

**INTEROFFICE
MEMORANDUM**

M-1086

DATE April 8, 1960

SUBJECT Average Response Computer Program (ARC)
TO PDP Distribution List FROM John C. Conley

This computer application program is written to pick out and display a weak signal which has been distorted by a high degree of noise. The signal, with noise, is fed into an analog to digital convertor for measurement and conversion to binary information. Successive measurements are made over the same portion of the input, added to the sum of previous samples, and stored in memory. The resultant sum is displayed after each sample and as the sample size increases the display shows the true signal with decreasing distortion.

This program is written for memory storage in registers 0-167 with sample storage in registers 170-1170. This is a sample and display of 512 points on each pass.

As explained in the operating instructions, the program has several variable features which control speed of operation and display characteristics. Continuous display, at any preassigned point, is possible for analysis and picture taking of waveform. Overall speed of the averaging process can be controlled by the sense switches. The display part of the program is time consuming and can be cut out for very rapid sampling and a display of the final results.

Operating Instructions

- 1) Read in binary format tape of ARC program.
- 2) Set or clear sense switches 1,2 and 3 as desired. See Note 1 for function of sense switches.
- 3) Set left nine and right nine bits of test word as needed. See Notes 1 and 2 for function of test word bits.
- 4) Set test address to zero.
- 5) Turn on signal source.
- 6) Push start switch on console.

Program will run and display 512 points on each pass. The program is controlled by a sync instruction from the input, such that each sample will be taken from the same starting point in the input source.

Note 1 - Function of sense switches

Sense switch 1 controls the speed with which a sample is made and so the number of cycles included in the 512 points.

SW 1 .. Set .. Fastest sample time

SW 1 .. Clear -- Delayed sampling - a delay is introduced between the measurement of each point. The length of this delay is specified by bits 9-17 of the test word.

Sense switch 2 controls the display of each sample taken.

SW 2 .. Set .. Points are displayed after each sample

SW 2 .. Clear .. Points are displayed after each X samples. X is determined by bits 9-17 of test word.

Sense switch 3 determines continuous or limited sampling.

SW 3 .. Set .. Samples are taken and displayed continuously until machine is stopped.

SW 3 .. Clear .. Stops sampling after X samples and displays continuously what is then in storage. X is in register 133.
(Program is now set for 1000 samples.)

Note 2 - Function of test word bits

As explained in Note 1, test word bits 9-17 are used either to specify delay between points in a sample or the number of samples between displays depending on the setting sense switches 1 and 2.

Bits 0-8 specify the position of the first measured point, in a sample, after the sync signal is received by the computer. The more bits used the shorter the delay between sync signal and first measured point.

ARC

| <u>KEY</u> | <u>ADDRESS</u> | <u>INSTRUCTION</u> | <u>CODE</u> | <u>COMMENTS</u> |
|------------|----------------|--------------------|-------------|--|
| A | 0 | JMP 133 | 60 0133 | Start |
| | 1 | JSP src | 62 0151 | src sets initial address for storage |
| | 2 | CLA | 76 0200) | Clear register containing max scale factor |
| | 3 | DAC T | 24 0145) | |
| B | 4 | CLA | 76 0200) | Clear storage registers before sampling begins |
| | 5 | DAC&N | 25 0150) | |
| | 6 | IDX N | 44 0150) | |
| | 7 | SAS Y 52 | 52 0142) | |
| | 10 | JMP B | 60 0004) | |
| cc | 11 | SZF 2 | 64 0020) | Display after each sample |
| | 12 | JMP H | 60 0017) | |
| | 13 | LAT | 76 2200) | Display after each X samples |
| | 14 | AND M | 02 0155) | |
| | 15 | CMA | 76 1000) | X in bits 9-17 of test word |
| | 16 | DAC dd | 24 0041) | |
| H | 17 | JSP src | 62 0151 | |
| AB | 20 | IOT 20 | 73 0020 | Analog sync instruction |
| AC | 21 | LAT 76 22 | 76 2200) | (Delay in start of sample in bits 0-8 of test word |
| | 22 | AND S | 02 0156) | |
| u | 23 | ADD 0 | 40 0141) | (Delay some more |
| | 24 | SPA | 64 0200) | |
| | 25 | JMP U | 60 0023) | |
| AD | 26 | IOT | 73 0010) | Analog input-puts 6 bits in IO 0-5 |
| | 27 | RCL 9 | 66 3777) | |
| | 30 | RCL 9 | 66 3777) | Put sign in AC-0 |
| | 31 | SAR 6 | 67 5077) | Most significant bits in AC 13-17 with proper sign AC 0-12 |
| | 32 | SAR 6 | 67 5077) | |
| | 33 | 10 ADD&N | 41 0150) | Add to previous responses and store |
| | 34 | 10 DAC&N | 25 0150) | |
| | 35 | 10 IDX N | 44 0150) | |
| | 36 | 10 SAS Y | 52 0142) | |

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|------------|----------------|--------------------|-------------|-----------------------------------|
| | 37 | JMP R | 60 0043) ← | Not finished |
| | 40 | JMP | 60 0121) ← | Last response |
| dd | 41 | | | Counter for X samples |
| bb | 42 | | | Counter for 1000 samples |
| R | 43 | SZF 1 | 64 0010) | |
| | 44 | JMP D | 60 0026) | |
| | 45 | LAT | 76 2200) | Sample at fastest |
| | 46 | AND M | 02 0155) | rate delay between |
| | 47 | CMA | 76 1000) | responses test word |
| | 50 | DAC F | 24 0143) | bits 9-17 artificial |
| W | 51 | ISP F | 46 0143) | expansion ends at |
| | 52 | JMP W | 60 0051) | register 53 |
| | 53 | JMP D | 60 0026) | |
| E | 54 | JSP src | 62 0151 | Reset initial address for display |
| G | 55 | LIO&N | 23 0150 | Load response sum for display |
| | 56 | SIL | 66 6000 | |
| V | 57 | SIL P | 66 6777 | Scale factor |
| | 60 | LAC N | 20 0150 | Set up X axis in AC |
| | 61 | ADD X | 40 0144 | |
| | 62 | JMP | 60 0163 | Go to display point |
| AF | 63 | LAC&N | 21 0150) | Check point for max |
| | 64 | SPA | 64 0200) | scale factor |
| | 65 | CMA | 76 1000) | |
| | 66 | SUB T | 42 0145 | Subtract present max |
| | 67 | SPA | 64 0200 | |
| | 70 | JMP L | 60 0075 | No new maximum |
| | 71 | LAC&N | 21 0150 | New maximum |
| | 72 | SPA | 64 0200 | |
| | 73 | CMA | 76 1000 | |
| | 74 | DAC T | 24 0145 | |

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|------------|----------------|--------------------|-------------|---|
| L | 75 | IDX N | 44 0150 | |
| AG | 76 | SAS Y | 52 0142 | Check for lost point |
| | 77 | JMP G | 60 0055 | More points to display |
| | 100 | LAW-9 | 71 0011) | Last point, set counter for maximum scale number. Put zero in scale register |
| | 101 | DAC K | 24 0157) | |
| | 102 | LAW 6000 | 70 6000) | |
| | 103 | DAP V | 26 0057) | |
| | 104 | LAC T | 20 0145) | 104-120 scales pres- ent maximum |
| Q | 105 | RAL l | 66 1001) | |
| | 106 | DAC J | 24 0146) | |
| | 107 | SPA | 64 0200) | |
| aa | 110 | JMP cc | 60 0011) | |
| | 111 | ISP K | 46 0157) | |
| | 112 | JMP Z | 60 0114) | |
| ab | 113 | JMP cc | 60 0011) | max scaling is zero |
| Z | 114 | LAC Y | 20 0057) | Put one shift in scale |
| | 115 | RAL l | 66 1001) | |
| | 116 | ADD A | 40 0147) | |
| | 117 | DAP V | 26 0057) | |
| | 120 | JMP | 60 0166) | |
| | 121 | SZF 3 | 64 0030 | Switch for continu- ous or limited sampling |
| | 122 | JMP ac | 60 0160 | Continuous sampling |
| | 123 | ISP bb | 46 0042 | Stop adding after 1000 samples |
| | 124 | JMP ac | 60 0160 | |
| | 125 | LAW 54 | 70 0054) | Set jump instruction for continuous display after 1000 samples |
| | 126 | DAP aa | 26 0110) | |
| | 127 | DAP ab | 26 0113) | |
| | 130 | ISP dd | 46 0041 | |
| | 131 | JMP H | 60 0017 | 1000 not reached |
| | 132 | JMP E | 60 0054 | 1000 reached - con- tinuous display |
| | 133 | LAW-1747 | 71 1747 | Set counter for 1000 samples |
| | 134 | DAC bb | 24 0042 | bb is counter |

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|------------|----------------|--------------------|-------------|--|
| | 135 | LAW | 70 0011) | Set jump location for continuous samp- ling |
| | 136 | DAP aa | 26 0110) | |
| | 137 | DAP ab | 26 0113) | |
| | 140 | JMP | 60 0001 | |
| O | 141 | | 00 1000 | |
| Y | 142 | | 00 1170 | End of storage |
| F | 143 | | | Counter for artifi- cial expansion |
| X | 144 | | 77 7207 | Scale for X axis |
| T | 145 | | 00 0000 | |
| J | 146 | | | |
| A | 147 | | 00 2000 | |
| N | 150 | | 00 0170 | Beginning storage register |
| src | 151 | DAP | 26 0154) | Specify initial address for storage of responses |
| | 152 | LAW | 70 0170) | |
| | 153 | DAC N | 24 0150) | |
| | 154 | JMP | 60 | Exit |
| M | 155 | | 00 0777 | Mask |
| S | 156 | | 77 7000 | Mask |
| K | 157 | | | |
| ac | 160 | SZF Z | 64 0020 | Switch for sample display |
| | 161 | JMP E | 60 0054 | Display each sample |
| | 162 | JMP | 60 0130 | Display every X samples |
| | 163 | SAL 9 | 66 5777 | |
| | 164 | DSP | 73 0007 | |
| | 165 | JMP AF | 60 0063 | |
| | 166 | LAC J | 20 0146 | |
| | 167 | JMP Q | 60 0105 | |