"MEASY" Modified E-SY Assembly SYstem for the Burroughs 205

or, "More Elegant Assembly System Yet"

ME-SY is an improved version of EASY, for use with 205's which have magnetic tape and on-line 407. MEASY punches no cards. The input language is the same as regular EASY.

Operating Instructions: Mount any calibrated tape on TSU 4 and enable writing. Then load the MEASY deck in the Cardatron, followed by your input cards. Ready the 407 with a skip-to-1 carriage control tape, and a standard 120-120 board.*

MEASY is a 1½ pass assembler; during the first pass a 407 listing will be produced at about 120 lines per minute. Forward references will not be shown on this listing -- a "lozenge" will appear next to an address which is to be fixed up later. If the same symbol occurs twice in the symbolic location field the flag "HM.." will appear on the listing.

The result of the first pass is a self-loading tape -- it can be loaded by

```
0040 MTS 0000
0340 MRD 1000
     BOF  1-
     CUB 1045.
```

The loading routine on this tape is the other ½ pass of the program -- it fixes up forward references which were made. If locations greater than 3999 appear, the instructions will not be loaded into their locations during this pass; the loading routine operates out of all four high-speed loops and does not overlay itself.

There are two programmed stops in MEASY.

08 8421 Mispunched symbolic OP-code is displayed in the A register. Change the A register to the correct alphanumeric code and depress program start; the new code will be substituted for the old.

(Note: to enter new symbolic OP-codes into MEASY's repertoire, simply punch them in OP field and wait for a 08 8421 stop. Note the contents of the B register at this point. Store the alphanumeric code plus seven into (1900+rB) and the two-digit numeric equivalent into (2900+rB).)

08 1111 The END card has been sensed. TSU 4, now being rewound, contains your program tape. Depressing program start (i.e., Continuous) will cause your assembled program to be loaded. The switch on the tape control unit should, of course, be set to B Suppress.

If the number of different symbols in your program plus the number of symbolic Opcodes in MEASY's repertoire exceeds 1000 the assembler will go into a closed loop -- there is no stop for this.

Don Knuth
Case Institute of Tech.
24 Aug 1960

* T-relay 1 for skip to 1 after print; T-relay 4 for extra space before print. Break Zero Print Control in columns 4, 9, 34, 42, 43, 66, 69.

P.S. There has been some question as to the meaning of the word "elegant" as used in EASY. This is to be taken in its mathematical connotation of "short and sweet." Excluding the OP-table entries the number of non-zero locations in the MEASY program is less than 300, including the format bands and the loading routine!

```
                                                    1000 START
      1000 0 0140 40 8000 HM..    MREAD    140008000 MRD
      1001 0 5000 64 0000¤                           CAD          5F 5
      1002 0 0000 12 7003       1                    STA    GET     7
      1003 0 0000 66 4000 HM..    GET          4000 CAA
      1004 0 0000 12 5045                            STA    T0      5
      1005 0 0000 13 0004                          4 SRT
      1006 0 0000 12 5046       2                    STA    T1      5
      1007 0 0000 74 5045                            ADD    T0      5
      1008 0 0000 28 5699                       5699 BOF
      1009 0 0000 20 6030                            BUN    TRY     6
      1010 0 0000 64 5046 HM..    NXT                CAD    T1      5
      1011 0 5000 74 0000¤                           ADD          7F 5
      1012 0 7000 28 0000¤                           BOF          3F 7
      1013 0 0000 72 7003                            LDB    GET     7
      1014 1 0000 64 0001                 1        1 CAD
      1015 0 0000 72 5046,                           LDB    T1      5
      1016 1 0000 12 0000                 1          STA
1012  1017 0 0000 64 7003       3                    CAD    GET     7
      1018 0 5000 74 0000¤                           ADD          8F 5
      1019 0 0000 28 7002                            BOF          1B 7
      1020 1 0000 64 0001 HM..    FIX    1        1 CAD
      1021 0 0000 12 5045                            STA    T0      5
      1022 0 5000 63 0000¤                           EXT          6F 5
      1023 0 0000 76 5046                            ADA    T1      5
      1024 0 0000 13 0009                          9 SRT
      1025 0 6000 04 0000¤                           CNZ          1F 6
      1026 0 0000 13 0001                          1 SRT
      1027 0 0000 64 5045       3                    CAD    T0      5
      1028 0 0000 14 0010                         10 SLT
      1029 1 0000 02 0001                 1        1 STC
      1030 0 0000 72 5045 HM..    TRY                LDB    T0      5
      1031 0 0000 22 6020                            DBB    FIX     6
      1032 0 0000 20 7010                            BUN    NXT     7
1025  1033 0 0000 02 5047       1                    STC    T2      5
      1034 0 0000 14 0006                          6 SLT
      1035 0 5000 63 0000¤                           EXT          9F 5
      1036 0 0000 74 5047                            ADD    T2      5
      1037 0 0000 13 0007                          7 SRT
      1038 0 0000 20 6027                            BUN          3B 6
      1039 0 0000 08 7555 HM..    HLT          7555 HLT
1001  1040 0 9000 66 4000       5          9000004000 CAA
1022  1041 0 1111 11 0000       6          1111110000
1011  1042 0 9999 99 6000       7          9999996000
1018  1043 0 9000 00 0002       8          9000000002
1035  1044 0 1111 11 1110       9          1111111110
      1045 0 0000 35 1039 HM..    T0                 BT5    HLT
      1046 0 0000 36 1020 HM..    T1                 BT6    FIX
      1047 0 0000 30 1000 HM..    T2                 CUB    MREAD
      1048 0 0010 48 1231 HM..    BEGIN     10000000 CRF    FI
      1049 0 0030 58 1260                   30000000 CWF    FO
      1050 0 0340 50 1000                  340001000 MOW
      1051 0 0000 28 7050                            BOF          1- 7
      1052 0 0000 35 1055                            BT5    PROC
```

```
      1053 0 0000 36 8000                                  8000 BT6
      1054 0 0000 20 5055                                       BUN    PROC      5
      1055 0 0010 44 6005 HM••    PROC                10006005 CRD
      1056 0 0000 26 1600 HM••    LOOK                    1600 BF6
      1057 0 0000 64 6012                                 6012 CAD
      1058 0 5000 04 0000¤                                     CNZ             1F 5
      1059 0 0000 64 6011 HM••    ADDR                    6011 CAD
      1060 0 5000 04 0000¤                                     CNZ             2F 5
      1061 0 0000 72 6009                                 6009 LDB
      1062 0 5000 22 0000¤                                     DBB             3F 5
      1063 0 0000 73 6012 HM••    FLAG                    6012 OSD
      1064 0 0000 38 1224                                      CCB    STRT
      1065 0 0000 30 1116                                      CUB    LOCAT
1058  1066 0 5000 74 0000¤      1                              ADD             4F 5
      1067 0 5000 72 0000¤                                     LDB             5F 5
      1068 0 0000 30 1135                                      CUB    TABLE
1060  1069 0 0000 30 1134      2                              CUB    SYMBL
1062  1070 1 0000 30 1064      3          1                1 CUB    FLAG
1066  1071 0 0000 00 0007      4                           7
1067  1072 0 0000 30 0000¤      5                              CUB             4F

                                                          10 START FLAG
      1073 0 0000 64 6010                                 6010 CAD
      1074 0 7000 20 0000¤                                     BUN             2F 7
1072  1075 0 0000 12 1614      4                          1614 STA
      1076 0 0000 13 0002                                    2 SRT
      1077 0 0000 04 1614                                 1614 CNZ
      1078 0 0000 20 5059                                      BUN    ADDR      5
      1079 0 0000 64 6012      3                          6012 CAD
      1080 0 0000 08 8421                                 8421 HLT
      1081 0 0000 12 6012                                 6012 STA
      1082 0 0000 20 5056                                      BUN    LOOK      5

                                                          20 START FLAG
      1083 0 0000 65 6010                                 6010 CSU
1074  1084 0 0000 74 6021      2                          6021 ADD
      1085 0 0000 74 6013 HM••    EQ                      6013 ADD
      1086 0 0000 12 1613                                 1613 STA
      1087 0 0000 20 5063                                      BUN    FLAG      5
      1088 0 0000 08 7557                                 7557 HLT
      1089 0 0000 12 1613 HM••    CHAIN                   1613 STA
      1090 0 7000 64 0000¤                                     CAD             1F 7
      1091 0 0000 12 6019                                 6019 STA
      1092 0 0000 64 6015                                 6015 CAD
      1093 0 0000 13 0003                                    3 SRT
      1094 0 0000 64 6008                                 6008 CAD
      1095 0 0000 14 0003                                    3 SLT
      1096 0 0000 02 1615                                 1615 STC
      1097 0 0000 65 6021                                 6021 CSU
      1098 1 0000 02 2900                    1            2900 STC
      1099 0 0000 12 1608                                 1608 STA
      1100 0 0000 30 1116                                      CUB    LOCAT
1090  1101 0 0400 00 0000      1                     400000000
      1102 0 0000 65 6012 HM••    START                   6012 CSU
      1103 0 0000 12 6012                                 6012 STA
      1104 0 0000 20 5059                                      BUN    ADDR      5
```

```
      1053  0 0000 36 8000                                  8000 BT6
      1054  0 0000 20 5055                                       BUN    PROC      5
      1055  0 0010 44 6005 HM••    PROC              10006005 CRD
      1056  0 0000 26 1600 HM••    LOOK                  1600 BF6
      1057  0 0000 64 6012                                6012 CAD
      1058  0 5000 04 0000¤                                    CNZ             1F 5
      1059  0 0000 64 6011 HM••    ADDR                  6011 CAD
      1060  0 5000 04 0000¤                                    CNZ             2F 5
      1061  0 0000 72 6009                                6009 LDB
      1062  0 5000 22 0000¤                                    DBB             3F 5
      1063  0 0000 73 6012 HM••    FLAG                  6012 OSD
      1064  0 0000 38 1224                                     CCB    STRT
      1065  0 0000 30 1116                                     CUB    LOCAT
1058  1066  0 5000 74 0000¤      1                             ADD             4F 5
      1067  0 5000 72 0000¤                                    LDB             5F 5
      1068  0 0000 30 1135                                     CUB    TABLE
1060  1069  0 0000 30 1134      2                             CUB    SYMBL
1062  1070  1 0000 30 1064      3          1                  1 CUB    FLAG
1066  1071  0 0000 00 0007      4                             7
1067  1072  0 0000 30 0000¤      5                             CUB             4F

                                                           10 START FLAG
      1073  0 0000 64 6010                                6010 CAD
      1074  0 7000 20 0000¤                                    BUN             2F 7
1072  1075  0 0000 12 1614      4                         1614 STA
      1076  0 0000 13 0002                                   2 SRT
      1077  0 0000 04 1614                                1614 CNZ
      1078  0 0000 20 5059                                     BUN    ADDR      5
      1079  0 0000 64 6012      3                         6012 CAD
      1080  0 0000 08 8421                                8421 HLT
      1081  0 0000 12 6012                                6012 STA
      1082  0 0000 20 5056                                     BUN    LOOK      5

                                                           20 START FLAG
      1083  0 0000 65 6010                                6010 CSU
1074  1084  0 0000 74 6021      2                         6021 ADD
      1085  0 0000 74 6013 HM••    EQ                    6013 ADD
      1086  0 0000 12 1613                                1613 STA
      1087  0 0000 20 5063                                     BUN    FLAG      5
      1088  0 0000 08 7557                                7557 HLT
      1089  0 0000 12 1613 HM••    CHAIN                 1613 STA
      1090  0 7000 64 0000¤                                    CAD             1F 7
      1091  0 0000 12 6019                                6019 STA
      1092  0 0000 64 6015                                6015 CAD
      1093  0 0000 13 0003                                   3 SRT
      1094  0 0000 64 6008                                6008 CAD
      1095  0 0000 14 0003                                   3 SLT
      1096  0 0000 02 1615                                1615 STC
      1097  0 0000 65 6021                                6021 CSU
      1098  1 0000 02 2900                    1           2900 STC
      1099  0 0000 12 1608                                1608 STA
      1100  0 0000 30 1116                                     CUB    LOCAT
1090  1101  0 0400 00 0000      1                   400000000
      1102  0 0000 65 6012 HM••    START                 6012 CSU
      1103  0 0000 12 6012                                6012 STA
      1104  0 0000 20 5059                                     BUN    ADDR      5
```

```
                                                          42 START FLAG
      1105 0 0000 72 6010                           6010 LDB
      1106 1 0000 64 3900                    1      3900 CAD
      1107 0 0000 30 1085                                 CUB    EQ

                                                          46 START FLAG
      1109 0 0000 64 6010                           6010 CAD
      1110 0 7000 74 0000¤                                ADD           1F 7
      1111 0 0000 12 7120                                 STA           9& 7
      1112 0 0000 72 7120                                 LDB           8& 7
      1113 1 0000 64 2900                    1      2900 CAD
      1114 0 0000 30 1089                                 CUB    CHAIN
1110  1115 0 0000 00 1050        1                  1050
      1116 0 0000 64 6017 HM••     LOCAT          6017 CAD
      1117 0 7000 04 0000¤                                CNZ           1F 7
      1118 0 0000 64 6018                           6018 CAD
      1119 0 7000 04 0000¤                                CNZ           2F 7
      1120 0 0000 64 1613 HM••     FINIS          1613 CAD
      1121 0 0000 13 0004                              4 SRT
      1122 0 0000 64 1608                           1608 CAD
      1123 0 0000 30 1174                                 CUB    FIN1
1117  1124 0 7000 72 0000¤        1                      LDB           3F 7
      1125 0 0000 30 1135                                 CUB    TABLE
1119  1126 0 0000 72 6018        2                  6018 LDB
      1127 1 0000 64 3950                    1      3950 CAD
      1128 0 0000 12 6022                           6022 STA
      1129 0 0000 64 6021                           6021 CAD
      1130 1 0000 02 3900                    1      3900 STC
      1131 1 0000 12 3950                    1      3950 STA
      1132 0 0000 20 7120                                 BUN    FINIS     7
1124  1133 0 0000 30 1165        3                      CUB    A4
      1134 0 7000 72 0000¤HM••     SYMBL              LDB           1F 7
      1135 0 0000 02 6023 HM••     TABLE          6023 STC
      1136 0 0000 11 0000                                 BA
      1137 0 7000 74 0000¤                                ADD           3F 7
      1138 0 0000 12 0000¤                                STA           9F
      1139 0 7000 64 0000¤                                CAD           2F 7
      1140 0 0000 60 6023                           6023 MUL
      1141 0 0000 02 7134                                 STC    SYMBL     7
      1142 0 0000 14 0003                              3 SLT
      1143 0 0000 12 7134                                 STA    SYMBL     7
      1144 0 0000 72 7134                                 LDB    SYMBL     7
      1145 0 0000 30 1149                                 CUB    SERCH
1134  1146 0 0000 30 1085        1                      CUB    EQ
1137  1147 0 0000 30 0004        3                      4 CUB
1139  1148 0 1001 00 1001        2              1001001001
      1149 1 0000 64 1900 HM••     SERCH 1        1900 CAD
      1150 0 7000 04 0000¤                                CNZ           2F 7
      1151 0 0000 64 6023                           6023 CAD
      1152 1 0000 02 1900                    1      1900 STC
1138  1153 0 0000 08 0000        9                      HLT
      1154 0 0000 00 0999        3                  999
1150  1155 0 0000 75 6023        2                  6023 SUB
      1156 0 7000 04 0000¤                                CNZ           2F 7
      1157 1 0000 64 2900                    1      2900 CAD
      1158 0 0000 73 7151                                 OSD           7- 7
```

```
      1159 0 0000 28 7153                                  BOF          9B 7
      1160 0 0000 72 7153                                  LDB          9B 7
      1161 1 0000 29 9996                  1     299996
1156  1162 0 0000 22 7149        2                         DBB    SERCH    7
      1163 0 0000 72 7154                                  LDB          3B 7
      1164 0 0000 20 7149                                  BUN    SERCH    7
      1165 0 0000 64 6019 HM..    A4              6019     CAD
      1166 0 7000 74 0000¤                                 ADD          3F 7
      1167 0 0000 12 6019                          6019    STA
      1168 0 0000 30 1120                                  CUB    FINIS
      1169 0 0000 12 6022 HM..    A3              6022     STA
      1170 0 0000 64 6021                          6021    CAD
      1171 1 0000 12 2900                  1       2900    STA
      1172 0 0000 30 1120                                  CUB    FINIS
1166  1173 0 0048 54 0303        3           48540303
      1174 0 7000 04 0000¤HM..    FIN1                     CNZ          1F 7
      1175 0 0000 64 1614        2                 1614    CAD
      1176 0 0000 13 0002                             2    SRT
      1177 0 0000 64 1615                          1615    CAD
      1178 0 0000 13 0004                             4    SRT
      1179 0 0000 64 6016                          6016    CAD
      1180 0 0000 01 0009                             9    CIRA
      1181 0 0000 14 0010                            10    SLT
      1182 0 0000 12 6020                          6020    STA
      1183 0 0000 30 0000¤                                 CUB          2F
1174  1184 0 0000 14 0001        1                    1    SLT
      1185 0 0000 64 6008                          6008    CAD
      1186 0 0000 13 0001                             1    SRT
      1187 0 0000 20 7175                                  BUN          2B 7
      1188 0 7000 72 0000¤HM..    END                      LDB          8F 7
      1189 0 7000 64 0000¤                                 CAD          1F 7
      1190 1 0000 02 0000                  1               STC
      1191 0 0000 12 6021                          6021    STA
      1192 0 1030 54 6005                    1030006005    CWR
      1193 0 0140 50 8000                     140008000    MOW
      1194 0 0040 42 0000                      40000000    MTS
      1195 0 0000 08 1111                          1111    HLT
      1196 0 0340 40 1000                     340001000    MRD
      1197 0 0000 28 7196                                  BOF          1- 7
      1198 0 0000 30 1045                                  CUB    TO
1189  1199 0 9999 99 9999        1          9999999999
1183  1200 0 7000 72 1188¤       2                         LDB          8F 7
      1201 1 0000 12 0001                  1          1    STA
      1202 0 0000 64 6022                          6022    CAD
      1203 0 0000 13 0004                             4    SRT
      1204 0 0000 66 6021                          6021    CAA
      1205 0 0000 14 0004                             4    SLT
1200  1206 0 9000 12 4000        8          9000004000    STA
      1207 0 0030 54 6005                      30006005    CWR
      1208 0 0000 64 6021                          6021    CAD
      1209 0 7000 74 0000¤                                 ADD          1F 7
      1210 0 0000 02 6021                          6021    STC
      1211 0 0000 12 6022                          6022    STA
      1212 0 0000 12 6019                          6019    STA
      1213 0 0000 64 7206                                  CAD          6B 7
      1214 0 7000 74 0000¤                                 ADD          2F 7
```

```
      1215 0 0000 38 0000¤                                  CCB          4F
      1216 0 0000 30 0000¤                                  CUB          5F
1209  1217 0 0000 00 0001       1                 1
1214  1218 0 9000 00 0002       2          9000000002
1216  1219 0 0140 50 8000       5           140008000 MOW
      1220 0 7000 64 0000¤                                  CAD          1F 7
1215  1221 0 0000 02 1206       4                        STC          8B
      1222 0 0000 12 6020                          6020 STA
      1223 0 0000 20 5055                               BUN    PROC      5
      1224 0 0000 02 7231 HM••    STRT                  STC          7& 7
      1225 0 0000 12 6021                          6021 STA
      1226 0 4030 54 6005                    4030006005 CWR
      1227 0 0000 64 1613                          1613 CAD
      1228 0 0000 12 6021                          6021 STA
      1229 0 0000 20 5055                               BUN    PROC      5
1220  1230 0 9000 12 4000       1          9000004000 STA
      1231 3 3333 33 3333 HM••    FI      33333333333
      1232 3 3333 33 3333                   33333333333
      1233 3 3333 33 3333                   33333333333
      1234 3 3333 33 3333                   33333333333
      1235 1 1111 11 3333                   11111113333
      1236 1 1111 11 0111                   11111110111
      1237 1 1111 11 0111                   11111110111
      1238 0 2221 33 0111                    2221330111
      1239 0 0011 00 0000                      11000000
      1240 0 2221 00 0000                    2221000000
      1241 1 1111 00 0000                   11111000000
      1242 1 1113 21 1111                   11113211111
      1243 1 3132 11 1111                   13132111111
      1244 0 0000 03 1313                         31313
      1245 0 0000 03 1310                         31310
      1246 3 1313 13 1000                   31313131000
      1247 2 2310 00 0000                   22310000000
      1248 1 1100 00 0000                   11100000000
      1249 2 1321 11 1111                   21321111111
      1250 3 0022 22 2222                   3  22222222
      1251 3 3333 33 3333                   33333333333
      1252 3 3333 33 3333                   33333333333
      1253 3 3333 33 3333                   33333333333
      1254 3 3333 33 3333                   33333333333
      1255 3 3333 33 3333                   33333333333
      1256 3 3333 33 3333                   33333333333
      1257 3 3333 33 3333                   33333333333
      1258 3 3333 33 3333                   33333333333
      1259 3 3333 33 3333                   33333333333
      1260 0 0000 00 0000 HM••    FO
      1261 0 0000 00 0000
      1262 0 0000 00 0000
      1263 0 0000 00 0000
      1264 0 0000 00 0000
      1265 0 0000 00 0000
      1266 0 0000 00 0000
      1267 0 0000 00 0000
      1268 0 0000 00 0000
      1269 1 1111 11 1000                   1111111100
```

1270	1	1111	11	1311	11111111311
1271	1	1111	11	1311	11111111311
1272	3	3311	20	0311	33311200311
1273	3	3331	13	3333	33331133333
1274	3	3311	23	3333	33311233333
1275	1	1111	13	3333	11111133333
1276	1	1110	03	1111	11110031111
1277	2	2003	11	1111	22003111111
1278	2	2333	33	3322	22333333322
1279	2	2333	33	3333	22333333333
1280	1	2333	33	3322	12333333322
1281	1	1333	33	3331	11333333331
1282	0	0311	11	1111	3111111111
1283	3	3333	33	3112	33333333112
1284	3	1111	11	1111	31111111111
1285	2	0022	00	2222	2 22002222
1286	2	2200	20	0222	22200200222
1287	2	2233	33	3112	22233333112
1288	0	0031	11	1112	31111112

END