

DataGeneral

**TECHNICAL
STATEMENT**

TEXT LISTING

068-000637-00

PROGRAM

MICRO-NOVA ANALOG TO DIGITAL
INTERFACE EXERCISER

TEXT TAPE

097-000637-00

ABSTRACT

THIS IS AN OPEN ENDED ANALOG EXERCISER ROUTINE FOR THE
A/D CONVERTER AND ANALOG INPUT MULTIPLEXER SECTIONS
OF THE MODEL 4223 MICRO NOVA ANALOG TO DIGITAL INTERFACE.

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; NAME: MNADE.TX          PART NUMBER: 097-000637
;
; DESCRIPTION: MICRO NOVA ANALOG TO DIGITAL INTERFACE EXERCISER
;
; REVISION HISTORY:
; REV.          DATE
; 00          04/28/78
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PROGRAM NAME:
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MNADE - MICRO NOVA ANALOG TO DIGITAL INTERFACE
EXERCISER

REVISION HISTORY:
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REV 00 - 04/28/78

MACHINE REQUIREMENTS:
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1. MICRO NOVA CENTRAL PROCESSOR WITH AT LEAST
4K READ/WRITE (RAM) MEMORY
LOK IF USING CATS/KITTEN DCH EXERCISER)
2. MICRO NOVA ASYNCHRONOUS INTERFACE
3. TELETYPE OR CRT TERMINAL
4. PAPER TAPE READER AND/OR DISKETTE DRIVE

TEST REQUIREMENTS:
-----
1. MICRO NOVA ANALOG TO DIGITAL INTERFACE
2. SHOULD BE RUN FIRST TO DETECT AND CORRECT ANY
LOGIC LEVEL FAULTS ON THE A/D INTERFACE.
- AB TAPE PART # 095 - 000539
- LISTING PART # 096 - 000539
3. MICRO NOVA ANALOG TO DIGITAL INTERFACE EXERCISER
- AB TAPE PART # 095 - 000637
- LISTING PART # 096 - 000637
4. FOR ACCURATE A/D CONVERTER CALIBRATION, A PRECISION
VOLTAGE SOURCE AND A 4 1/2 DIGIT DIGITAL MULTIMETER
(OR VOLTMETER) WILL BE NECESSARY.

SUMMARY:
-----
THIS IS AN OPEN ENDED ANALOG EXERCISER ROUTINE FOR THE
A/D CONVERTER AND ANALOG INPUT MULTIPLEXER SECTIONS
OF THE MODEL 4223 MICRO NOVA ANALOG TO DIGITAL INTERFACE.
PROGRAMS INCLUDED ARE:
- ANALOG MULTIPLEXER CHANNEL SCANNER
(READS AND DISPLAYS MULTIPLEXER (MUX) CHANNEL VALUES)
- A/D CONVERTER CALIBRATION
(READS AND DISPLAYS ONE MUX CHANNEL'S VALUES FOR
CALIBRATION PURPOSES)
- A/D HISTOGRAM & HISTOGRAM WITH DATA CHANNEL EXERCISER
(READS AND SORTS ONE MUX CHANNEL'S VALUES INTO A
HISTOGRAM FOR A/D CONVERTER STABILITY TESTING)

RESTRICTIONS:
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1. THIS EXERCISER CAN TEST ONE A/D INTERFACE
AT A TIME.

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10003 .MAIN
01 ? PROGRAM DESCRIPTION/THEORY OF OPERATION:
02 ?
03 ? NOTE: THE FOLLOWING CONVENTION IS USED IN THE
04 ? DESCRIPTION TO INDICATE LOW ACTIVE SIGNALS:
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7.1 4223 ANALOG TO DIGITAL CONVERTER OPERATION:

THE A/D BOARD FOR THE MICRONOVA CONSISTS OF A TWO HYBRID PACKAGE DATA ACQUISITION SYSTEM (DAS) ALONG WITH INTERFACE AND LOGIC CIRCUITRY. AN ON-BOARD DC-DC CONVERTER PROVIDES +/- 15 VOLTS REQUIRED BY THE ANALOG CIRCUITRY. ONE HYBRID PACKAGE OF THE DAS CONSISTS OF TWO EIGHT-TO-ONE ANALOG MULTIPLEXERS ANALOG SWITCH TO SELECT SINGLE ENDED OR DIFFERENTIAL CHANNELS, INSTRUMENTATION AMPLIFIER, AND SAMPLE AND HOLD. THE OTHER PACKAGE CONTAINS A 12-BIT A/D CONVERTER WITH INTERNAL CLOCK. THE DAS CAN BE USED EITHER WITH 16. SINGLE-ENDED OR, FOR HIGHER COMMON-MODE REJECTION RATIO, WITH 8. DIFFERENTIAL ANALOG INPUTS. THE SELECTION OF SINGLE-ENDED OR DIFFERENTIAL CHANNELS IS PROGRAM SELECTABLE. VOLTAGE RANGES, WHICH ARE JUMPER SELECTABLE, ARE 0-5, 0-10, +/- 5, +/- 10 VOLTS. CONVERSION TIME IS 25 US MAXIMUM WITH A THROUGHPUT RATE OF 30 KHZ. LINEARITY AND DIFFERENTIAL NONLINEARITY ERRORS ARE EACH TYPICALLY 1/2 LSB. CONVERSION IS MONOTONIC, AND OVERALL RELATIVE ACCURACY AT 25 DEGREES C IS 0.025% OF FULL SCALE READING.

THERE ARE SEVEN DIFFERENT CLOCK SOURCES FOR STARTING A/D CONVERSIONS. FOR PROGRAMMED I/O THESE ARE /STR1/, NO CLOCK SYNCHRONIZATION; /STR1/, INTERNAL CLOCK SYNC; /STR1/, EXTERNAL CLOCK SYNC. FOR DATA CHANNEL TRANSFERS THESE ARE: /IOPLS/ (ONE CONVERSION FOR EVERY /IOPLS/ COMMAND - THE TIME BETWEEN /IOPLS/ COMMANDS SHALL BE GREATER THAN THE MAXIMUM DATA CHANNEL LATENCY OR 33 US, WHICHEVER IS GREATER); /DCHI/, NO CLOCK SYNC (MAXIMUM TRANSFER RATE); INTERNAL CLOCK SYNC; EXTERNAL CLOCK SYNC. THE EXTERNAL CLOCK SHOULD HAVE A PERIOD GREATER THAN 35 US. ALL DATA CHANNEL TRANSFER SEQUENCES BEGIN WITH /STR1/ COMMAND. THE CLOCK SOURCE IS SELECTED BY THREE STATUS BITS IN A DOA INSTRUCTION. THIS INSTRUCTION MUST ALSO CONTAIN AN INITIAL AND FINAL MULTIPLEXER ADDRESS. A MUX CHANNEL COUNTER FIRST ADDRESSES THE INITIAL CHANNEL AND IS INCREMENTED ONCE FOR EVERY CONVERSION. AFTER THE VOLTAGE ON THE FINAL CHANNEL IS CONVERTED, THE INITIAL CHANNEL IS AGAIN ADDRESSED. THIS SEQUENCE THEN REPEATS ITSELF. HENCE, FOR CONVERSIONS ON ONLY ONE CHANNEL THE FINAL AND INITIAL CHANNELS ARE SET EQUAL TO THE DESIRED CHANNEL.

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CHANNEL ADDRESS (OCTAL)	SINGLE-ENDED	CHANNEL SELECTED	DIFFERENTIAL
0	ANA0 (A49) HI	ANA0 (A49) LO	ANA8 (A50) LO
1	ANA1 (A45) HI	ANA1 (A45) LO	ANA9 (A46) LO
2	ANA2 (A41) HI	ANA2 (A41) LO	ANA10 (A42) LO
3	ANA3 (A37) HI	ANA3 (A37) LO	ANA11 (A38) LO
4	ANA4 (A33) HI	ANA4 (A33) LO	ANA12 (A34) LO
5	ANA5 (A29) HI	ANA5 (A29) LO	ANA13 (A30) LO
6	ANA6 (A25) HI	ANA6 (A25) LO	ANA14 (A26) LO
7	ANA7 (A21) HI	ANA7 (A21) LO	ANA15 (A22) LO
10	ANA8 (A50) HI	ANA8 SE RET (A48) LO	SAME AS CHANNEL 0
11	ANA9 (A46) HI	ANA9 SE RET (A44) LO	SAME AS CHANNEL 1
12	ANA10 (A42) HI	ANA10 SE RET (A40) LO	SAME AS CHANNEL 2
13	ANA11 (A38) HI	ANA11 SE RET (A36) LO	SAME AS CHANNEL 3
14	ANA12 (A34) HI	ANA12 SE RET (A32) LO	SAME AS CHANNEL 4
15	ANA13 (A30) HI	ANA13 SE RET (A28) LO	SAME AS CHANNEL 5
16	ANA14 (A26) HI	ANA14 SE RET (A24) LO	SAME AS CHANNEL 6
17	ANA15 (A22) HI	ANA15 SE RET (A20) LO	SAME AS CHANNEL 7

CODING JUMPERS:
DAS 0 LO = W7
DAS 0 HI = W6

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;AN INTERESTING FEATURE OF THE CHANNEL ADDRESSING LOGIC IS
;ITS ABILITY TO "WRAP AROUND" ADDRESS 17 OCTAL.  THUS, THE
;FINAL CHANNEL MAY BE LESS THAN THE INITIAL CHANNEL.  FOR
;EXAMPLE, IF THE INITIAL CHANNEL IS 12 OCTAL AND THE FINAL
;CHANNEL IS 5 OCTAL, CONVERSIONS OCCUR FOR CHANNELS 12,13,
;14,15,16,17,0,1,2,3,12,13,....  THE EIGHT DIFFERENTIAL
;CHANNELS WOULD NORMALLY BE NUMBERED 0-7.  IF IT IS
;DESIRED TO USE THE WRAP-AROUND FEATURE TO CONVERT DIFFERENTIAL
;CHANNELS 6,7,0,1,2, HOWEVER, THE INITIAL CHANNEL MUST
;BE GIVEN AS 16 OCTAL AND THE FINAL AS 2 OCTAL, SINCE THE
;WRAP-AROUND OCCURS AROUND 17 OCTAL.

;THE DOA INSTRUCTION SHOULD NOT BE GIVEN IF BUSY IS SET.
;ALL STATUS BITS SET UP BY THE DOA INSTRUCTION REMAIN
;THE SAME UNTIL THE NEXT DOA INSTRUCTION FOR /IORST/,
;WHICH CLEARS ALL STATUS BITS.

;AN END-OF-CONVERSION SIGNAL FROM THE DAS WHEN CONVERTING
;IN PROGRAMMED I/O MODE, OR A /WCEZ/ SIGNAL FROM THE
;MN603 I/O CONTROLLER CHIP IN DATA CHANNEL MODE SETS
;DONE AND WILL REQUEST AN INTERRUPT IF INTERRUPTS
;ARE ENABLED.

;A CLOCK OVERRUN WILL OCCUR IF AN END-OF-CONVERSION
;SIGNAL (EOC) OCCURS BEFORE DATA FROM THE PREVIOUS
;CONVERSION IS READ INTO THE CPU.  THIS CAUSES THE CURRENT
;DATA TO BE LOST.  THE CLOCK OVERRUN SIGNAL SETS
;A STATUS BIT WHICH CAN BE READ BY A DIA INSTRUCTION
;AND CAN ALSO, BY SETTING A JUMPER, SET DONE.  THE DIA
;INSTRUCTION ALSO READS IN THE CURRENT MUX CHANNEL, EOC
;AND A BIT INDICATING AN EXTERNAL INTERRUPT REQUEST.
;SUCH A REQUEST, WHICH OCCURS BY PULLING THE /EXTERNAL
;INTERRUPT REQUEST/ LINE LOW, DIRECTLY REQUESTS AN
;INTERRUPT WITHOUT SETTING DONE.  EOC IS LOW DURING AN
;A/D CONVERSION AND OTHERWISE IS HIGH.  READING IN EOC
;BY A DIA INSTRUCTION IS USEFUL IN THE IOPLS DATA CHANNEL
;MODE TO INDICATE THAT NEW DATA IS READY AND THAT,
;AFTER THE APPROPRIATE DATA CHANNEL LATENCY, WILL BE
;READ TO THE CPU.

;AN ADC READY SIGNAL (TRUE HIGH OR LOW, JUMPER SELECT-
;ABLE) IS A HANDSHAKING SIGNAL THAT INDICATES TO THE
;USER THAT THE DAS HAS FINISHED THE CURRENT CONVERSION
;AND IS READY TO DO ANOTHER CONVERSION.  AS SOON AS A
;NEW CONVERSION BEGINS, THIS SIGNAL CHANGES STATE UNTIL
;THE NEXT END-OF-CONVERSION SIGNAL.

;THE NOMINAL INTERNAL CLOCK RANGE (PERIOD) IS:
;500 US = 500 US (ADJUSTABLE BY POTENTIOMETER R26).

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PROGRAM OPERATION:
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:7.2.0
GENERAL DESCRIPTIONS & INFORMATION:
THIS EXERCISER CONSISTS OF SEVERAL DIFFERENT ROUTINES
THAT ARE USED TO 1) CALIBRATE THE A/D CONVERTER MODULE,
2) READ AND DISPLAY VALUES PRESENT AT THE MULTIPLIER
INPUTS, 3) TEST A/D CONVERTER STABILITY UNDER DIFFERENT
OPERATING MODES AND CONDITIONS AND 4) EVALUATE OVERALL
A/D CONVERTER PERFORMANCE.  IT IS A VERY FLEXIBLE PROGRAM
THAT ENABLES THE OPERATOR TO CHANGE PROGRAMMABLE PARAM-
ETERS DURING INDIVIDUAL ROUTINE OPERATION, SELECT TESTS
FROM A SINGLE STARTING ADDRESS, ENTER AN INTERNAL OCTAL
DEBUGGER FOR ERROR ISOLATION AND OTHER FUNCTIONS.
THERE ARE SEVERAL OPERATOR/PROGRAM INTERACTIONS THAT ARE
POSSIBLE (BUT NOT NECESSARY) SUCH AS DETAILED ERROR AND
CONFIGURATION SUMMARY REPORTS AND THE ABILITY TO PERFORM
DIFFERENT ACTIONS WHEN AND IF AN ERROR OCCURS DURING
PROGRAM OPERATION.
THIS EXERCISER CONTAINS THE FOLLOWING ROUTINES, THAT
WILL BE DESCRIBED IN FULL:
1) A/D ANALOG MULTIPLIER (INPUT) CHANNEL SCANNER
2) A/D CALIBRATION
3) A/D HISTOGRAM
4) A/D HISTOGRAM WITH DATA CHANNEL EXERCISER
THE CHANNEL SCANNER ALLOWS THE OPERATOR TO EASILY
INSPECT THE VALUES PRESENT AT THE MULTIPLIER INPUTS.
THE A/D CALIBRATION, USED IN CONJUNCTION WITH CALIBRA-
TION PROCEDURES INCLUDED, ENABLES ACCURATE OFFSET AND
GAIN ADJUSTMENTS ON THE CONVERTER MODULE TO BE MADE.
ACCURATE CALIBRATION IS NECESSARY TO INSURE A/D DATA
VALIDITY.  THE A/D HISTOGRAM IS A TEST FOR THE
STABILITY OF THE A/D CONVERTER AND MULTIPLIER SECTIONS.
THE HISTOGRAM WITH DATA CHANNEL (OCH) EXERCISER IS
INCLUDED TO CHECK HOW THE A/D BEHAVES IN THE PRESENCE
OF OTHER SYSTEM ACTIVITY (NOISE).
THIS PROGRAM IS AN OPEN-ENDED EXERCISER, IN THAT THE
OPERATOR APPLIES KNOWN INPUTS (VOLTAGES) TO THE
A/D VIA THE MULTIPLIER CHANNELS, AND EVALUATES
THE CONVERTER PERFORMANCE BY INSPECTING THE DATA
RETURNED.  SEVERAL DIFFERENT TYPES OF ERRORS ARE
DETECTED AND REPORTED, BUT NO PASS/FAIL INFORMATION
IS REPORTED.  THE ACCEPTABILITY OF THE A/D'S PERFORMANCE
BELONGS TO THE OPERATOR.

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10007 .MAIN
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02 PROGRAM DESCRIPTION: ANALOG MULTIPLEXER CHANNEL SCANNER
03
04 THIS PROGRAM IS USED TO INSPECT THE VOLTAGES (VALUES)
05 PRESENT AT THE SPECIFIED MULTIPLEXER ANALOG INPUT
06 CHANNELS. THE ROUTINE SCANS (SAMPLES) THE CHANNELS
07 AND DISPLAYS THE DATA VALUES RECEIVED IN TABULAR
08 FORM TO THE OUTPUT DEVICE.
09
10 WHEN FIRST STARTED, THE DEFAULT PARAMETERS WILL BE:
11 - PROGRAMMED I/O (PIO) MODE
12 - START (STRT) PULSE TRIGGERING, NO SYNCRONIZATION
13 - MULTIPLEXER TYPE IS DIFFERENTIAL
14 - INITIAL MUX CHANNEL IS CHANNEL 0
15 - FINAL MUX CHANNEL IS CHANNEL 17 (OCTAL)
16
17 HOWEVER, THESE PARAMETERS CAN BE CHANGED DURING PROGRAM
18 OPERATION (SEE SECTION 9 - OPERATOR INPUTS) TO ANY
19 A/D MODE, TRIGGERING ETC.
20
21 THE PROGRAM SCANS ALL CHANNELS UNDER TEST IN THE
22 DESIRED A/D PARAMETER CONFIGURATION (SEI-UP), STORES
23 THE RESULTS IN A TABLE, THEN OUTPUTS THE TABLE TO
24 THE OPERATOR. THE CYCLE IS THEN REPEATED.
25
26 OUTPUT FORMAT:
27 CHANNEL DATA MV MMM/TTT
28 I XXXXX YYY
29 * *
30 * XXXXX YYY
31 F
32 WHERE:
33 I = INITIAL MUX CHANNEL (0 - 17 OCTAL)
34 F = FINAL MUX CHANNEL (0 - 17 OCTAL)
35 XXXXX = CHANNEL VALUE CONVERTED BY THE A/D
36 (OCTAL DATA IS LEFT JUSTIFIED TO BIT 0)
37 YYY = THE SIGNED DECIMAL MILLIVOLT EQUIVALENT OF
38 THE DATA (XXXXX); ACCURACY IS +/- 1 LSB
39 MMM/TTT = A/D MODE (MMM) AND TRIGGERING (TTT)
40 THAT THE SCAN WAS PERFORMED IN
41 (NOTE: INITIAL AND FINAL CHANNELS CAN BE THE SAME)
42
43 TO STOP THE MUX SCAN OUTPUT FOR INSPECTION OF A
44 PARTICULAR RESULT, HIT THE "SPACE" BAR ON THE TTY.
45 HIT "SPACE" AGAIN TO RESUME OUTPUT.
46
47
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10008 .MAIN
01
02 PROGRAM DESCRIPTION: A/D CALIBRATION
03
04 THIS PROGRAM IS INTENDED TO BE USED IN CONJUNCTION
05 WITH THE A/D CALIBRATION PROCEDURES OUTLINED IN
06 SECTION 7.2.3 FOR CALIBRATION OF AN A/D CONVERTER.
07
08 THE PROGRAM CONTINUALLY SAMPLES A SINGLE, SPECIFIED
09 MULTIPLEXER CHANNEL IN THE DESIRED A/D PARAMETER
10 CONFIGURATION, AND DISPLAYS THE MUX CHANNEL DATA
11 (IN SETS OF EIGHT CONVERSIONS) FOR USE IN ADJUSTING
12 THE A/D CONVERTER SUBSYSTEM FOR OFFSET AND GAIN.
13
14 WHEN FIRST STARTED, THE DEFAULT PARAMETERS WILL BE:
15 - PROGRAMMED I/O (PIO) MODE
16 - START (STRT) TRIGGERING, NO SYNCRONIZATION
17 - MUX TYPE IS DIFFERENTIAL
18 - SAMPLE CHANNEL = 0 (INITIAL CHANNEL = FINAL CHANNEL)
19
20 HOWEVER, THESE PARAMETERS CAN BE CHANGED DURING PROGRAM
21 OPERATION (SEE SECTION 9 - OPERATOR INPUTS).
22
23 OUTPUT FORMAT:
24
25 THE CHANNEL'S VALUE IS DISPLAYED CONTINUOUSLY (8 DATA
26 VALUES PER LINE) TO THE OUTPUT DEVICE. THE FORMAT OF
27 THE DATA IS AS FOLLOWS:
28 - IF "SWREG" SWITCH 0 = 0, THE DATA IS IN OCTAL. THE
29 ANALOG VOLTAGE PRESENT AT THE CHANNEL UNDER TEST. IT
30 IS LEFT JUSTIFIED TO BIT 0 (BITS 12-15 = 0).
31 - IF "SWREG" SWITCH 0 = 1, THE DATA IS THE SIGNED,
32 DECIMAL MILLIVOLT EQUIVALENT OF THE CONVERTED DATA.
33
34 OTHER FEATURES:
35
36 THE PROGRAM WILL ONLY OUTPUT DATA (OCTAL OR MILLIVOLTS)
37 IF "SWREG" SWITCH C = 0. IF SWITCH C = 1, THE PROGRAM WILL
38 NOT DISPLAY THE RESULTS. INSTEAD, THE PROGRAM WILL
39 ONLY PERFORM A/D CONVERSIONS AT HIGH SPEED. THIS IS
40 USED 1) TO INSPECT THE CONVERSION CYCLE (I.E. FOR ERROR
41 DETECTION WITH AN OSCILLOSCOPE OR ANALYSER) AND 2) TO
42 USE THE "ADC CROSS PLOT" TEST AS A DIFFERENT MEANS OF
43 CALIBRATING THE A/D CONVERTER OR INSPECTION OF DATA
44 BEING CONVERTED BY THE A/D.
45
46 IN ADDITION, HITTING "SPACE" ON THE TTY KEYBOARD WILL
47 STOP THE OUTPUT OF DATA FOR INSPECTION. HIT "SPACE"
48 AGAIN TO RESUME OUTPUT.

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; /,2*5 A/D CONVERTER CALIBRATION PROCEDURES
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; THE FOLLOWING IS A DESCRIPTION OF HOW TO PROPERLY
; ADJUST THE A/D CONVERTER MODULE FOR OFFSET AND GAIN.
; A PRECISION DC VOLTAGE SOURCE (10 VDC ± MAXIMUM) AND
; A 4 1/2 DIGIT DIGITAL MULTIMETER (DMM) OR EQUIVALENT
; IS REQUIRED.
;
; CALIBRATION OF THE 4223 A/D CONVERTER
;
; # OF BITS =12
; RESOLUTION (MV/BIT): 1.22 FOR UNIPOLAR 5V FULL SCALE
; 2.44 FOR UNIPOLAR 10V FULL SCALE
; 2.44 FOR BIPOLAR 5V FULL SCALE
; 4.88 FOR BIPOLAR 10V FULL SCALE
;
; RANGES ARE: 0-5, 0-10, +/-5, +/-10 VOLTS
;
; "DATA" IN THE FOLLOWING PROCEDURE REFERS TO
; DATA 0-11: BIT 0=MSB, BIT 11=LSB FOR
; UNIPOLAR MODE; BIT 0=SIGN, BIT 1=MSB AND
; BIT 11=LSB FOR BIPOLAR MODES. WHEN REP-
; RESENTED IN OCTAL, DATA IS LEFT JUSTIFIED
; WITH UNUSED BITS=0.
;
; TO CALIBRATE THE 4223 A/D CONVERTER, FIRST START THE
; A/D CALIBRATION (SEE SECTION 9 FOR TEST STARTING
; INFORMATION; SEE SECTION 7.2.2 FOR A DESCRIPTION
; OF TEST OPERATION).
;
; A/D CALIBRATION IS ACCOMPLISHED BY APPLYING
; A KNOWN, ACCURATE VOLTAGE DIRECTLY TO THE MULTIPLIER
; INPUT(S) OF THE A/D INTERFACE AND ADJUSTING THE GAIN
; AND OFFSET TRIMPTS FOR APPROPRIATE A/D OUTPUT DATA.
; CHANNEL 0 CAN BE USED FOR CALIBRATION (SEE SECTION
; 7.1 FOR CHANNEL NUMBERING INFORMATION).
;
; *****
; NOTE: THE OCTAL DATA VALUES GIVEN ARE FOR THE FOLLOWING
; CODING CONVENTIONS (SEE SECTION 11.5 FOR MORE INFORMATION):
; - UNIPOLAR VALUES: CODING = OFFSET BINARY
; - BIPOLAR VALUES: CODING = TWO'S COMPLEMENT
; *****
; OFFSET ADJUST POTENTIOMETER IS R20
; GAIN ADJUST POTENTIOMETER IS R21
;
; *****
; UNIPOLAR CALIBRATION
; *****
; LISTED BELOW ARE VOLTAGES TO BE APPLIED TO
; THE A/D INPUT, THEIR CORRESPONDING A/D OUTPUT
; CODES WHEN CORRECTLY ADJUSTED AND THE TRIMPT
; USED TO ACHIEVE THE CORRECT ADJUSTMENT
;
; STEPS 1 AND 2 ARE FOR TRIMPT ADJUSTMENT TO
; GIVE CORRECT CODE FOR APPLIED VOLTAGES. ASTERISKS
; INDICATE A VOLTAGE/CODE CHECK ONLY, IF DATA IS
; INCORRECT, REPEAT STEPS 1 AND 2.
;
; STEP INPUT VOLTAGE A/D OUTPUT CODE TRIMPT RANGE
; ----
; 1 0.0024 000040 OFFSET 0-5V
; 2 4.9963 177720 GAIN 0-5
; 3 0.0000 000000 * 0-5
; 4 4.9988 177760 * 0-5
;
; 1 0.0048 000040 OFFSET 0-10V
; 2 9.9927 177720 GAIN 0-10
; 3 0.0000 000000 * 0-10
; 4 9.9976 177760 * 0-10
;
; BIPOLAR CALIBRATION
; *****
; LISTED BELOW ARE VOLTAGES TO BE APPLIED TO THE
; A/D INPUT, THEIR CORRESPONDING A/D OUTPUT
; CODES WHEN CORRECTLY ADJUSTED AND THE TRIMPT
; USED TO ACHIEVE THE CORRECT ADJUSTMENT.
;
; STEPS 1 AND 2 ARE INTENDED FOR TRIMPT ADJUST-
; MENT TO GIVE CORRECT OUTPUTS FOR
; SPECIFIC APPLIED VOLTAGES. STEPS 3-5 ARE CHECKS.
; IF INCORRECT DATA REPEAT STEPS 1 AND 2, THEN
; RE-CHECK.
;
; STEP INPUT VOLTAGE OUTPUT CODE TRIMPT RANGE
; ----
; 1 -4.9951 100040 OFFSET +/-5V
; 2 +4.9927 077720 GAIN +/-5
; 3 0.0000 000000 * +/-5
; 4 -5.0000 100000 * +/-5
; 5 +4.9976 077760 * +/-5
;
; 1 -9.9902 100040 OFFSET +/-10V
; 2 +9.9854 077720 GAIN +/-10
; 3 0.0000 000000 * +/-10
; 4 -10.0000 100000 * +/-10
; 5 +9.9951 077760 * +/-10
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PROGRAM DESCRIPTION: A/D HISTOGRAM WITH DCH EXERCISER
(CATS/KITTEN)

THIS PROGRAM IS INTENDED TO BE USED AS A MEANS OF
CHECKING A/D CONVERTER STABILITY. THE PROGRAM
CONTINUALLY SAMPLES A SINGLE, SPECIFIED MULTIPLIER
CHANNEL, STORES THE DATA IN A BLOCK, THEN SORTS
THE CONVERTED DATA INTO A HISTOGRAM (SEE THEORY OF
OPERATION SECTION). THE CYCLE THEN REPEATS. THE
HISTOGRAM RESULTS CAN DISPLAYED AT ANY TIME. THE
A/D CONVERTER SUBSYSTEM (CONVERTER MODULE, ANALOG
MULTIPLEXER AND ANALOG PATHS). WHEN RUN WITH THE
DATA CHANNEL EXERCISER (DCH), THIS PROGRAM IS USED
TO DETERMINE HOW THE STABILITY IS AFFECTED WHEN
OTHER SYSTEM ACTIVITY IS PRESENT (BUS NOISE DUE
TO DATA CHANNEL ACTIVITY).

WHEN FIRST STARTED, THE DEFAULT PARAMETERS WILL BE:
- PROGRAMMED I/O (PIO) MODE
- START PULSE TRIGGERING (STRT), NO SYNCHRONIZATION
- MUX TYPE IS DIFFERENTIAL
- SAMPLE CHANNEL = 0 (INITIAL CHANNEL = FINAL CHANNEL)

HOWEVER, THESE PARAMETERS CAN BE CHANGED DURING
PROGRAM OPERATION (SEE SECTION 9 - OPERATOR INPUTS).

WHEN FIRST STARTED, THE FOLLOWING QUESTION WILL BE
ASKED:
"SAMPLE CENTER VALUE = "

THERE ARE TWO POSSIBLE RESPONSES:
- THE OPERATOR INPUTS AN OCTAL DATA VALUE
- THAT REPRESENTS THE DESIRED HISTOGRAM CENTER
VALUE. THE 12-BIT DATA WORD CORRESPONDING TO
THIS VALUE IS IN THE RANGE FROM 0 TO 177760
(A 12-BIT DATA VALUE, LEFT JUSTIFIED TO BIT
0, WITH BITS 12-15 = 0). FOR EXAMPLE, 1 LEAST
SIGNIFICANT BIT (LSB) IS REPRESENTED AS OCTAL
20, AND A FULL COUNT IS OCTAL 177760. LEADING
ZEROS ARE NOT NECESSARY. A "CR" MUST FOLLOW THIS
DATA VALUE. IF "CR" ONLY IS ENTERED, THE QUESTION
IS SKIPPED WITHOUT CHANGING THE CENTER VALUE.

- IF THE RESPONSE IS AN ASCII "A", THEN THE PROGRAM
WILL DETERMINE THE CENTER VALUE FOR YOU BY
TAKING 8. SAMPLES FROM THE CHANNEL SPECIFIED,
AND USING THEIR AVERAGE AS THE CENTER VALUE.

ANY OTHER RESPONSE WILL CAUSE AN ERROR MESSAGE
AND A LIST OF VALID INPUTS TO THE QUESTION
TO BE TYPED.

NOTE: SEE DGC PART # 094-782 FOR INFORMATION
PERTAINING TO THE DTOS MOVING HEAD DISK DCH
EXERCISER PROGRAM.

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10012 .MAIN

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? THE HISTOGRAM RUNS CONTINUOUSLY UNTIL TERMINATED
? BY THE OPERATOR. TO DISPLAY THE RESULTS, HIT
? THE "SPACE" BAR ON THE TTY KEYBOARD (ONE REPORT
? PER ENTRY). (SPECIAL NOTE: IF RUNNING WITH THE
? DCH EXERCISER, THE EXERCISER PROGRAM DOES NOT
? START UNTIL THE HISTOGRAM IS DISPLAYED ONCE. IT WILL
? INDICATE THAT IT HAS STARTED BY PRINTING "S" ON THE
? CONSOLE DEVICE. AFTER STARTING, A NEW HISTOGRAM IS
? ALSO STARTED.)

? THE ACTION TAKEN AFTER THE RESULTS ARE DISPLAYED
? DEPENDS ON THE STATE OF "SWREG" SWITCH E.
? IF SWITCH E = 0, THEN THE EXISTING HISTOGRAM IS
? MERELY CONTINUED. IF SWITCH E = 1, THEN A NEW
? HISTOGRAM IS STARTED AFTER THE RESULTS ARE TYPED.
? (IF AUTO CENTER WAS SELECTED, A NEW CENTER VALUE
? WILL BE CALCULATED ALSO). IF AN A/D PARAMETER CHANGE
? OCCURS DURING HISTOGRAM OPERATION, A NEW HISTOGRAM
? WILL BE STARTED, INCLUDING A NEW AUTO-CENTER VALUE
? CALCULATION IF SO INDICATED. THIS IS NECESSARY, SINCE
? VALUES RECEIVED FROM THE MUX CHANNEL INPUTS CAN CHANGE
? (I.E. WHEN THE MUX TYPE IS CHANGED FROM DIFFERENTIAL TO
? SINGLE ENDED ETC.).

? OTHER NOTES:

? THE DATA BLOCK USED FOR CONVERTED DATA TEMPORARY
? STORAGE HAS A RANDOM STARTING ADDRESS AND A
? RANDOM WORD COUNT (BUT <= 400). THIS PROVIDES
? AN ADDED CHECK OF THE ADDRESS AND WORD COUNT
? REGISTERS WHEN OPERATING IN DATA CHANNEL MODE.
? NO PROGRAM DESTRUCTION WILL OCCUR.

? SPECIAL NOTE:

? WHEN RUNNING THIS PROGRAM WITH THE DCH EXERCISER (CATS)
? THE DCH EXERCISER MAY REPORT AN "I/O ADDR ERROR" FOLLOWED
? BY TWO OCTAL NUMBERS. THIS ERROR, IF IT OCCURS, WILL BE
? REPORTED WHEN AN OUTPUT REQUEST IS MADE (I.E. HISTOGRAM
? RESULTS PRINTOUT TO THE TTY), AND WILL BE REPORTED MORE
? FREQUENTLY FOR CONSOLES THAT HAVE SLOW BAUD RATES. THIS
? ERROR INDICATES THAT AN INTERRUPT WAS NOT RECEIVED FROM
? THE DISK WITHIN 20 MS FROM INITIATION OF A DISK DCH CYCLE
? (DUE TO INTERRUPTS BEING DISABLED DURING THIS TIME PERIOD
? IN THE A/D EXERCISER PROGRAM). THESE ERRORS SHOULD NOT,
? HOWEVER, BE REPORTED DURING NORMAL HISTOGRAM OPERATION
? (I.E. DURING CONTINUOUS PERIODS OF A/D SAMPLING WITHOUT
? ANY OUTPUT REQUESTS) IF ALLOWED TO RUN LONG ENOUGH
? WITHOUT OUTPUT REQUESTS, THE DCH EXERCISER SHOULD
? INDICATE A PASS BY PRINTING "P" ON THE OUTPUT DEVICE
? (UNLESS A HARD ERROR ACTUALLY EXISTS IN THE DISK). THE
? FIRST "P" SHOULD OCCUR WITHIN APPROXIMATELY 5 MINUTES
? FROM THE STARTING OF THE DCH EXERCISER.

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10015 .MAIN
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UPDATING MODES/SWITCH COMMANDS:
-----
LOCATION "SWREG" IS USED TO SELECT THE PROGRAM OPTIONS
(LAND SPECIAL OPTIONS), WHILE RUNNING UNDER DTOS,
THIS LOCATION WILL BE LOADED BY THE MONITOR.
HOWEVER UNDER STAND ALONE AND PROGRAM LOAD MODES THIS
LOCATION WILL BE SET ACCORDING TO THE ANSWERS SUPPLIED
BY THE OPERATOR. IN ANY CASE THE OPTIONS CAN BE CHANGED
OR VERIFIED BY USING ONE OF THE COMMANDS GIVEN IN SEC.
8.2

8.1.0 SWITCH OPTIONS - STANDARD (DTOS) SWITCHES:
DIFFERENT BITS AND THEIR INTERPRETATION AT LOCATION
"SWREG" IS AS FOLLOWS:
BIT OCTAL BINARY INTERPRETATION
VALUE VALUE
1 40000 1 LOOP ON ERROR
DO NOT LOOP ON ERROR
2 20000 1 PRINT TO CONSOLE
DO NOT PRINT OUT TO CONSOLE
5 02000 1 DO NOT PRINT ON THE LINE PRINTER
PRINT ON THE LINE PRINTER
6 01000 1 DO NOT HALT ON ERROR
HALT ON ERROR
7 00400 1 DO NOT PRINT ERROR SUMMARY
PRINT ERROR SUMMARY

8.1.1 SWITCH OPTIONS - SPECIAL EXERCISER FUNCTIONS
BIT OCTAL BINARY INTERPRETATION
VALUE VALUE
C 00010 1 PRINT TEST DATA
DO NOT PRINT DATA, ONLY PERFORM
A/D CONVERSIONS (CALIBRATION ONLY)
D 00004 1 PRINT A/D DATA IN OCTAL
PRINT A/D DATA IN SIGNED DECIMAL
MILLIVOLTS (CALIBRATION ONLY)
E 00002 1 DO NOT DESTROY HISTOGRAM ON OUTPUT
START NEW HISTOGRAM ON OUTPUT
(HISTOGRAM ONLY)

10016 .MAIN
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SWITCH COMMANDS
UNCE THE PROGRAM STARTS EXECUTING THE STATE OF ANY OF
THE BITS CAN BE CHANGED BY HITTING KEYS 1-9, A-F. THE
PROGRAM WILL CONTINUE RUNNING AFTER UPDATING THE OPTIONS.
EACH KEY WILL COMPLEMENT THE STATE OF THE BIT AFFILIAT-
ED WITH IT, THUS BIT 4 CAN BE ALTERED BY HITTING KEY 4.
SETTING OF ANY BIT OF LOCATION "SWREG" WILL SET BIT 0.
(DEFAULT MODE IS DEFINED AS ALL BITS OF SWREG SET TO 0)
THE PROGRAM CAN BE LOCKED INTO SWITCH MODIFICATION MODE
BY TYPING A 0, IN WHICH CASE MORE THAN ONE BIT CAN BE
CHANGED BEFORE CONTROL IS ALLOWED TO RETURN TO THE
MAIN PROGRAM.

8.2.1 OTHER COMMANDS
"CK" A "RETURN" CAN BE TYPED TO CONTINUE THE PROGRAM
AFTER ITS LOCKED IN A SWITCH MODIFICATION MODE
TO DEFAULT MODE AND RESTART THE PROGRAM.
"D THIS COMMAND GIVEN AT ANY TIME WILL RESET "SWREG"
"R THIS COMMAND GIVEN AT ANY TIME WILL RESTART THE
PROGRAM. SWITCHES ARE LEFT WITH THE VALUES THEY
HAD BEFORE THE COMMAND WAS ISSUED.
"O THIS COMMAND GIVEN AT ANY TIME WILL CAUSE THE
PROGRAM TO GO TO THE OCTAL DEBUG TOOL (ODT).
M THIS COMMAND GIVEN AT ANY TIME WILL PRINT THE
CURRENT VALUE OF THE SWITCHES (OPERATING MODES).

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10017 .MAIN

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01 19. OPERATING PROCEDURE/OPERATOR INPUTS:
02 -----
03 NOTE: THE POWER SHOULD ALWAYS BE OFF DURING INSERTION
04 AND REMOVAL OF THE A/D INTERFACE (OR ANY BOARD)
05 INTO MICRO NOVA CHASSIS.
06
07 19.1
08
09 1. INSERT A/D INTERFACE INTO AN I/O SLOT
10 WITH THE INTERRUPT PRIORITY (/INTP//) AND
11 DATA CHANNEL PRIORITY (/DCHP//) I/O LINES
12 PROPERLY JUMPED.
13 2. LOAD THE EXERCISER VIA PAPER TAPE OR
14 DUUS DISKETTE.
15 3. STARTING ADDRESS IS 200 (OR 500) OCTAL
16 4. AFTER THE PROGRAM HAS BEEN STARTED, THE
17 MEMORY WILL BE SIZED AND THE MESSAGE
18
19 "TOP OF MEMORY - XXXXX"
20
21 WILL BE PRINTED WHERE XXXXX IS THE
22 HIGHEST LOGICAL MEMORY ADDRESS IN
23 OCTAL.
24 5. AFTER THE PROGRAM TITLE IS PRINTED, ANSWER
25 THE FOLLOWING QUESTIONS:
26
27 "DEVICE CODE - "
28
29 ENTER THE 6-BIT DEVICE CODE OF THE
30 A/D INTERFACE IN OCTAL.
31 (MUST BE < 77 OCTAL).
32
33 "RANGE? "
34
35 THIS IS THE VOLTAGE RANGE OF THE A/D. ENTER:
36 - L FOR 5 VOLT RANGE (0-5 OR +/- 5)
37 - H FOR 10 VOLT RANGE (0-10 OR +/- 10)
38
39 "POLARITY? "
40
41 THIS IS THE POLARITY OF THE A/D. ENTER:
42 - U FOR UNIPOLAR (0-5 OR 0-10)
43 - B FOR BIPOLAR (+/- 5 OR +/- 10)
44
45 "TEST? "
46
47 THIS IS THE DESIRED TEST TO BE RUN. ENTER:
48 - S FOR ANALOG MULTIPLEXER CHANNEL SCANNER
49 - C FOR A/D CALIBRATION
50 - H FOR A/D HISTOGRAM
51 - D FOR A/D HISTOGRAM WITH DCH EXERCISER
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10018 .MAIN

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ANY INVALID ENTRY CAUSES AN ERROR MESSAGE, AND
A LIST OF VALID RESPONSES FOR THE QUESTION
TO BE TYPED. IF "CR" IS ENTERED ONLY, THE
QUESTION IS SKIPPED, AND THE PARAMETER THAT
WAS PREVIOUSLY ENTERED WILL REMAIN. NOTE THAT
ON INITIAL PROGRAM LOADING, THE DEFAULT
PARAMETERS WILL BE USED. THEY ARE:
- RANGE = L (5V)
- POLARITY = U (UNIPOLAR)
- TEST = S (MUX CHANNEL SCANNER)

ALSO NOTE THAT IF TEST "D" (HISTOGRAM W/DCH
EXERCISER) IS SELECTED, THE CATS/KITTEN DCH
EXERCISER MUST BE LOADED WITH THIS PROGRAM
(I.E. A "CLOAD" IF RUNNING UNDER DTOS DISKETTE).

OPERATOR INPUTS DURING PROGRAM OPERATION:

THERE ARE SEVERAL OPERATOR INPUTS THAT CAN BE
ENTERED DURING THE OPERATION OF ANY OF THE TESTS
INCLUDED IN THIS EXERCISER. THEY ARE USED TO
PERFORM SEVERAL DIFFERENT FUNCTIONS. THESE
INPUTS FALL INTO ONE OF SEVERAL CLASSES AS FOLLOWS:
- INPUTS THAT CHANGE OR DISPLAY THE "SWREG" SWITCHES
- INPUTS THAT ALTER PROGRAM OR TEST FLOW
- INPUTS THAT CONTROL PROGRAM OUTPUT
- INPUTS THAT DISPLAY INFORMATION TO THE OPERATOR
- INPUTS THAT ALTER A/D PROGRAMMABLE PARAMETERS

WHEN RUNNING A TEST, THE FOLLOWING COMMANDS CAN
BE ENTERED TO PERFORM THEIR CORRESPONDING ACTION:

ENTER:          TO PERFORM FUNCTION:
-----
0 - 9, A - F SET/CLEAR SELECTED "SWREG" SWITCH
(SEE SECTION 8)
N                DISPLAY "SWREG" SWITCHES
CNTRL = 0       ENTER OCTAL DEREG TOOL (ODT)
CNTRL = R       RESTART PROGRAM (NO SWREG CHANGE)
CNTRL = D       RESTART PROGRAM (DEFAULT SWREG)
CNTRL = T       SELECT A NEW TEST
CNTRL = S       PRINT THE A/D SET-UP SUMMARY
ESC             ENTER A/D EXERCISER COMMAND MODE
(SEE BELOW)
SPACE          STOP/START TEST ROUTINE OUTPUT
(MUX CHANNEL SCANNER, CALIBRATION)
?             OR REQUEST TEST RESULTS (HISTOGRAM)
              PRINT A LIST OF POSSIBLE COMMANDS

ALL INPUTS ARE ECHOED. ANY INVALID INPUT CAUSES THE
MESSAGE "TYPE ? FOR HELP" TO BE PRINTED.

IF "ESC" (ESCAPE) IS ENTERED, THE PROGRAM WILL ENTER
THE A/D EXERCISER COMMAND MODE.
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10019 -MAIN
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19.3 A/D EXERCISER COMMAND MODE SUMMARY:
: THIS SECTION ALLOWS THE OPERATOR TO ALTER THE A/D
: PROGRAMMABLE FUNCTIONS DURING TEST OPERATION.
: OPERATOR MUST ENTER AN ESCAPE "ESC" CHARACTER
: TO ENTER THE A/D EXERCISER COMMAND INTERPRETER.
: ON ENTERING THE COMMAND INTERPRETER THE FOLLOWING
: PROMPT WILL BE TYPED:
: "COMMAND? "
: POSSIBILITIES ARE:
: - M = MODE
: - I = TRIGGERING
: - I = INITIAL MUX CHANNEL
: - P = FINAL MUX CHANNEL
: - X = MUX TYPE
: IF "M" WAS THE COMMAND, THE FOLLOWING IS TYPED:
: "MODE? "
: POSSIBILITIES ARE:
: - P = PROGRAMMED I/O (PIO) MODE
: - D = DATA CHANNEL (DCH) MODE
: IF "I" WAS THE COMMAND, THE FOLLOWING IS TYPED:
: "TRIGGERING? "
: POSSIBILITIES ARE:
: DCH MODE
: *****
: P = IOPLS, NO SYNC
: D = DCHI, NO SYNC (MAX RATE)
: I = STRT, INT CLK SYNC I = INT CLK SYNC
: E = STRT, EXT CLK SYNC E = EXT CLK SYNC
: WHERE: INT CLK = INTERNAL CLOCK (ON BOARD)
: EXT CLK = EXTERNAL CLOCK
: IF "I" WAS THE COMMAND, THE FOLLOWING IS TYPED:
: "INITIAL CHANNEL? "
: POSSIBILITIES ARE:
: - 0 - 17 (OCTAL) FOLLOWED BY "CR"

10020 -MAIN
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: IF "F" WAS THE COMMAND, THE FOLLOWING IS TYPED:
: "FINAL CHANNEL? "
: POSSIBILITIES ARE:
: - 0 - 17 (OCTAL) FOLLOWED BY A "CR"
: NOTE: THE FINAL CHANNEL IS ONLY USED BY THE MUX
: CHANNEL SCANNER, AND IGNORED BY OTHER TESTS.
: IF "X" WAS THE COMMAND, THE FOLLOWING IS TYPED:
: "MUX TYPE? "
: POSSIBILITIES ARE:
: - S = SINGLE-ENDED (16. CHANNELS)
: - D = DIFFERENTIAL (8. CHANNELS)
: A "CR" ENTERED AS THE RESPONSE FOR ANY QUESTION WILL
: TERMINATE THE COMMAND INPUT SEQUENCE WITH NO AFFECT
: TO ANY PARAMETERS.
: AN INVALID RESPONSE TO ANY QUESTION CAUSES A LIST OF
: VALID RESPONSE POSSIBILITIES TO BE PRINTED.
: IF A VALID RESPONSE IS INPUT (NOT "CR") TO A QUESTION,
: (REGARDLESS OF WHETHER OR NOT THE PARAMETER WAS
: ACTUALLY CHANGED), AN A/D SET-UP CHANGE IS ASSUMED.
: THIS INDICATES THAT THE A/D MODE WORD MUST BE ADJUSTED
: TO ACCOUNT FOR THE CHANGE. THEREFORE AFTER THE PARAMETER
: IS "ALTERED", THE A/D MODE WORD IS ADJUSTED, AND THE
: PROGRAM CONTINUES NORMALLY FROM WHERE IT LEFT OFF.
: IN THE CASE OF THE A/D HISTOGRAM PROGRAM, A NEW
: HISTOGRAM IS STARTED AFTER THE A/D PARAMETER CHANGE
: IS MADE.
: *****
: NOTE: THE COMBINATION OF "PIO" MODE AND "DCHI" TRIGGERING
: IS AN INVALID A/D OPERATING CONDITION. IF AN ATTEMPT IS
: MADE TO USE THE A/D IN THIS MODE/TRIGGERING (PIO/DCHI),
: A "CONVERSION TIME OUT" WILL BE REPORTED (SEE SECTION
: 10 - ERRORS). THIS CAN BE ELIMINATED BY CHANGING THE
: INCORRECT A/D PARAMETERS TO A VALID COMBINATION.
: *****

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10021 .MAIN
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PROGRAM OUTPUT/ERROR DESCRIPTION:
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1) ALL PROGRAM OUTPUTS, BOTH MESSAGES AND ERROR
   REPORTS, ARE CONTROLLED BY THE VALUE OF "SMREG"
   (SEE SECTION 8) SWITCHES 2 AND 5 AS FOLLOWS:

2) SWITCH PRINTOUT IO
   2-----5
   LPT
   YES NO
   0 0
   1 1
   0 NO
   1 NO
   1 YES

:10.1 ERROR DESCRIPTIONS:
:
: ERRORS THAT DETECTED AND REPORTED ARE:
: (SEE BELOW FOR MORE DETAILED ERROR DESCRIPTIONS)
:
: 1) CONVERSION TIME OUTS
: - OCCURS IF AN END OF CONVERSION (OR CYCLE) INTERRUPT
: IS NOT REQUESTED AT THE END OF THE CONVERSION CYCLE.
: 2) DCH CONVERSION ERROR
: - OCCURS IF THE DCH FINAL ADDRESS DOES NOT AGREE WITH
: THE EXPECTED FINAL ADDRESS (CALCULATED FROM THE DCH
: STARTING ADDRESS AND WORD COUNT LOADED).
: 3) DCH DATA ERROR
: - OCCURS IF A WORD(S) IN THE CONTIGUOUS DATA BLOCK WAS
: SKIPPED (NOT WRITTEN INTO) DURING A DCH OPERATION.
: 4) A/D STATUS ERROR
: - OCCURS IF THE A/D STATUS REGISTER CONTENTS DO NOT
: AGREE WITH THE EXPECTED STATUS (CHECKED AT THE START
: AND END OF EACH CONVERSION CYCLE).
:
: ERRORS 2) AND 3) ABOVE ARE REPORTED IN DCH MODE ONLY.

:10.2 ERROR FORMATS:
:
: 1) "CONVERSION TIME OUT
: DIA = (A/D STATUS) (MODE/TRIGGER SELECT)
: CONVERSIONS: EXPECTED = (X) RECEIVED = (Y)"
:
: 2) "DCH CONVERSION ERROR
: DIB = (DCH ADDRESS REGISTER)
: CONVERSIONS: EXPECTED = (X) RECEIVED = (Y)"
:
: 3) "DCH DATA ERROR AT (ADDR)"
:
: 4) "A/D STATUS ERROR"
: GOOD/BAD
: 666666 888888"

10022 .MAIN
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ERROR DESCRIPTIONS (DETAILED):
:
: 1) A CONVERSION TIME OUT IS REPORTED IN THE EVENT
: THAT AN INTERRUPT IS NOT REQUESTED WITHIN A
: SPECIFIED AMOUNT OF TIME AFTER THE STARTING OF
: A CONVERSION OR DCH CONVERSION CYCLE. THIS
: INTERRUPT RESULTS FROM "END OF CONVERSION" (EOC)
: IN PIO MODE OR "WORD COUNT=0" (AS A RESULT OF THE
: LAST CONVERSION OF A DCH CYCLE) IN DCH MODE.
: THE A/D MODE (PIO OR DCH) AND THE TRIGGER SELECT
: (STRT, IOPLS, INT/EXT CLK, DCHI) ARE PRINTED AS
: WELL AS THE A/D STATUS WORD (DIA).
: SEE SECTION 11.4 FOR A/D STATUS WORD INFORMATION.
: THE # OF CONVERSIONS EXPECTED AND RECEIVED ARE
: ALSO REPORTED AS FOLLOWS:
:
: PIO MODE: (1) EXPECTED, (0) RECEIVED
:
: DCH MODE: (1 - 256.) EXPECTED (DEPENDING ON TEST),
: (Y) RECEIVED. (Y) IS CALCULATED BY
: READING THE DCH ADDRESS REGISTER AND
: SUBTRACTING THE DCH STARTING ADDRESS TO
: DETERMINE THE ACTUAL # OF CONVERSIONS
: PERFORMED.
:
: THE AMOUNT OF TIME THAT THE PROGRAM WAITS FOR
: THE "EOC" INTERRUPT DEPENDS ON THE MODE AND
: TRIGGERING OF THE A/D. THEY ARE AS FOLLOWS:
:
: MODE TRIGGERING INTERRUPT WAIT
: ---
: PIO STRT, INT CLK 600 US
: DCH DCHI, INT CLK 180 MS
: IOPLS 60 US
:
: IN PIO MODE, THERE IS ONE INTERRUPT PER
: SINGLE CONVERSION. FOR DCH (DCHI, INT CLK)
: THE WAIT TIME IS FOR THE ENTIRE DCH CYCLE
: (ALWAYS <= 400 OCTAL CONVERSIONS). FOR
: DCH (IOPLS) THE ENTIRE WAIT TIME IS THE
: TOTAL # OF CONVERSIONS TIMES 60 US.
: NO CONVERSION TIMEOUTS ARE REPORTED IF
: THE TRIGGERING IS EXTERNAL CLOCK (IN
: EITHER PIO OR DCH MODE). HOWEVER, IF THE
: EXTERNAL CLOCK MODE IS BEING USED, AND AN
: ERROR EXISTS, THE PROGRAM IN OPERATION WILL
: APPEAR TO FREEZE. ALL TTY INPUTS ARE STILL
: PROCESSED IN THE USUAL MANNER.
:
: IF A TIME OUT OCCURS, FIRST CHECK IF THE
: TEST CONFIGURATION IS AS SPECIFIED.

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10023 .MAIN

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2) AN A/D CONVERTER DCH ADDRESS CHECK IS PERFORMED ON ALL ROUTINES WHEN OPERATING IN DCH MODE TO INSURE THAT THE # OF CONVERSIONS ACTUALLY RECEIVED IS EQUAL TO THE # THAT ARE EXPECTED. AT THE END OF A DCH CONVERSION CYCLE, THE DCH ADDRESS REGISTER IS READ AND CHECKED TO INSURE THAT THE FINAL DCH ADDRESS IS THE SAME AS THAT CALCULATED FROM THE DCH STARTING ADDRESS AND WORD COUNT (FINAL = STARTING ADDRESS + WORD COUNT). IF THEY ARE NOT EQUAL, A DCH CONVERSION ERROR IS REPORTED. ALONG WITH THE DCH ADDRESS REGISTER CONTENTS (DIB), THE EXPECTED # OF CONVERSIONS AND THE # OF CONVERSIONS ACTUALLY RECEIVED. THE "DIB" WORD IS PRINTED IN OCTAL.

3) IN ADDITION TO AN ADDRESS CHECK (SEE ABOVE) AFTER A DCH CYCLE, THE DCH DATA BLOCK IS ALSO CHECKED TO MAKE SURE THAT ALL ADDRESSES WERE ACTUALLY WRITTEN INTO WITH A/D DATA. BEFORE A DCH CYCLE, THE DCH DATA BLOCK IS INITIALIZED WITH -1'S (17777). IF AFTER THE DCH CYCLE ANY LOCATION WITHIN THE DEFINED DCH BLOCK (SPECIFIED BY THE DCH STARTING ADDRESS AND WORD COUNT) IS STILL = -1 THEN A DCH DATA ERROR IS REPORTED. (ADDR) IS THE DATA WORD ERROR LOCATION.

4) THE A/D STATUS REGISTER IS CHECKED AT THE BEGINNING AND END OF EACH CONVERSION CYCLE TO INSURE PROPER A/D FUNCTIONING. IF A STATUS ERROR IS DETECTED DURING PROGRAM OPERATION, AN A/D STATUS ERROR IS REPORTED ALONG WITH THE GOOD (GGGGGG) AND THE BAD (BBBBBB) STATUS REGISTER CONTENTS (DIA). SEE SECTION 11.4 FOR STATUS INFORMATION.

ERRORS 2) AND 3) ARE ONLY DETECTED AND REPORTED DURING DATA CHANNEL OPERATIONS ON THE A/D INTERFACE. IF EITHER OR BOTH OF THESE ERRORS ARE REPORTED DURING PROGRAM OPERATION, IT GENERALLY INDICATES A PROBLEM WITH THE DCH LOGIC OR TIMING (POSSIBLY DCH CONTENTION). AND IN MOST CASES, THE PROBLEM WILL EXIST IN THE MN403 I/O CONTROLLER CHIP ITSELF (SINCE ALL DCH LOGIC IS CONTAINED IN THIS DEVICE).

10024 .MAIN

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OTHER ERRORS:

- "FATAL STACK BOUNDARY VIOLATION. SP = (XXXXXX)" IS REPORTED, FOLLOWED BY A HALT, IF A STACK BOUNDARY IS CROSSED (256 WDS). XXXXXX IS THE VALUE OF THE STACK POINTER (OCTAL). IF CONTINUED, THE PROGRAM WILL RESTART (200).
- "*** RTC FAILURE ***" IS REPORTED, FOLLOWED BY A HALT IF THE REAL-TIME CLOCK FAILS TO CAUSE INTERRUPTS DURING TIMER VALUE CALCULATIONS.
- "UNIDENTIFIED INTERRUPT = (DVC)" IS REPORTED IF ANY DEVICE OTHER THAN THE A/D INTERFACE REQUESTS AN INTERRUPT DURING EXERCISER OPERATION. DVC = THE OCTAL DEVICE CODE OF THE DEVICE REQUESTING THE INTERRUPT. ALSO, THE PROGRAM WILL ATTEMPT TO CLEAR THE INTERRUPT BY ISSUING AN 'NIOC' INSTRUCTION TO THE DEVICE. (SEE BELOW FOR ACTION TAKEN AFTER THIS ERROR).
- "EXTERNAL INTERRUPT = (DVC)" IS REPORTED IF AN UNEXPECTED A/D EXTERNAL INTERRUPT (CAUSED BY GROUNDING THE /EXT INT REQ/ LINE) DURING EXERCISER OPERATION. THE INTERRUPT IS NOT CLEARED BY THE INTERRUPT SERVICE ROUTINE. DVC IS THE A/D DEVICE CODE (OCTAL). (SEE BELOW FOR ACTION TAKEN AFTER THIS ERROR).

ERROR HANDLING:

THE ACTION TAKEN FOLLOWING ERROR MESSAGE PRINTOUT (EXCEPT FOR A/D EXTERNAL OR UNIDENTIFIED INTERRUPTS) DEPENDS ON THE VALUE OF "SWREG". (SEE SECTION 8). IF SWITCH 6 = 1 THEN THE PROGRAM WILL HALT AFTER THE MESSAGE "HALTED ON ERROR" IS PRINTED. IF SWITCH 1 = 0 THEN THE PROGRAM WILL LOOP ON THE ERROR AFTER THE MESSAGE "LOOPING ON ERROR" IS PRINTED. THIS FORMS A TEST SCOPE LOOP FOR FAILURE TRACING WITH AN OSCILLOSCOPE. IF SWITCH 1 = 0 & SWITCH 6 = 1 THE PROGRAM WILL FIRST HALT, THEN LOOP ON THE ERROR IF THE PROGRAM IS CONTINUED. TO ESTABLISH A HIGH SPEED LOOP (WHEN LOOPING ON ERROR) INHIBIT TTY/PT OUTPUTS. THIS PROVIDES A CONVENIENT METHOD OF ERROR TRACING WITH AN OSCILLOSCOPE OR LOGIC ANALYSER.

IN THE CASE OF AN A/D EXTERNAL INTERRUPT, OR AN UNIDENTIFIED INTERRUPT, THE PROGRAM WILL TRY TO CLEAR THE INTERRUPT FIRST, THEN RESTART THE PROGRAM. (FOR AN EXTERNAL INTERRUPT, THE CLEAR IS TO THE A/D CONVERTER'S DEVICE CODE. FOR AN UNIDENTIFIED INTERRUPT, AN "NIOC" IS ISSUED TO THE INTERRUPTING DEVICE). IT IS POSSIBLE TO HALT ON ERROR WHEN EITHER OF THESE SITUATIONS OCCUR. HOWEVER IF THE INTERRUPT WILL NOT CLEAR, THE PROGRAM WILL REMAIN IN THE LOOP. (FATAL EXERCISER ERRORS). AN A/D EXTERNAL INTERRUPT IS COUNTED AS AN A/D STATUS ERROR (ALTHOUGH NOT REPORTED AS ONE). AN UNIDENTIFIED INTERRUPT IS NOT.

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10025 -MAIN
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:10.6 MISCELLANEOUS PROGRAM OUTPUTS:
:
: THERE ARE TWO TYPES OF SUMMARY REPORTS THAT ARE POSSIBLE.
: THE FIRST IS AN ERROR SUMMARY REPORT. THIS IS
: OBTAINED WHEN "SMREG" SWITCH 7 GOES FROM A 0 TO A 1.
: THE REPORT FORMAT IS:
:
: CONVERSION TIMES OUTS: (#)
: DCH CONVERSION ERRORS: (#)
: DCH DATA ERRORS: (#)
: A/D STATUS ERRORS: (#)
:
: ALL COUNTS ARE DECIMAL.
:
: THE SECOND IS AN A/D - MULTIPLEXER SET-UP SUMMARY
: REPORT. THIS CAN BE OBTAINED ANY TIME BY ENTERING
: A "S (CNTRL S). ITS FORMAT IS:
:
: POLARITY: (UNIPOLAR OR BIPOLAR)
: RANGE: (5V OR 10V)
: MODE: (PIO OR DCH)
: TRIGGERING: (FOR PIO: STRT, INT CLK OR EXT CLK)
: CODING: (OFFSET BINARY OR TWO'S COMPLEMENT)
: MUX TYPE: (DIFFERENTIAL OR SINGLE-ENDED)
: INITIAL CHANNEL: (0-17 OCTAL)
: FINAL CHANNEL: (0-17 OCTAL)

:11.1
:
: *****
: *** OCTAL DEBUG TOOL (ODT) ***
:
: THE DIAGNOSTIC IS EQUIPPED WITH A BUILT IN ODT WHICH CAN
: BE ACCESSED BY HITTING CONTROL 0 ("O") AT ANY TIME DURING
: THE EXECUTION OF THE PROGRAM (AFTER SETTING THE PARA-
: METERS).
: ON ENTERING ODT THE ADDRESS OF THE LOCATION HAVING THE
: NEXT INSTRUCTION TO BE EXECUTED WILL BE TYPED-OUT.
:
: CONVENTIONS AND SYMBOLS
: THE FOLLOWING CONVENTIONS ARE USED BY THE ODT:
: ? PRESSED ANY ILLEGAL KEY CAUSES THE ODT TO RES-
: POND WITH A "2".
: @ ODT IS READY AND AT YOUR SERVICE.
:
:11.2
: COMMAND STRUCTURE
: AN ODT COMMAND HAS THE FOLLOWING FORMAT:
: (ARGUMENT) (COMMAND)
: AN ARGUMENT MAY BE ONE OF THE FOLLOWING:
: "EXP" AN OCTAL EXPRESSION CONSISTING OF OCTAL NUMBERS
: SEPARATED BY PLUS (+) OR MINUS (-) SIGNS. LEAD-
: ING ZEROS NEED NOT BE TYPED.
: "ADR" AN ADDRESS IS THE SAME AS AN EXPRESSION EXCEPT
: THAT BIT 0 IS NEGLECTED.
: A COMMAND IS A SINGLE TELETYPE CHARACTER
:
:11.3
: ODT COMMANDS
: THE LOCATIONS THAT CAN BE EXAMINED AND MODIFIED BY THE
: USER ARE CALLED CELLS. THESE CELLS ARE OF TWO TYPES:
: INTERNAL CPU CELLS AND MEMORY LOCATIONS.
:
:11.3.1
: OPENING INTERNAL CELLS
: THE COMMAND TO OPEN ONE OF THE INTERNAL REGISTERS IS OF
: THE FORM "NA" WHERE N IS ANY OCTAL EXPRESSION BETWEEN
: 0 AND 7
:
: 0-3 FOR ACCUMULATORS 0-3
: 4 FOR PC OF THE NEXT INSTRUCTION TO BE EXECUTED IN
: THE EVENT OF A "P" COMMAND.
: 5 CPU AND I/O STATUS
: BIT INTERPRETATION
: 15 STATUS OF I/O DONE FLAG
: 14 STATUS OF INTERRUPTS (ION FLAG)
: 13 STATUS OF CARRY BIT
: 6 ADDRESS OF THE LOCATION HAVING THE BREAK POINT (IF
: ANY)
: 7 INSTRUCTION AT THE BREAK POINT LOCATION
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10026 -MAIN
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10027 .MAIN
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OTHER COMMANDS TO OPEN CELLS ARE:
"ADR"/ OPEN THE CELL AND PRINT ITS CONTENTS.
"/ OPEN THE CELL CURRENTLY POINTED TO BY THE POINTER
AND PRINT ITS CONTENTS.
+ "ADR"/ ADD "ADR" TO THE POINTER, OPEN THE CELL AND PRINT
ITS CONTENTS.
- "ADR"/ SUBTRACT "ADR" FROM THE POINTER, OPEN THE CELL AND
PRINT ITS CONTENTS.
"CR" THE RETURN KEY IS USED TO CLOSE THE OPEN CELL
WITH OR WITHOUT MODIFICATION.
"LF" LINE FEED IS USED TO CLOSE THE OPEN CELL WITH OR
WITHOUT MODIFICATION AND TO OPEN THE SUCCEEDING
CELL.
^ CLOSE THE OPEN CELL WITH OR WITHOUT MODIFICATION
AND OPEN THE PRECEDING CELL
/ CLOSE THE OPEN CELL WITHOUT MODIFICATION, AND
CLOSE THE CELL POINTED TO BY ITS CONTENTS.
+ "ADR"/ CLOSE THE OPEN CELL WITHOUT MODIFICATION, AND
OPEN THE CELL POINTED TO BY ITS CONTENTS + "ADR".
- "ADR"/ CLOSE THE OPEN CELL WITHOUT MODIFICATION, AND
OPEN THE CELL POINTED TO BY ITS CONTENTS - "ADR".

11.3.2 MODIFICATION OF A CELL
ONCE A CELL HAS BEEN OPENED ITS CONTENTS CAN BE MODIFIED
BY TYPING THE NEW VALUE THE CELL IS TO CONTAIN IN THE
FORM OF AN OCTAL EXPRESSION FOLLOWED BY "CR" OR "LF".
IF A + OR - IS TYPED AS THE FIRST CHARACTER OF THE EX-
PRESSION THEN THE VALUE OF THE EXPRESSION IS ADDED TO OR
SUBTRACTED FROM THE OLD CONTENTS OF THE CELL. THE
ADDRESS ITSELF OR AN EXPRESSION RELATIVE TO THE ADDRESS
CAN BE DEPOSITED BY TYPING A " " OR " "-OCTAL EXPRESS-
ION". A RUBOUT COMMAND GIVEN RIGHT AFTER OPENING A CELL
ALLOWS THE MODIFICATION OF ITS CONTENTS AS IF THEY WERE
TYPED IN JUST BEFORE THE COMMAND WAS ISSUED.

11.3.3 OTHER ODT COMMANDS
RUBOUT
THIS KEY IS USED TO DELETE ERRONEOUSLY TYPED
DIGITS. EACH TIME THE KEY IS PRESSED THE RIGHT MOST
DIGIT IS DELETED AND ECHOED ON THE TERMINAL. IF
THE RUBOUT KEY IS PRESSED RIGHT AFTER OPENING A
CELL THEN IT DELETES THE RIGHT MOST DIGIT OF THE CELLS
CONTENTS. THIS ALLOWS THE MODIFICATION OF THE CELL
AS IF ITS CONTENTS WERE TYPED IN JUST BEFORE THE
KEY WAS PRESSED.
"ADR"B
INSERT A BREAK POINT AT LOCATION "ADR".
ONLY ONE BREAK POINT CAN BE INSERTED AND ANY
ENTRY TO ODT AFTER EXECUTING A BREAK POINT WILL
CAUSE IT TO BE DELETED.
D
DELETE THE BREAK POINT IF ANY.
P
RESTART THE EXECUTION OF THE PROGRAM AT LOCATION
POINTED BY "A".
"ADR"R
START EXECUTING THE PROGRAM AT "ADR" AFTER AN
IO-RESET.
K
KILL THE STRING TYPED SO FAR. THE ODT RESPONDS
WITH A "?" AND THE OPEN CELL IS CLOSED WITHOUT
MODIFICATION.
=
PRINT THE OCTAL VALUE OF THE INPUT ONLY.
THIS WILL CLOSE ANY OPEN CELLS WITHOUT
MODIFICATION AND WILL NOT OPEN A CELL

NOTE:
IN PROGRAMS WHICH RELOCATE THEMSELVES THE
THE USER SHOULD PLACE BREAK POINTS ONLY IN THE
THE ORIGINAL PROGRAM AREA. IF A BREAK POINT IS
PLACED OUTSIDE THIS AREA THE RESULTS WILL
BE UNPREDICTABLE.

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10029 .MAIN
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:11.4 INSTRUCTION SET:
:DOA: OUTPUTS INITIAL DOA MUX CHANNEL, FINAL MUX
: CHANNEL, AND STATUS BITS TO THE INTERFACE.
:
: D0, D1, D2 ARE THE CLOCK SOURCE SELECT BITS:
:
: 00 D1 D2 CLOCK SOURCE TO START A/D CONVERSIONS
:
:
: 0 0 0 /STRT/, NO SYNC
:
:PROGRAMMED 0 0 1 NO CONVERSIONS
:
: I/O 0 1 0 /STRT/, INTERNAL CLOCK SYNC
: (FALLING EDGE)
:
: 0 1 1 /STRT/, EXTERNAL CLOCK SYNC
: (FALLING EDGE)
:
: 1 0 0 /IOPLS/, (1 DATA CHANNEL CONVERSION
: FOR EVERY /IOPLS/, NO SYNC
:
:DATA 1 0 1 /DCHI/, NO SYNC
: (MAXIMUM TRANSFER RATE)
:
:CHANNEL 1 1 0 INTERNAL CLOCK SYNC
: (FALLING EDGE)
:
: 1 1 1 EXTERNAL CLOCK SYNC
: (FALLING EDGE)
:
:ALL DATA CHANNEL SEQUENCES BEGIN WITH THE NEXT CLOCK
:SOURCE SIGNAL AFTER STRT. SYNCHRONIZATION OCCURS ON
:THE FALLING EDGE OF THE INTERNAL OR EXTERNAL CLOCK.
:
: 03 SINGLE-ENDED/DIFFERENTIAL
: CHANNEL SELECT
: 0 = DIFFERENTIAL
: 1 = SINGLE-ENDED
:
: 04-07 FINAL MUX CHANNEL, BIT 4 MSB
:
: 012-015 INITIAL MUX CHANNEL, BIT 12 MSB
:
:TO READ DATA ON ONLY ONE CHANNEL, BOTH THE FINAL AND
:INITIAL CHANNELS SHOULD EQUAL THE DESIRED CHANNEL.
:/IORS1/ CLEARS ALL STATUS BITS. THE DOA INSTRUCTION
:/SHOULD NOT BE GIVEN IF BUSY IS SET.

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10030 .MAIN
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:DOB: OUTPUTS TO ADDRESS REGISTER FOR DATA CHANNEL
: TRANSFERS
:
:DOC: OUTPUTS TO WORD-COUNT REGISTER FOR DATA CHANNEL
: TRANSFERS
:
:OIA: INPUTS CURRENT MUX CHANNEL AND STATUS BITS:
:
: 00 1 IF EXTERNAL INTERRUPT REQUEST
: HAS OCCURRED, 0 OTHERWISE
:
: 01 1 IF EOC IS HIGH (CONVERSION
: IS FINISHED), 0 OTHERWISE
:
: 08 1 IF CLOCK OVERRUN HAS OCCURRED,
: 0 OTHERWISE.
:
: 012-015 CURRENT MUX CHANNEL
:
: ALL OTHER BITS ARE CLEARED. EXTERNAL INTERRUPT
: REQUEST BIT AND CLOCK OVERRUN BIT ARE CLEARED
: BY I/O CLEAR INSTRUCTION OR IORS1.
:
:OIB: INPUTS DCH ADDRESS REGISTER
:
:DIC: INPUTS DATA FROM A/D CONVERTER. DATA IS LEFT
: JUSTIFIED IN BITS 0-11, WITH BIT 0 THE MSB.

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10031 .MAIN

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01 : 11.5 GENERAL INFORMATION:
02 :
03 : THE FOLLOWING FORMAT IS ALWAYS USED IN THIS PROGRAM FOR
04 : OCTAL VALUES THAT ARE USED AS DATA, EITHER INPUT TO
05 : OR OUTPUT FROM THE A/D CONVERTER.
06 :
07 : DATA VALUES = xxxxxx - ONE FULL OCTAL WORD (16 BITS)
08 : DATA LEFT JUSTIFIED TO BIT 0 WITH ALL UNUSED BITS = 0.
09 :
10 : ANALOG CONVERTER VALUE/DATA CORRESPONDANCE
11 : LEFT JUSTIFIED OCTAL DATA:
12 :
13 : OCTAL DATA EQUIVALENTS **
14 : 12-BIT A/D CONVERTER
15 :
16 : -----
17 : ANALOG VALUE UNIPOLAR BIPOLAR
18 : + FS = 1 LSB 177760 077760
19 : + 1/2 FS 100000 040000
20 : + 1 LSB 000020 000020
21 : 0 (TRUE ZERO) 000000 000000
22 : - 1 LSB 177760 177760
23 : - 1/2 FS 140000 140000
24 : - FS + 1 LSB 100020 100020
25 : - FS -----
26 :
27 : WHERE: FS = A/D FULL SCALE VOLTAGE
28 : LSB = LEAST SIGNIFICANT BIT
29 :
30 : ** THE ABOVE OCTAL DATA VALUES ARE FOR THE FOLLOWING:
31 : - UNIPOLAR VALUES: CODING = OFFSET BINARY
32 : - BIPOLAR VALUES: CODING = TWO'S COMPLEMENT
```

10032 .MAIN

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01 :
02 : A/D CODING CONVENTIONS (FOR OCTAL DATA VALUES):
03 :
04 : OFFSET BINARY IS DEFINED AS A/D DATA BIT 0
05 : (MOST SIGNIFICANT BIT OR MSB) = 0 AS A RESET VALUE.
06 : IN OFFSET BINARY, DATA VALUES RECEIVED ARE ABSOLUTE
07 : VALUES (MAGNITUDES ONLY). IN OTHER WORDS, THE LOWER
08 : VOLTAGES HAVE LOWER OCTAL CODES, AND THE HIGHER
09 : VOLTAGES HAVE HIGHER CODES WHERE 000000 = LOWEST CODE
10 : AND 177760 = HIGHEST CODE. (BIT 0 IS NOT A SIGN BIT).
11 : 0 VDC (UNIPOLAR), -5 VDC (LOW RANGE BIPOLAR) OR -10 VDC
12 : (HIGH RANGE BIPOLAR) = LOWEST VOLTAGES AND +5 VDC (LOW
13 : RANGE UNIPOLAR/BIPOLAR) OR +10 (HIGH RANGE UNIPOLAR/BI-
14 : POLAR) = HIGHEST VOLTAGES.
15 :
16 : TWO'S COMPLEMENT IS DEFINED AS A/D DATA BIT
17 : 0 (MSB) = 1 AS A RESET VALUE. IN TWO'S COMPLEMENT
18 : CODING, THE VALUES ARE "SIGNED", WITH BIT 0 = SIGN BIT.
19 : BIT 0 = 0 INDICATES "POSITIVE" VALUES, AND BIT 0 = 1
20 : INDICATES "NEGATIVE" VALUES. IN THE CASE OF UNIPOLAR
21 : A/D CONVERTER VALUES (0-5 OR 0-10 VDC), HALF FULL
22 : SCALE (2.5 OR 5.0 VDC) BECOMES THE "000000" DATA POINT.
23 : VALUES BETWEEN 0 AND 2.5 (OR 5.0) HAVE BIT 0 = 1,
24 : AND VALUES BETWEEN 2.5 (OR 5.0) AND 5.0 (OR 10.0)
25 : HAVE BIT 0 = 0.
26 :
27 : (I.E. 100000 = 0 VDC, 177760 = 1/2 FULL SCALE = 1
28 : LSB, 000000 = 1/2 FULL SCALE, 000020 = 1/2 FULL SCALE
29 : + 1 LSB AND 077760 = FULL SCALE; WHERE FULL SCALE =
30 : +5 VDC LOW RANGE OR +10 VDC HIGH RANGE UNIPOLAR).
31 :
32 : FOR THE BIPOLAR CASE, 0 VDC = 000000 IS THE TRUE
33 : ZERO POINT. VOLTAGES IN THE RANGE OF 0 TO +5 (OR +10)
34 : VDC HAVE POSITIVE OCTAL CODES (BIT 0 = 0 WITH 077760 =
35 : + FULL SCALE) AND VOLTAGES IN THE RANGE OF -5 (OR -10)
36 : TO 0 VDC HAVE NEGATIVE OCTAL CODES (BIT 0 = 1 WITH
37 : 100000 = - FULL SCALE). THEY ARE TRUE SIGNED NUMBERS.
38 :
39 : THEREFORE, WHEN EITHER ONE OF THE FOLLOWING CASES
40 : OCCUR, FOR THE DATA VALUES SHOWN, SIMPLY COMPLEMENT
41 : BIT 0 (THE MSB) TO GET THE TRUE DATA VALUES:
42 : - UNIPOLAR W/TWO'S COMPLEMENT CODING (MSB=1)
    - BIPOLAR W/OFFSET BINARY CODING (MSB=0)
```

10033 .MAIN

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:
: THE FOLLOWING IS A TABLE OF DATA WORD FORMATS FOR THE
: A/D CONVERTER:
:
: TYPE #BITS SIGN BIT MSB LSB RES
: ----
: UNIPOLAR 12 NONE 0 11 12
: BIPOLAR 12 0 1 11 12
:
: MSB/LSB = MOST/LEAST SIGNIFICANT BITS.
: RES = RESOLUTION = THE # OF ACTUAL DATA BITS PER DATA
: WORD (NOT INCLUDING THE SIGN BIT). 2**RES IS THE TOTAL
: # OF INCREMENTS THAT THE FULL SCALE VALUE CAN BE BROKEN
: DOWN INTO. FOR EXAMPLE, A 12-BIT A/D HAS 2**12. = 4096.
: POSSIBLE DATA VAULES.
:
: THE FOLLOWING IS A TABLE OF ACTUAL RESOLUTION VALUES
: FOR THE A/D CONVERTER.
:
: MODE FULL SCALE RESOLUTION
: ----
: UNIPOLAR 5V 1.22 MV/BIT
: BIPOLAR 10V 2.44 MV/BIT
: BIPOLAR 5V 2.44 MV/BIT
: BIPOLAR 10V 4.88 MV/BIT
:

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10034 .MAIN

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PROGRAM SUBROUTINE DESCRIPTIONS:

:
: NOTE: THESE ARE THE DESCRIPTIONS OF SOME OF THE MOST
: COMMONLY USED SUBROUTINES CONTAINED IN THE A/D
: EXERCISER PROGRAM. THEY CONTAIN INFORMATION THAT
: HAS ALREADY BEEN DESCRIBED IN PREVIOUS SECTIONS,
: AS WELL AS ADDITIONAL INFORMATION. THEY ARE INCLUDED
: AS A QUICK REFERENCE GUIDE (AS A DEBUGGING AID).
:
: 1) A/D EXERCISER CORE ROUTINES:
:
: CALL SCAN
: # OF CONVERSIONS = "COUNT"
: BLOCK STARTING ADDRESS = "BSTR1"
: A/D MODE/TRIGGERING = "MODEM"
:
: THE ABOVE MUST BE PREVIOUSLY SET BEFORE CALLING
: THIS ROUTINE (CONSTANTS ARE IN PAGE 0).
:
: RETURNS TO:
: CALL + 1 IF AN A/D SET-UP CHANGE OCCURS DURING SCAN
: CALL + 2 NORMAL RETURN
:
: THE "CORE" CONSISTS OF THE FOLLOWING SECTIONS:
: SECTION I: A/D CONVERTER SAMPLER/SCANNER
: SECTION II: TTY INPUT MONITOR/PROCESSOR
: SECTION III: A/D EXERCISER COMMAND INTERPRETER
:
: THE PAGE 0 RETURN ADDRESSES ARE AS FOLLOWS:
: "SCANR" = MAIN RETURN FROM A/D SCANNER/TTY PROCESSOR
: (POINTS TO CALL+1 WHERE CALL = "SCAN")
: "CMR" = RETURN FROM SECTION II OR III BACK TO
: SECTION I (POINTS TO CALL+1 WHERE CALL =
: "CHKTTY").
:

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SECTION I: A/D SAMPLER/SCANNER:
PERFORM A/D CONVERSIONS IN THE MODE AND TRIGGERING
SPECIFIED BY THE A/D (DOA) MODE WORD "MODEW". THE
CONVERTED DATA IS STORED IN CONTIGIOUS LOCATIONS IN
A DATA BLOCK THAT IS SPECIFIED BY THE BLOCK STARTING
ADDRESS AND WORD COUNT (WORDS "BSTART" AND "COUNT"
RESPECTIVELY). THESE PARAMETERS ARE IN PAGE 0, AND MUST
BE SPECIFIED BY THE CALLING TEST.
ERRORS THAT DETECTED AND REPORTED ARE:
1) CONVERSION TIME OUTS
- OCCURS IF AN END OF CONVERSION (OR CYCLE) INTERRUPT
IS NOT REQUESTED AT THE END OF THE CONVERSION CYCLE.
2) DCH CONVERSION ERROR
- OCCURS IF THE DCH FINAL ADDRESS DOES NOT AGREE WITH
THE EXPECTED FINAL ADDRESS (CALCULATED FROM THE DCH
STARTING ADDRESS AND WORD COUNT LOADED).
3) DCH DATA ERROR
- OCCURS IF A WORD(S) IN THE CONTIGIOUS DATA BLOCK WAS
SKIPPED (NOT WRITTEN INTO) DURING A DCH OPERATION.
4) A/D STATUS ERROR
- OCCURS IF THE A/D STATUS REGISTER CONTENTS DO NOT
AGREE WITH THE EXPECTED STATUS (CHECKED AT THE START
AND END OF EACH CONVERSION CYCLE).
THE ACTION TAKEN AFTER ANY ERROR (EXCEPT A/D EXTERNAL
INTERRUPTS) DEPENDS OF THE STATE OF THE SWITCHES (SWREG).
OPTIONS ARE: 1) HALT OR NO HALT ON ERROR AND 2) LOOP OR
NO LOOP ON ERROR (CONTINUE NORMALLY). THESE OPTIONS ARE
SWITCH (SWREG) SELECTABLE (SEE SECTION II FOR THE SWITCH
SUMMARY). IF HALT ON ERROR AND LOOP ON ERROR IS DESIRED,
THE PROGRAM WILL FIRST HALT, THEN LOOP ON ERROR IF
CONTINUED. WHEN LOOPING ON AN ERROR, THE LOOP ALWAYS STARTS
AT LOCATION "RSCAN". TO FACILITATE ERROR TRACING WITH AN
OSCILLOSCOPE (OR ANALYSER), A SCOPE LOOP SHOULD BE FORMED
BY SUPPRESSING ALL OUTPUTS TO TTY/LPT. THIS PRODUCES A
HIGH SPEED A/D CONVERSION CYCLE LOOP.

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NOTE: IN THE CASE OF AN A/D EXTERNAL INTERRUPT, THE
PROGRAM WILL TRY TO CLEAR IT AND RESTART THE LOOP. IF
THE EXTERNAL INTERRUPT WILL NOT CLEAR, THE PROGRAM WILL
REMAIN IN THIS LOOP (FATAL EXERCISER ERROR). IT IS
POSSIBLE HOWEVER, TO HALT ON THIS ERROR BEFORE
A RETURN TO THE TOP OF THE LOOP IS MADE. THE
SAME ACTION IS TAKEN ON RECEIVING AN UNIDENTIFIED
INTERRUPT. AN 'NIOC' INSTRUCTION IS ISSUED TO THE
DEVICE, AND AN ERROR MESSAGE IS TYPED INDICATING
THE PROBLEM. THE ONLY DIFFERENCE IS THAT AN
UNIDENTIFIED INTERRUPT IS NOT COUNTED AS AN A/D
STATUS ERROR AND AN A/D EXTERNAL INTERRUPT IS.
THIS ROUTINE RETURNS TO CALL + 1 IF DURING THE SCAN
SEQUENCE, THE OPERATOR PERFORMED A COMMAND SEQUENCE
THAT ALTERED ONE OF THE A/D PROGRAMMABLE PARAMETERS
(SEE SECTION III). OTHERWISE THE RETURN IS TO CALL + 2
(UNLESS THE PROGRAM IS LOOPING ON AN ERROR).
SEE SECTIONS II AND III FOR OTHER INFORMATION REGARDING
THE POSSIBLE VALID TTY INPUTS AND COMMANDS.

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SECTION II: TTY INPUT MONITOR AND PROCESSOR:
CALL CHKTY
PROCESSES ANY TTY INPUTS. VALID INPUTS ARE:
0 - 9, A - F SET/CLEAR SELECTED "SWREG" SWITCH
(SUMMARY BELOW)
M DISPLAY "SWREG" SWITCHES
ENTER OCTAL DEBUG TOOL (ODT)
CNTRL = R RESTART PROGRAM (NO SWREG CHANGE)
CNTRL = D RESTART PROGRAM (DEFAULT SWREG)
CNTRL = Y SELECT A NEW TEST
CNTRL = S PRINT THE A/D SET-UP SUMMARY
ESC ENTER A/D EXERCISER COMMAND MODE
(SEE SECTION III)
SPACE STOP/START TEST ROUTINE OUTPUT
(MUX CHANNEL SCANNER, CALIBRATION)
OR REQUEST TEST RESULTS (HISTOGRAM)
? PRINT A LIST OF POSSIBLE COMMANDS

ALL INPUTS ARE ECHOED. ANY INVALID INPUT CAUSES THE
MESSAGE "TYPE ? FOR HELP" TO BE PRINTED. SWREG SWITCH
FUNCTIONS ARE AS FOLLOWS:
- STANDARD SWITCH FUNCTIONS:
SWITCH 1 = 0 LOOP ON ERROR
SWITCH 1 = 1 DO NOT LOOP ON ERROR
SWITCH 2 = 0 PRINT TO TTY CONSOLE
SWITCH 2 = 1 DO NOT PRINT TO TTY CONSOLE
SWITCH 5 = 0 DO NOT PRINT TO LINE PRINTER
SWITCH 5 = 1 PRINT TO LINE PRINTER
SWITCH 6 = 0 DO NOT HALT ON ERROR
SWITCH 6 = 1 HALT ON ERROR
SWITCH 7 = 0 DO NOT PRINT ERROR SUMMARY REPORT
SWITCH 7 = 1 PRINT ERROR SUMMARY REPORT
- SPECIAL SWITCH FUNCTIONS:
SWITCH C = 0 PRINT TEST DATA
SWITCH C = 1 DO NOT PRINT DATA, ONLY PERFORM
A/D CONVERSIONS (CALIBRATION ONLY)
SWITCH D = 0 PRINT A/D DATA IN OCTAL
SWITCH D = 1 PRINT A/D DATA IN SIGNED DECIMAL
MILLIVOLTS (CALIBRATION ONLY)
SWITCH E = 0 DO NOT DESTROY HISTOGRAM ON OUTPUT
SWITCH E = 1 START NEW HISTOGRAM ON OUTPUT
(HISTOGRAM ONLY)
RETURNS TO SECTION I (CALL +1, WHERE CALL = "CHKTY") OF
THE CORE, UNLESS A SET UP CHANGE OCCURS IN THE COMMAND
INTERPRETER (SEE SECTION III).

SECTION III: EXERCISER COMMAND INTERPRETER
THIS SECTION ALLOWS THE OPERATOR TO ALTER THE A/D
PROGRAMMABLE FUNCTIONS DURING TEST OPERATION.
OPERATOR MUST ENTER AN ESCAPE "ESC" CHARACTER TO ENTER
THE A/D EXERCISER COMMAND INTERPRETER (SEE SECTION II).
ON ENTERING THE COMMAND INTERPRETER THE FOLLOWING PROMPT
WILL BE TYPED:
"COMMAND? "
POSSIBILITIES ARE:
- M = MODE
- Y = TRIGGERING
- I = INITIAL MUX CHANNEL
- F = FINAL MUX CHANNEL
- X = MUX TYPE
IF "M" WAS THE COMMAND, THE FOLLOWING IS TYPED:
"MODE? "
POSSIBILITIES ARE:
- P = PROGRAMMED I/O (PIO) MODE
- D = DATA CHANNEL (DCH) MODE
IF "Y" WAS THE COMMAND, THE FOLLOWING IS TYPED:
"TRIGGERING? "
POSSIBILITIES ARE:
PIO MODE DCH MODE
-----
S = STRI, NO SYNC P = IOPLS, NO SYNC
I = STRT, INT CLK SYNC D = DCHI, NO SYNC (MAX RATE)
E = STRT, EXT CLK SYNC I = INT CLK SYNC
E = STRT, EXT CLK SYNC E = EXT CLK SYNC
WHERE: INT CLK = INTERNAL CLOCK (ON BOARD)
EXT CLK = EXTERNAL CLOCK
IF "I" WAS THE COMMAND, THE FOLLOWING IS TYPED:
"INITIAL CHANNEL? "
POSSIBILITIES ARE:
- 0 - 17 (OCTAL) FOLLOWED BY "CR"

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10039 .MAIN
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IF "F" WAS THE COMMAND, THE FOLLOWING IS TYPED:
"FINAL CHANNEL? "
POSSIBILITIES ARE:
- 0 - 17 (OCTAL) FOLLOWED BY A "CR"
NOTE: THE FINAL CHANNEL IS ONLY USED BY THE MUX
CHANNEL SCANNER, AND IGNORED BY OTHER TESTS.
IF "X" WAS THE COMMAND, THE FOLLOWING IS TYPED:
"MUX TYPE? "
POSSIBILITIES ARE:
- S = SINGLE-ENDED (16. CHANNELS)
- D = DIFFERENTIAL (8. CHANNELS)
A "CR" ENTERED AS THE RESPONSE FOR ANY QUESTION WILL
TERMINATE THE COMMAND INPUT SEQUENCE WITH NO AFFECT
TO ANY PARAMETERS. RETURNS TO SECTION I OF CORE
(CALL + 1, WHERE CALL = "CHKTTY").
AN INVALID RESPONSE TO ANY QUESTION CAUSES A LIST OF
VALID RESPONSE POSSIBILITIES TO BE PRINTED.
IF A VALID RESPONSE IS INPUT (NOT "CR") TO A QUESTION,
(REGARDLESS OF WHETHER OR NOT THE PARAMETER WAS
ACTUALLY CHANGED), AN A/D SET-UP CHANGE IS ASSUMED.
THIS INDICATES THAT THE A/D MODE WORD MUST BE ADJUSTED
TO ACCOUNT FOR THE CHANGE. THEREFORE AFTER THE PARAMETER
IS "ALTERED", THE RETURN IS TO THE INSTRUCTION THAT
FOLLOWS THE CALL TO "SCAN", WHICH IS THE COMMAND THAT
INVOKES THE ENTIRE A/D SCANNER/TTY INPUT PROCESSOR. IT
DOES NOT RETURN TO EITHER SECTION I OR II (SEE SECTION
I FOR MORE INFORMATION).
("PIO" MODE AND "DCHI" TRIGGERING IS AN INVALID A/D
OPERATING CONDITION).

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10040 .MAIN
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CALL IWAIT
RETURNS TO:
- CALL + 1 IF NO INTERRUPT
- CALL + 2 IF A/D EXTERNAL OR UNIDENTIFIED INTERRUPT
- CALL + 3 IF A/D I/O INTERRUPT
WAITS FOR TIME SPECIFIED BY TIMER CONSTANT "DELAY"
FOR A/D END OF CONVERSION/CYCLE (EOC) INTERRUPT
AC'S ARE AS FOLLOWS ON RETURN:
TYPE AC0 AC1 AC2
-----
NONE DVC 0 NC
UNIDENTIFIED DVC BAD NC
A/D EXTERNAL DVC DVC DIA
A/D I/O INTR DVC DVC DIA
WHERE:
DVC = A/D DEVICE CODE
BAD = UNIDENTIFIED DEVICE CODE
NC = NO CHANGE
DIA = A/D STATUS WORD
BIT 0 = 0 FOR A/D I/O INTERRUPT
BIT 1 = 1 FOR A/D EXT INTERRUPT
OTHER STATUS BITS ARE
BIT 1 = EOC
BIT 8 = CLK OVERRUN
UNIDENTIFIED INTERRUPT = (##) IS REPORTED IF
ANY DEVICE OTHER THAN THE A/D IS REQUESTING
AN INTERRUPT WHERE (##) IS THE INTERRUPTING DEVICE
CODE. THE ROUTINE WILL ATTEMPT TO CLEAR THE INTERRUPT
WITH AN 'NIOC' INSTRUCTION ISSUED TO THE DEVICE.
EXTERNAL INTERRUPT = (##) IS REPORTED IF AN
EXTERNAL INTERRUPT IS REQUESTED FROM THE A/D.
(##) IS THE A/D DEVICE CODE. IN ADDITION, BIT
0 OF AC2 SHOULD BE = 1, INDICATING AN A/D
EXTERNAL INTERRUPT. THE INTERRUPT IS NOT CLEARED.
CALL NOTTY
MASK OUT TTY INPUT & TTY OUTPUT (TTI/TTO) INTERRUPTS
(PRIORITY MASK BITS: TTI = 14, TTO = 15)
CALL DEFAULT
SET A/D PROGRAMMABLE PARAMETERS TO THEIR
DEFAULT STATES AS FOLLOWS:
MODE = PIO
TRIGGERING = STRT, NO SYNC
MUX TYPE = DIFFERENTIAL
INITIAL MUX CHANNEL = 0
FINAL MUX CHANNEL = 0
RETURNS CALL + 1 (AC0 DESTROYED)

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10041 .MAIN
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:5) CALL READC
: READ AN ASCII CHARACTER FROM THE TTY INPUT DEVICE
: RETURNS:
: - CALL + 1 IF CHARACTER IS CARRIAGE RETURN ("CR")
: - CALL + 2 IF ANY OTHER CHARACTER IN AC0
: (7 - BIT ASCII W/PARITY REMOVED)
: (AC0 DESTROYED)
:
:6) CALL MODES
:
: FORMS THE COMPOSITE A/D MODE WORD (DOA) FROM THE PAGE 0
: A/D SWITCHES (MODE, TRIG, MUX1, IMUXC, FMUXC), AND
: PUTS RESULT IN PAGE 0 WORD "MODEM".
:
: MODE WORD FORMAT IS:
: - BIT 0 A/D MODE (0=PIO, 1=DCH)
: - BITS 1,2 A/D TRIGGERING
: PIO: 0=STR1, 2=INT CLK 3=EXT CLK
: DCH: 0=IOPLS, 1=DCHI, 2=INT CLK, 3=EXT CLK
: - BIT 3 MUX TYPE (0=DIFFERENTIAL, 1=SINGLE-ENDED)
: - BITS 4-7 FINAL MUX CHANNEL #
: - BITS 12-15 INITIAL MUX CHANNEL #
:
: RETURNS TO CALL + 1 (ALL AC'S SAVED)
:
:7) CALL DSAMC
:
: ON RETURN TO CALL + 1:
: AC0 = DCH RANDOM WORD COUNT (<= 400 OCTAL)
: AC1 = DCH RANDOM STARTING ADDRESS
: AC2 = DCH FINAL ADDRESS (AFTER DCH CYCLE)
:
: THE RANDOM STARTING ADDRESSES/WORD COUNTS ARE
: DETERMINED SUCH THAT NO PROGRAM OR BINARY LOADER
: DESTRUCTION WILL OCCUR FOR PROPERLY FUNCTIONING
: DATA CHANNEL LOGIC, NOR WILL ANY MEMORY LOCATIONS
: RESERVED FOR THE CONSOLE DEBUG OPTION OR THE
: HAND HELD CONSOLE (077777-077377) BE ADDRESSED.
:
: IF THE CATS/KITTEN DATA CHANNEL (DCH) EXERCISER IS
: IS USE (HISTOGRAM ONLY) THEN THE STARTING ADDRESSES
: AND WORD COUNTS ARE CALCULATED SUCH THAT NO DCH
: EXERCISER PROGRAM SPACE WILL BE DESTROYED.
:
: NOTE: MEMORY REQUIREMENTS FOR RUNNING THIS EXERCISER
: WITH THE DCH EXERCISER IS 8K MINIMUM. OTHERWISE
: THE MINIMUM REQUIRED IS 4K.
:
:8) CALL BLKINIT
: RETURNS TO CALL + 1
:
: ROUTINE INITIALIZES THE STORAGE AREA DEFINED BY THE
: BLOCK STARTING ADDRESS/WORD COUNT (PAGE 0) TO -1 FOR
: SUBSEQUENT DATA CHANNEL DATA CHECKS.
:
:9) CALL BLKCHK
: RETURNS CALL + 1 IF DATA ERROR (AC2 = BAD ADDRESS)
: RETURNS CALL + 2 IF NO DATA ERROR
:
:10) ROUTINE CHECKS IF ALL LOCATIONS SPECIFIED BY BLOCK
: STARTING ADDRESS/WORD COUNT WERE WRITTEN INTO
: BY THE A/D DATA CHANNEL CYCLE. IF A "1" IS FOUND
: IN ANY LOCATION, A DCH ADDRESS ERROR IS ASSUMED.
:
: CALL CDATA
: - AC1 CONTAINS OCTAL A/D DATA FOR CONVERSION
: - AC1 CONTAINS CONVERTED DATA ON RETURN
: (ALL OTHER AC'S SAVED)
: CALL CLRBLK
:
:11) SETS DATA WORDS IN SPECIFIED BLOCK = 0
: - CALL + 1 = START ADDRESS OF DATA BLOCK
: - CALL + 2 = OCTAL WORD COUNT OF DATA BLOCK
: RETURNS TO CALL + 3
: (NO AC'S SAVED)
:
:12) CALL READN
: READ AN ASCII CHARACTER FROM THE TTY INPUT DEVICE
: RETURNS:
: - CALL + 1 IF CHARACTER IS CARRIAGE RETURN ("CR")
: ("CR" AND "LF" ARE ECHOED AND TTY IS CLEARED)
: - CALL + 2 IF ANY OTHER CHARACTER IN AC0
: (7 - BIT ASCII W/PARITY REMOVED. NOTE THAT THE
: TTY IS NOT CLEARED, NOR IS THE CHARACTER ECHOED.)
:
: THIS ROUTINE IS USED TO TEST FOR THE SKIPPING OF A
: QUESTION BY ENTERING "CR" AS THE ONLY RESPONSE.
: (USED WITH "FIN?0" OCTAL INPUT OR "TIN?0" DECIMAL
: INPUT ROUTINES IN DLIB TTY PACKAGE).
:
:12. SPECIAL NOTES/SPECIAL FEATURES:
:
: SEE INDIVIDUAL TEST DESCRIPTIONS.
:
:13. RUN TIME:
:
: N/A

```

10043 .MAIN

**00000 TOTAL ERRORS, 00000 PASS 1 ERRORS