

1 /FOCAL-8 REPLACE
2 /DEC-08-LFRRRA-A-LA1
3
4 /OCTOBER 1971 RM/SM
5
6 /COPYRIGHT 1971 DIGITAL EQUIPMENT CORPORATION
7 / MAYNARD, MASSACHUSETTS 01754
8
9 /FOCAL IS A REGISTERED TRADEMARK OF
10 /DIGITAL EQUIPMENT CORPORATION
11
12
13 /ASSEMBLY INSTRUCTIONS:
14 /.R PAL8 OR .R PAL10
15 /*REPLACE,REPLACE_REPLACE
16
17
18

```

NOPUNCH
  90          XLIST
  91          ENPUNCH
  92          /
*****
  93          *35
  94 000035   4617  BOTTOM, FEXP-1  /*****
  95          /
*****
  96          NOPUNCH
 410          XLIST
 411          ENPUNCH
 412          *402
 413          /
*****
 414 000402   5000          ARTN      /FATN      -ARCTANGENT
 415 000403   4620          FEXP      /FEXP      -E^X
 416 000404   5040          FLOG      /FLOG      -LN(X)
 417 000405   5205          FSIN      /FSIN      -SINE
 418 000406   5200          FCOS      /FCOS      -COSINE
 419          /
*****
 420          NOPUNCH
2379          XLIST
2380          ENPUNCH
2381          /
*****
2382          /FLOATING POINT PACKAGE - EXPONENTIAL
2383
2384          GETSGN=TAD FLAC+1
2385          RETURN=JMP I EFUN3I
2386
2387          *4600+20
2388
2389 004620   1045  FEXP,    GETSGN          /TAKE ABSOLUTE
VALUE
2390 004621   7710          SPA CLA
2391 004622   4724          JMS I NEGP
2392 004623   3033          DCA T3          /C(SIGN)=-1 IF I X2<0
2393 004624   4407          FINT
2394 004625   4313          FMUL LG2E
2395 004626   6675          FPUT I X2
2396 004627   0000          FEXT
2397 004630   4453          JMS I INTEGER  /TAKE INTEGER PART
2398 004631   3325          DCA FLAG2      /SAVE LOW ORDER DATA
2399 004632   4407          FINT
2400 004633   7000          FNOR
2401 004634   6676          FPUT I XSQ2
2402 004635   0675          FGET I X2
2403 004636   2676          FSUB I XSQ2
2404 004637   6675          FPUT I X2

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2405	004640	4675	FMUL I X2
2406	004641	6676	FPUT I XSQ2
2407	004642	1310	FADD DF
2408	004643	6326	FPUT TEMP
2409	004644	0305	FGET CF
2410	004645	3326	FDIV TEMP
2411	004646	2675	FSUB I X2
2412	004647	1277	FADD AF
2413	004650	6326	FPUT TEMP
2414	004651	0302	FGET BF
2415	004652	4676	FMUL I XSQ2
2416	004653	1326	FADD TEMP
2417	004654	6326	FPUT TEMP
2418	004655	0675	FGET I X2
2419	004656	3326	FDIV TEMP
2420	004657	4321	FMUL TWO
2421	004660	1316	FADD ONE
2422	004661	0000	FEXT
2423	004662	1325	TAD FLAG2
2424	004663	1044	TAD FLAC
2425	004664	3044	DCA FLAC
2426	004665	2033	ISZ T3
2427	004666	5536	RETURN
2428	004667	4407	FINT
2429	004670	6675	FPUT I X2
2430	004671	0316	FGET ONE
2431	004672	3675	FDIV I X2
2432	004673	0000	FEXT
2433	004674	5536	RETURN
2434			

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2435          /CONSTANTS FOR FEXP
2436
2437 004675 5321 X2,      X
2438 004676 5325 XSQ2,   XSQR
2439 004677 0004 AF,      0004
2440 004700 2372          2372
2441 004701 1402          1402
2442 004702 7774 BF,      7774
2443 004703 2157          2157
2444 004704 5157          5157
2445 004705 0012 CF,      0012
2446 004706 5454          5454
2447 004707 0343          0343
2448 004710 0007 DF,      0007
2449 004711 2566          2566
2450 004712 5341          5341
2451 004713 0001 LG2E,    0001
2452 004714 2705          2705
2453 004715 2435          2435
2454 004716 0001 ONE,     0001
2455 004717 2000          2000
2456 004720 0000          0000
2457 004721 0002 TWO,     0002
2458 004722 2000          2000
2459 004723 0000          0000
2460 004724 5163 NEGP,    FNEG
2461
2462 004725 0000 FLAG2,    0
2463 004726 0000 TEMP,     0
2464 004727 0000          0
2465 004730 0000          0
2466 004731 0000          0
2467
2468
2469

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2470 /MAIN ALGORITHM FOR ARCTANGENT

2471

2472	004732	4407	ARCALG,	FINT
2473	004733	0675		FGET I X2
2474	004734	4675		FMUL I X2
2475	004735	6676		FPUT I XSQ2
2476	004736	4374		FMUL BET2
2477	004737	1371		FADD BET1
2478	004740	4676		FMUL I XSQ2
2479	004741	1366		FADD BETZ
2480	004742	6326		FPUT TEMP
2481	004743	0363		FGET ALF2
2482	004744	4676		FMUL I XSQ2
2483	004745	1360		FADD ALF1
2484	004746	4676		FMUL I XSQ2
2485	004747	1355		FADD ALFZ
2486	004750	4675		FMUL I X2
2487	004751	3326		FDIV TEMP
2488	004752	0000		FEXT
2489	004753	5754		JMP I .+1
2490	004754	5024		ARCRTN

2491

2492

2493

2494 /CONSTANTS - FLOATING ARC TANGENT

2495	004755	0000	ALFZ,	0000
2496	004756	2437		2437
2497	004757	1643		1643
2498	004760	7777	ALF1,	7777
2499	004761	3304		3304
2500	004762	4434		4434
2501	004763	7773	ALF2,	7773
2502	004764	3306		3306
2503	004765	5454		5454
2504	004766	0000	BETZ,	0000
2505	004767	2437		2437
2506	004770	1646		1646
2507	004771	0000	BET1,	0000
2508	004772	2427		2427
2509	004773	2323		2323
2510	004774	7775	BET2,	7775
2511	004775	3427		3427
2512	004776	7052		7052

2513

2514

2515

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2516
/-----
2517
/-----
2518          /FLOATING POINT ARC TANGENT
2519
2520          *5000
2521
2522 005000 1045 ARTN,  GETSGN          /TAKE ABSOLUTE VALUE
2523 005001 7710      SPA CLA
2524 005002 4363      JMS FNEG
2525 005003 3033      DCA T3
2526 005004 4407      FINT
2527 005005 6635      FPUT I X1
2528 005006 2637      FSUB I CON1
2529 005007 0000      FEXT
2530 005010 1045      GETSGN
2531 005011 7710      SPA CLA
2532 005012 5221      JMP GO          /LESS THAN ONE
2533 005013 4407      FINT
2534 005014 0637      FGET I CON1
2535 005015 3635      FDIV I X1
2536 005016 6635      FPUT I X1
2537 005017 0000      FEXT
2538 005020 7240      CLA CMA
2539 005021 3362 GO,   DCA FLAG1      /SIGN FLAG OF RESULT
2540 005022 5623      JMP I .+1      /CALL ALGORITHM
2541 005023 4732      ARCALG
2542 005024 2362 ARCRTN, ISZ FLAG1     /RETURN HERE
2543 005025 5634      JMP I EXIT1
2544 005026 4407      FINT
2545 005027 6635      FPUT I X1
2546 005030 0636      FGET I PI2
2547 005031 2635      FSUB I X1
2548 005032 0000      FEXT
2549 005033 5634      JMP I .+1
2550 005034 5301 EXIT1, EXIT2
2551
2552          /CONSTANTS FOR ARCTANGENT
2553 005035 5321 X1,    X
2554 005036 5315 PI2,   PIOT
2555 005037 4716 CON1,  ONE
2556
2557

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2558	005040	1045	FLOG,	GETSGN	/FLOATING LOGARITHM
2559	005041	7450		SNA	
2560	005042	4566		ERROR3	/ZERO ARGUEMENT FOR LOG
2561	005043	7710		SPA CLA	
2562	005044	4566		ERROR3	/NEGATIVE ARGUMENT
2563	005045	4407		FINT	
2564	005046	6756		FPUT I TEM	
2565	005047	2637		FSUB I CON1	
2566	005050	0000		FEXT	
2567	005051	1045		GETSGN	
2568	005052	7450		SNA	
2569	005053	5536		RETURN	
2570	005054	7700		SMA CLA	
2571	005055	5264		JMP STARTL	
2572	005056	4407		FINT	
2573	005057	0637		FGET I CON1	
2574	005060	3756		FDIV I TEM	
2575	005061	6756		FPUT I TEM	
2576	005062	0000		FEXT	
2577	005063	7240		CLA CMA	
2578	005064	3033	STARTL,	DCA T3	
2579	005065	1005		TAD P13	
2580	005066	3044		DCA FLAC	
2581	005067	7040		CMA	
2582	005070	1756		TAD I TEM	
2583	005071	3045		DCA FLAC+1	
2584	005072	3046		DCA FLAC+2	
2585	005073	3047		DCA FLAC+3	
2586	005074	7001		IAC	
2587	005075	3756		DCA I TEM	
2588	005076	4407		FINT	
2589	005077	4357		FMUL LOG2	
2590	005100	6635		FPUT I X1	
2591	005101	0756		FGET I TEM	
2592	005102	2637		FSUB I CON1	
2593	005103	6756		FPUT I TEM	
2594	005104	4353		FMUL LOG8	
2595	005105	1350		FADD LOG7	
2596	005106	4756		FMUL I TEM	
2597	005107	1345		FADD LOG6	
2598	005110	4756		FMUL I TEM	
2599	005111	1342		FADD LOG5	
2600	005112	4756		FMUL I TEM	
2601	005113	1337		FADD L4	
2602	005114	4756		FMUL I TEM	
2603	005115	1334		FADD L3	
2604	005116	4756		FMUL I TEM	
2605	005117	1331		FADD L2	
2606	005120	4756		FMUL I TEM	
2607	005121	1326		FADD L1	

2608	005122	4756	FMUL I TEM
2609	005123	1635	FADD I X1
2610	005124	0000	FEXT
2611	005125	5634	JMP I EXIT1
2612			

2613				
2614	005126	0000	L1,	0000
2615	005127	3777		3777
2616	005130	7742		7742
2617	005131	7777	L2,	7777
2618	005132	4000		4000
2619	005133	4100		4100
2620	005134	7777	L3,	7777
2621	005135	2517		2517
2622	005136	0310		0310
2623	005137	7776	L4,	7776
2624	005140	4113		4113
2625	005141	7211		7211
2626				
2627			/LOGARITHM	CONSTANTS
2628				
2629	005142	7776	LOG5,	7776
2630	005143	2535		2535
2631	005144	3301		3301
2632	005145	7775	LOG6,	7775
2633	005146	4746		4746
2634	005147	0771		0771
2635	005150	7774	LOG7,	7774
2636	005151	2236		2236
2637	005152	4304		4304
2638	005153	7771	LOG8,	7771
2639	005154	4544		4544
2640	005155	1735		1735
2641				
2642	005156	4726	TEM,	TEMP
2643	005157	0000	LOG2,	0
2644	005160	2613		2613
2645	005161	4414		4414
2646	005162	0000	FLAG1,	0
2647				
2648				
2649				
2650				
2651	005163	0000	FNEG,	0
2652	005164	4451		JMS I MINSKI
2653	005165	7240		CLA CMA
2654	005166	5763		JMP I FNEG
2655				
2656				

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2657
/-----
2658
/-----
2659          /FLOATING POINT SINE AND COSINE
2660
2661          *5200
2662
2663 005200 4407 FCOS,   FINT          /COS(X)=SIN(PI/2-X)
2664 005201 6321       FPUT X
2665 005202 0315       FGET PIOT
2666 005203 2321       FSUB X
2667 005204 0000       FEXT
2668 005205 1045 FSIN,   GETSGN
2669 005206 7740       SMA SZA CLA
2670 005207 5215       JMP MOD
2671 005210 1045       GETSGN
2672 005211 7700       SMA CLA
2673 005212 5536       RETURN          /YES SIN(0)=0
2674 005213 4451       JMS I MINSKI
2675 005214 7040       CMA          /NO:SIN(-X)=-SIN(X)
2676 005215 3033 MOD,   DCA T3
2677          /REDUCE X MODULO 2 PI
2678 005216 4407       FINT
2679 005217 3305       FDIV TWOPI
2680 005220 6325       FPUT XSQR
2681 005221 0000       FEXT
2682 005222 4453       JMS I INTEGER
2683 005223 4407       FINT
2684 005224 7000       FNOR
2685 005225 6321       FPUT X
2686 005226 0325       FGET XSQR
2687 005227 2321       FSUB X
2688 005230 4305       FMUL TWOPI
2689 005231 6321       FPUT X
2690 005232 2311       FSUB PI          /X<PI?
2691 005233 0000       FEXT
2692 005234 1045       GETSGN
2693 005235 7710       SPA CLA
2694 005236 5244       JMP PCHECK          /YES
2695 005237 4407       FINT          /NO, SIN(X-PI)=-SIN(X)
2696 005240 6321       FPUT X
2697 005241 0000       FEXT
          TAD T3          /INVERT THE SIGN
2698 005242 7040       CMA
2699 005243 3033       DCA T3
2700

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2701	005244	4407	PCHECK,	FINT	/X<PI/2?
2702	005245	0321		FGET X	
2703	005246	2315		FSUB PIOT	
2704	005247	0000		FEXT	
2705	005250	1045		GETSGN	
2706	005251	7710		SPA CLA	
2707	005252	5260		JMP PALG	/YES
2708	005253	4407		FINT	/NO
2709	005254	0311		FGET PI	/SIN(X)=SIN(PI-X)
2710	005255	2321		FSUB X	
2711	005256	6321		FPUT X	
2712	005257	0000		FEXT	
2713					
2714	005260	4407	PALG,	FINT	
2715	005261	0321		FGET X	
2716	005262	3315		FDIV PIOT	
2717	005263	6321		FPUT X	
2718	005264	4321		FMUL X	
2719	005265	6325		FPUT XSQR	
2720	005266	0331		FGET C9	
2721	005267	4325		FMUL XSQR	
2722	005270	1335		FADD C7	
2723	005271	4325		FMUL XSQR	
2724	005272	1341		FADD C5	
2725	005273	4325		FMUL XSQR	
2726	005274	1345		FADD C3	
2727	005275	4325		FMUL XSQR	
2728	005276	1315		FADD PIOT	
2729	005277	4321		FMUL X	
2730	005300	0000		FEXT	
2731	005301	2033	EXIT2,	ISZ T3	
2732	005302	5536		RETURN	
2733	005303	4451		JMS I MINSKI	
2734	005304	5536		RETURN	
2735					

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2736          /CONSTANTS AND POINTERS
2737
2738
2739
2740 005305 0003 TWOPI, 0003
2741 005306 3110      3110
2742 005307 3756      3756      /(3755) - FOR 4-WORD
2743 005310 3235      3235
2744
2745 005311 0002 PI,    0002
2746 005312 3110      3110
2747 005313 3756      3756
2748 005314 3235      3235
2749
2750 005315 0001 PIOT, 0001          /USED BY SINE AND COSINE
2751 005316 3110      3110
2752 005317 3756      3756
2753 005320 3235      3235
2754
2755 005321 0000 X,      0000
2756 005322 0000      0000
2757 005323 0000      0000
2758 005324 0000      0000
2759
2760 005325 0000 XSQR, 0000
2761 005326 0000      0000
2762 005327 0000      0000
2763 005330 0000      0000
2764
2765          /SINE CONSTANTS
2766
2767 005331 7764 C9,      7764
2768 005332 2501      2501
2769 005333 7015      7015
2770 005334 1042      1042
2771 005335 7771 C7,      7771
2772 005336 5464      5464
2773 005337 5514      5514
2774 005340 6150      6150
2775 005341 7775 C5,      7775
2776 005342 2431      2431
2777 005343 5361      5361
2778 005344 4736      4736
2779 005345 0000 C3,      0000
2780 005346 5325      5325
2781 005347 0414      0414
2782 005350 3167      3167
2783
2784          /END OF EXTENDED FUNCTIONS.
2785

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2786

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2787

NOPUNCH