASSIFIED
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50	(2)	22 BITS	5 MS	50 CYC/SEC
51				
52				
53	2560	22 BITS	SERIAL OVER 1.8 MS	2 MC
54				
55				
56				
57				
58				
59	13355	22	3.072 M/S MAX TO 12 M/S MIN	
60	3965	22	3.072 M/S MAX TO 12 M/S MIN	
61	3335	22	3.072 M/S MAX TO 12 M/S MIN	
62	3102	22	2 M/S	5 M/S
63				
64	2580	22 BITS	SERIAL OVER 1.8 MS	2 MC
65	2580	22 BITS	SERIAL OVER 1.8 MS	2 MC
66				
67				
RESP	NO. OF WORDS	SIZE OF WORDS	ACCESS TIME	REPEAT RATE

NOTES

(1) NO OF WORDS: 11,249 ON DRUM AND 125 IN CORE
 SIZE OF WORDS: 21 BITS ON DRUM AND 15 BITS IN CORE
 ACCESS TIME: 10 MS ON DRUM AND 5 MS IN CORE

(2) 4096 INSTRUCT WORDS AND 4096 DATA WORDS



Documents
 Document Sharing Hub

3.3 CONVERSION EQUIPMENT USED

[illegible]