SUBROUTINES

```
 ,Divide + Multiply test using random numbers
,9/25/61
,B.G. S.L.
be1       dzm ctn1   ,no. of goods
          dzm ctn2   , "   "   "
          dzm ctn3   , "   " over-flows
          dzm ctn4   , "   "   "   "
          lac rand1            ,initilize random no. gen.
          dac rd1
          lac rand2            ,    "         "    "   "
          dac rd2
p1        clf 6
          szo        ,clear overflow
          nop
          jsp abc    ,put rand no. in a,b,c
          rar s1     ,AC holds b
          xor a
          sma        ,is bit 17 of b equal to 0 of a
          jmp p2
          lac b
          xor rc1
          dac b      ,bit 0 of a equals bit 17 of b
p2        szs 60
          jmp muldiv           ,multiply + divide subroutine
          lac a
          lio b
          dis c      ,high speed divide
          jmp divovflo
          dac quot
          dio rem
          mus c      ,high speed multiply
p3        szs 20
          jmp p2
          spa
          stf 16     ,remember prod negative
          dac hprod
          dio lprod
          lac lprod
          szo
          nop        ,clear overflow from divd subroutine
          rar s1
          add rem    ,add remainder to low product
          szo        ,is there a carry into high product
          jmp p4
          ral s1
          dac t1
          jmp p5
p4        xor t2     ,fix up sign bit of low product
          ral s1
          dac t1
          law 1
          szf 6      ,sub one if hprod is negative
          cma
          add hprod
          dac hprod            ,lprod + rem carry added to hprod
          lac t1
p5        sas b
          jmp errorone         ,low product + remainder not equal to b
          lac hprod
          sas a
          jmp errortwo         ,high product not equal to a
          clf 6
          idx ctn1
          sma
```

```
            jmp p1
            dzm ctn1
            idx ctn2  ,count sucessful matches
            jmp p1
muldiv      lac a
            lio b
            jda dvd   ,use divide subroutine
            lac c
            jmp divovflo
            dac quot
            dio rem
            lac quot
            jda mpy   ,use multiply subroutine
            lac c
            jmp p3
divovflo    idx ctn3
            sma       ,count no of overflows

            idx ctn4
            dzm ctn3
            jmp p1
a           0
b           0
c           0
quot        0
rem         0
hprod       0
t1          0
lprod       0
ctn2        0
ctn1        0
ctn4        0
ctn3        0
t2          400000
t3          2
t4          lio t2    ,stop code for type out
t5          0
rc1         1
cr          77
rand1       742335
rand2       125131
rd1         0
rd2         0
errorone    lio rc1   ,print out errors
            jmp errortwo + 1
errortwo    lio t3
            tyo '
            law a
            dap p12
p11         lio t2
            tyo '
p12         lio
            law ' 6
            jda print
            idx p12
            sas t4
            jmp p11
            lio cr
            tyo '
            szs 20
            jmp p2
            szs 10
            jmp be1
            jmp p1
print       0
            dio t5
```

```
          dap p10
p7        cla
          lio t5
          rcl s3
          sza '
          lio t3
          lac t5
          rcl s3
          dac t5
          tyo '
          isp print
          jmp p7
p10       jmp
abc       dap out    ,get random number
          jsp random
          dac a
          jsp random
          dac c
          jsp random
          dac b
out       jmp
random    dap exit   ,random num generator
          lac rd2
          lio rd1
          rcr s7
          xor rd1
          lio rd2
          dac rd2
          dio rd1
exit      jmp
jmp be1 end .
~
```

PUNCH TEST

```
org 100
m       lac k       ,ppa ', setup punch 0, general test
        dac a + 1
        dac a + 5
        dac c + 1
        dac c + 3
        dac c + 7
        dac c + 11
        lac k + 1           ,ppb '
        dac e + 1
        jmp b
n       lac k + 2           ,ppa ' c1, setup punch 1
        dac a + 1
        dac a + 5
        dac c + 1
        dac c + 3
        dac c + 7
        dac c + 11
        lac k + 3           ,ppb ' c1
        dac e + 1
b       lac j + 1           ,-2 reset a ctrs
        dac h + 4
        lac j       ,-12
        dac h + 1
        dac h + 3
a       lio h       ,377, 10 lines all holes
        0
        isp h + 1           ,-12
        jmp a
        lio h + 2           ,777400, 10 lines no holes
        0
        isp h + 3           ,-12
        jmp a + 4
        isp h + 4           ,-2
        jmp b + 2
d       lac h + 2           ,reset c ctrs
        dac h + 6
        dac h + 7
c       lio h + 5           ,0, o,n,; on+1; etc.
        0
        lio h + 6           ,777400
        0
        isp h + 6
        jmp c
        lio h       ,377, n.,377, n + 1, etc.
        0
        lio h + 7           ,777400
        0
        isp h + 7
        jmpc + 6
f       lac h + 11          ,-100, reset e ctrs
        dac h + 10
        lac h + 5           ,0
        dac h + 12
e       lio h + 12          ,0 init, bin 0-77
        0
        lac h + 12
        add h + 13          ,10000
        dac h + 12
        isp h + 10
        jmp e
        szs 10
        jmp aa
        jmp e + 7
```

```
h       377         ,constants
        0
        777400
        0
        0
        0
        0
        0
        0
        - 100
        0
        10000
j       - 12
        - 2
org 220
g       lac k       ,0a, tw mode
        jmp g + 7
        lac k + 1           ,0b
        jmp g + 7
        lac k + 2           ,1a
        jmp g + 7
        lac k + 3           ,1b
        dac r
p       dac r + 2
        lac k + 4           ,-23 setup line ctr
        dac k + 5
        lac k + 6           ,-60k stop delay 250ms
        dac k + 7
        lat
        dac k + 10
        lio k + 10
r       0           ,punch rt half if a, lt half if b
        rir s9
        0           ,punch lt half if a, rt half if b
        isp k + 5           ,-23 line count
        jmp p + 7
        isp k + 7           ,-60k stop delay
        jmp r + 5
        jmp p + 1
k       ppa '       ,constants
        ppb '
        ppa ' c1
        ppb ' c1
        - 23
        0
        - 60000
        0
        0
aa      lac ah      ,100 locate data, general test read check

        dio ah + 1
        sad ah + 1
        jmp aa + 1
ac      lac j + 1           ,-2 reset ab and ad
        dac ah + 7
        lac ah + 4          ,-12
        dac ah + 3
        dac ah + 6
ab      lac ah + 2          ,377, check 10 lines all holes
        xor ah + 1
        sza
        jda bd      ,error
        isp ah + 3          ,-12
        jmp ab + 7
        jmp ad      ,check next 10
        rpa '
```

```
          dio ah + 1
          jmp ab
ad        rpa '      ,check 10 lines no holes
          dio ah + 1
          lac ah + 5          ,0
          ior ah + 1
          sza
          jda bd     ,error
          isp ah + 6          ,-12
          jmp ad
          isp ah + 7          ,-2
          jmp ad + 13         ,check next 10, 377
          jmp an
          rpa '
          dio ah + 1
          jmp ac + 2
an        lac ah + 5          ,0 reset for 0,n
          dac aj
          dac ah + 6
          lac aj + 1          ,-377
          dac ah + 3          ,pr ctr
          lac j + 1           ,-2
          dac ah + 7
          jmp ae     ,check 0,n
ae        rpa '
          dio ah + 1
          lac aj     ,0
          xor ah + 1
          sza
          jda bd
          rpa '
          dio ah + 1
          lac ah + 6          ,0 init
          xor ah + 1
          sza
          jd1 bd     ,error
          isp ah + 3          ,-377
          jmp ae + 17
          jmp af
          idx ah + 6          ,compare word
          jmp ae
af        isp ah + 7          ,-2
          jmp af + 3
          jmp af + 12
          lac ah + 2          ,377 reset for 377, n
          dac aj
          lac ah + 5          ,0
          dac ah + 6
          lac aj + 1          ,-377
          dac ah + 3          ,pr ctr
          jmp ae     ,check 377,n
          lac aj + 2          ,-100, reset for binary
          dac aj + 3
          lac aj + 4          ,200 compare word
          dac aj + 5
ag        rpa '      ,check binary
          dio ah + 1
          lac aj + 5          ,200 init
          xor ah + 1
          sza
          jda bd     ,error
          isp aj + 3          ,-100
          jmp ag + 11
          imp ag + 13
          idx aj + 5
          jmp ag
```

```
            lac ah     ,100 check feed
            rpa '
            dio ah + 1
            sad ah + 1
            hlt        ,test complete
            jda bd     ,error
ah          000        ,constants
            0
            377
            0
            - 12
            0
            0
            0
aj          0
            - 377
            - 100
            0
            200
            0
org 450
ba          lac ah     ,100, locate data
            rpa '
            dio ah + 1
            sad ah + 1
            jmp ba + 1
bb          lat        ,check data, rt alpha
            and ah + 2           ,377
            xor ah + 1
            sza
            jda bd     ,error
            rpa '
            dio ah + 1
bc          lat        ,check data lt
            sar s9
            and ah + 2           ,377
            xor ah + 1
            sza
            jda bd     ,error
            rpa '
            dio ah + 1
            jmp bb
org 500
be          lac ah     ,100 locate data
            rpa '
            dio ah + 1
            sad ah + 1
            jmp be + 1
bf          lat        ,check data , lt bin
            and bk     ,770000
            rar s6
            rar s6
            add aj + 4           ,200
            xor ah + 1
            sza
            jda bd     ,error
            rpa '
            dio ah + 1
bg          lat        ,check data, rt bin
            and bk + 1           ,770
            rar s3
            add aj + 4           ,200
            xor ah + 1
            sza
            jda bd     ,error
            rpa '
```

```
            dio ah + 1
            jmp bf
bk          770000
            770
bd          0
            dap bd + 4          ,error routine
            lacbd
            hlt
            jmp
org 0
bj          0
            jmp end
```

```
,TAPE CONTROL PROGRAM S. L.
,calling sequence
,law or lac command
,jda tape
,initial address back or foward
,final address      "    "
,hlt  non normal return
,hlt  normal return
opd msm   720073
opd mwc   720071
opd mrc   720072
opd mec   720034
opd mcb   720070
org 7000
tape      0          ,command
          dap → + 1
q100      lac
          dap k1
          idx q100
          lac ' q100
          dap k2
          idx q100
          dap k3
          lio tape
          rir s8
          spi        ,operate bit off
          jmp p104
          lac t105
          sza        ,tape is sopped
          lio tape
          msm
          cla
p102      mec        ,strobe status
          jmp ' k3
p104      lac tape
          and t111
          dac t3
          lac t105   ,what unit number
          dac t2
          and t111
          sas t3     ,was last operation continue
          jmp p60
          mec
          spi        ,is present unit busy
          jmp p103
p60       lio tape
          msm        ,start up tape transport
p103      dzm t105
          dzm t122   ,flag 4
          law p132
          dap p131
          law p131
          dap p134
          law q6
          dap p122
          dap q7 + 1
          dap q7 + 3
          dap q10 + 2
          law 6
          dap p32
          law q15
          dap q13 - 4
          law p44
          dap p133
```

```
          law p50
          dap p125
          law p52
          dap p130
          law q1
          dap q13
          mcb
          lio tape
          ril s6
          spi       ,early complete different unit
          jmp p105
p113      ril s1
          spi       ,its your gap
          jmp p106
p114      ril s1
          spi       ,read check
          jmp p107
p115      ril s1
          spi       ,space back or fow ard
          jmp p110
p116      ril s2
          spi       ,rewind
          jmp p137
          ril s1
          spi       ,foward or reverse
          jmp p111
p117      ril s1
          spi       ,read or write
          jmp p112
          jmp p120
p105      law p122
          dap p123
          jmp p113
p106      lac tape
          dac t105
          law p122
          dap p133
          dap p125
          dap p130
          jmp p114
p107      law rdck
          dap p134
          jmp p115
p110      law space
          dap p134
          law p134
          dap p133
          dap p125
          lac k1
          cma
          dac t110
          jmp p116
p137      idx k3
          dzm bk
          cli cla
          msm
          mec
          jmp ' k3
p111      law bread
          dap p131
          jmp p117
p112      lac t2
          sza '
          jmp → + 4
          law write + 2
          da p134
```

```
            jmp p120
            law write
            dap p134
p120        lac k1
            dap q31
            law ' 1
            add k1
            dap q6
            dap q15
            lac k2
            dap q33
            dap q11
            dap t103
            cli 7
p134        jmp p131
p131        jmp p132
p132        lac t107
            dac q7
            lac q32 + 1
            dac q2
            dac q4
            lac q30
            dac q5
            idx bk
            jsp read
p133        jmp p44     ,your gap
p44         lac t113    ,fixed delay for eob
            jda delay
p45         lio t3
            msm
 p123       jmp p46     ,early complete different
p46         lac t114    ,fixed stop delay
            jda delay
p122        lac q6
p32         szf 6
            jmp p56
            lac t122
            sza '
            jmp → + 3
            stf 4
            jmp p56
            idx k3
            lac bk
            mec
            jmp ' k3
p56         lac ' p122
            mec
            jmp ' k3    ,non-normal return
bread       lac q6
            dap q11
            dap t103
            lac k2
            dap q6
            dap q15
            lac t104
            dac q7
            lac t106
            dac q2
            dac q4
            dac q5
            law ' 1
            add bk
            dac bk
            stf 6
            jsp read
p125        jmp p50     ,your gap
```

```
p50         lac t115  ,delay back
            jda delay
            jmp p45
write       lac t116
            jda delay
            idx bk
            law q31
            dap p122
            jmp q30
q35         lac t117
            jda delay
            mcb
p130        jmp p52   ,your gap
p52         lac t120  ,stopping delay
            jda delay
            jmp p45
space       law p22
            dap q13
            isp t110
            jmp p131
            law p44
            dap p133
            law p50
            dap p125
            law 2000
            dap p32
            jmp p131
rdck        law q6
            dap q13 - 4
            law q15
            dap p122
            dap q7 + 1
            dap q7 + 3
            dap q10 + 2
            jmp p131
q30         nop
            law ' 2
            dac t2
q31         lio
q32         mwc
            ril s6
            cla
            jda delay
            isp t2
            jmp q32
            nop
            mwc
            nop
            idx q31
            sad q33
            jmp q35
            jmp q30
read        dap p31
            mcb
            lac t112  ,delay before error miss
            dac t2
p2          szf 2
            jmp → + 4
            isp t2
            jmp p2
            jmp q14   ,tape has no characters
            law t123
            cli
            dap
            mrc
            cla
```

```
            nop
q13         jmp q1
q1          szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            szf 2
            jmp q2
            jmp p22
q2          ril s6
q7          jmp q10
            add q6
            mrc
            dac q6
            jmp q3
q10         lac q6
            mrc
            idx q6
            jmp q3
q3          sad q11
            jmp p26
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            szf 2
            jmp q4
            jmp q14
q4          ril s6
            mrc
q5          nop
q6          dio
            cli clf 6
            szf 2
            jmp q12
            szf 2
            jmp q12
            szf 2
            jmp q12
            szf 2
            jmp q12
            szf 2
```

```
            jmp q12
            szf 2
            jmp q12
            szf 2
            jmp q12
            szf 2
            jmp q12
            szf 2
            jmp q12
            jmp q14
q12         lac t123
            mrc
q15         sas
            jmp p26 - 1
            jmp q1
q14         law ' 0
            dac t2
            szf 2
            jsp q16
            isp t2
            jmp q14 + 2
            jmp p26
q16         dap → + 3
            stf 6
            mrc
            jmp
p22         szf ' 6     ,is it eob
            jmp q14
            mrc
            clf 7
            jmp p2
            stf 6
p26         szf 4
            idx t122
            law ' 14    ,delay after character
            dac t2
            mrc
p27         szf 2
            jmp p26 + 2
            isp t2
            jmp p27
            cli clf 4
p31         jmp
delay       0
            dap exit
            isp delay
            jmp → - 1
exit        jmp
q11         dio
q33         lio
t2          0           ,index counter
t3          0           ,unit no + temp stor
k1          0           ,initial address
k2          0           ,final address
k3          0           ,non norm return
t7          0           ,address equal
t103        sas
t106        rir s6
t104        law ' 1
t105        0           ,continue memory
t107        jmp q10
t110        0           ,space count
bk          0           ,block count
t111        000003      ,unit mask
t112        - 764       ,begining delay onread mis char
t113        - 102       ,foward delay read before stop
```

```
t114    - 306     ,final stop delay read + write
t115    - 412     ,back read delay before stop
t116    - 424     ,write start delay
t117    - 13      ,eob delay write
t120    - 524     ,write delay before stop
t122    0         ,flag 4
t123    0         ,storage for read check
end
```

```
,anytape duplicator verifier
org 3000
            cla
            dap zero
zero        dzm
            idx zero
            sas limit           ,limit is 340400
            jmp zero
            hlt         ,set master then contin
leader      rpa '
            rcr s9
            rcr s9
            sas stopcode
            jmp leader
            rcr s9
            rcr s9
            szs 20      ,on is no punching
            jmp setreadbloc
            law punchbloc
            dap punchorread
            law 1000
            dap block
            jmp patch1
readbloc    law 1000
            dap block
            rpa '
            rcr s9
            rcr s9
            sad stopcode
            jmp patch2
            dap histo
block       dac
histo       idx
            idx block
            sas limit1          ,limit1 is 241100
            jmp readbloc + 2
punchorread         jmp
punchbloc           law 1000
            dap block1
            lac block
            dap limit2          ,limit2 is 22xxxx
block1      lio
            ppa '
            idx block1
            sas limit2
            jmp block1
            sad limit3          ,limit3 is 221100
            jmp readbloc
loadcopy    hlt         ,set copy then contin
            law 0400
            dap zero1
zero1       dzm
            idx zero1
            sas limit4          ,limit4 is 341000
            jmp zero1
leader1     rpa '
            rcr s9
            rcr s9
            sas stopcode
            jmp leader1
            jmp read + 5
read        rpa '
            rcr s9
```

```
          rcr s9
          sad stopcode
          jmp patch3
          add constant        ,constant is 000400
          dap histo1
histo1    idx
          jmp read
compare   law 0000
          dap masterhisto
          law 0400
          dap copyhisto
masterhisto         lac
copyhisto           sas
          jmp error
indexer   idx masterhisto
          idx copyhisto
          sas limit5          ,limit5 is 521000
          jmp masterhisto
          jmp loadcopy
error     lio save3
          tyo '     ,cr
          lio lc
          tyo '     ,lc
          lio sam
          tyo '     ,m
          rir s6
          tyo '     ,a
          rir s6
          tyo '     ,s
          cli
          tyo '     ,space
          lac masterhisto
          and save3
          jda type
          cli
          tyo '     ,space
          lac ' masterhisto
          jda type
          lio save3
          tyo '     ,cr
          lio poc
          tyo '     ,c
          rir s6
          tyo '     ,o
          rir s6
          tyo '     ,p
          cli
          tyo '     ,space
          lac copyhisto
          and save3
          jda type
          cli
          tyo '     ,space
          lac ' copyhisto
          jda type
          lio save3
          tyo '     ,cr
          szs 10    ,on to contin despite err
          jmp indexer
          hlt       ,if ss1 dn end prog
trailer   szs 20
          jmp loadcopy
          jmp punchbloc
setreadbloc         law readbloc
          jmp readbloc - 4
limit     340400
```

```
stopcode  000113
limit1    241100
limit2    220000
limit3    221100
limit4    341000
constant  000400
limit5    521000
poc       474663
lc        000072
sam       226144
save3     000777
type      0
          dap exit
          dzm temp1
          law ' 6
          dac temp
          lac type
          cli
          rcl s3
          dac type
          cla
          rcr s3
          sza '
          jmp leading
          rcl s3
          idx temp1
go        tyo '
          isp temp
          jmp type + 5
exit      jmp
leading   sas temp1
          jmp twenty
          law ' 1
          sas temp
          jmp go
twenty    lio two
          jmp go
temp      0
temp1     0
two       000020
patch1    rcr s9
          rcr s9
          jmp readbloc + 7
patch2    dap n
          dac block
n         idx ..
          idx block
          jmp trailer
patch3    add constant
          dap m
m         idx ..
          jmp compare
          jmp end
```

```
...multiply subroutine
...
xsy mpy
imp':b:    loc
           dap a
a:         xct
           jda g
           lac b
           idx a
           rir 1
           rcr 9
           rcr 9
           jmp'a
e:         loc ... temporary storage
mpy':g:    loc
           dap f
           lac g
           spa
           cma
           rcr 9
           rcr 9
f:         xct
           spa
           cma
           dac e
           cla
z eoc mus
           z e;z e;z e;z e;z e;z e;z e;z e;z e;z e;z e;z e;z e;z e;
           z e;z e;z e          ...17mus e
           dac e
           xct f
           xor g
           sma
           jmp h
           lac e
           cma
           rcr 9
           rcr 9
           cma
           rcr 9
           rcr 9
           dac e
h:         idx f
           lac e
           jmp'f
fin
```

```
   ...decprint subroutine, routine to print decimal
...July 11, 1961
...
decprint':          dap return
          law teny
          dap tenz  ...set the nonprint trap
          dzm value           ...reset value
          law'5
          dac position        ...reset position
          law a
          dap tenj  ...reset end trap
          rcl 9
          rcl 9
          sma       ...check for minus
          jmp b
          cma
          dac store
          law c
          dap printit         ...set trap to print minus sign
          jmp set
b.        dac store
          cli
          xct command         ...print space since no minus sign
set:      law store
          add position
          dap d     ...next number to subtract
form:     lac store
d:        sub
          spa
          jmp print
          dac store
          idx value
          jmp form
print:    add'd
          dac store           ...restore after going negative
          lac value
e:        sza
          jmp printit
printzero:          law 20
tenz:     jmp teny
tenx:     jmp printit
teny:     cli
          xct command         ...trap to print no leading zeros
          jmp tenb
printit:  jmp tenk
c:        lio minus
          xct command
tenk:     rcl 9
          rcl 9
          xct command
          dzm value
          law tenk
          dap printit
          law tenx
          dap tenz  ...unset nonprint trap
tenb.     isp position
          jmp set
          law tenx
          dap tenz
tenj:     jmp → + 1
a:        law return
          dap → - 2
          lac store
          jmp e
```

```
            loc 303240
            loc 23420
            loc 1750
            loc 144
            loc 12
store:      loc
value:      loc
position:               loc
return:     jmp
minus:      bci    -.
command:    tyo'
fin.
```

```
,binary punch and load package  modified 19JAN61 for read in check and b
 ,lo and mid version  (loader first)
,binary loader with check feature added
,19 JAN 61    BF
          org 1
a         dzm sum    ,clear suegister
          jsp rbs    ,read binary word and sum
          dac b
          dap c
          spa
          jmp e      ,negative ac      -      assumed jump
          lac a + 2
          szs 20
          lac c-p
          dip c
          jsp rbs    ,read length
          add c      ,compute end
          dac tsl
          jsp rcs    ,read check sum and check
d         jsp rbs    ,read binary word and sum
c         ..         ,dac in memory or sad with memory
          jmp → + 3
          lac ' c
          hlt
          idx c      ,index store or check address
          sas tsl    ,checks for end of block
          jmp d      ,store or check next word
          jsp rcs    ,end of block  read check sum and check
rcjmp     jmp a
e         jsp rcs
          szs 10     ,ss 1 off jump to address; set  -  halt
          hlt
b         jmp ..
rbw       dap f      ,read binary word subroutine
          rpb '
          dio bwd
          lac bwd
f         jmp ..
rbs       dap g      ,read binary word and sum subroutine
          jsp rbw
          add sum
          dac sum
          lac bwd
g         jmp ..
rcs       dap h      ,read check sum and check subroutine
          jsp rbw
          lac sum
          sas bwd
          hlt
          dzm sum
h         jmp ..
c-p       sad ..
sum       ,          contains sum
bwd                  ,contains binary word
tsl                  ,temporary storage
rim       jsp longlead
          lac rcdio
          dac bwd
15q       lio bwd
          jsp pbw
          lio ' bwd
          jsp pbw
          idx bwd
          sas rcendload
```

```
            jmp 15q
            lio rcjmp
            jsp pbw
            jmp pbt
,control and punch section
,
scontrol    dzm return?
control     lac jump?
            sza
            jmp pjp
            lac return?
            sza
return      jmp ..
clear       dzm sum
next        cli clf 1 cla
            szf 1
            jmp → + 2
            jmp → - 2
            tyi
            rcr s9
            rcr s9
            sad rc>
            jmp clear
            lio sum
            sad rc-b
            jmp begin
            sad rc-l
            jmp length
            sad rc-f
            jmp final
            sad rc-r
            jmp rim
            sad rc-p
            jmp pbt
            sad rc-j
            jmp jump
            sad rc-s
            jmp a
            ril s3
            rcr s3
            ril s3
            dio sum
            jmp next
begin       dio inl
            dzm jump?
            jmp clear
length      dio len
            jmp clear
final       idx sum
            sub inl
            dac len
            jmp clear
jump        dio jpl
            idx jump?
            jmp control + 3
rc-l        43
rc-f        66
rc-r        51
rc-p        47
rc-b        62
rc-j        41
rc-s        22
rc>         56
return?
jump?
,binary format punch routinepbt          jsp ptf    ,initial tape feed
```

```
          lio inl   ,lio starting address
          dio bwd
          jsp pws   ,punch location block containing initial location of
          lio len   ,program block, length of block and sum
          jsp pws
          dac fnl
          lio sum
          jsp pbw
,
jsp ptf   ,punch program block with check sum at end
b1        lio ' bwd
          jsp pws
          idx bwd
          sas fnl
          jmp b1
          lio sum
          jsp pbw,
exit      jmp control
,
pbw       dap a1    ,punch binary word subroutine
          xct punch-b
          ril s6
          xct punch-b
          ril s6
          xct punch-b
a1        jmp ..
,
pws       dap d1
          dio ts1,  punch word and sum subroutine
          jsp pbw
          lac ts1
          add sum
          dac sum
d1        jmp ..
,
pjp       jsp ptf   ,punch jump pair subroutine
          lac jp1
          dap jpx
          lio jpx
          jsp pbw
          lio jpx
          jsp pbw
          jsp longlead
          dzm jump?
          jmp exit
,
ptf       dap jpx
          lio lead
          dzm sum
h1        xct punch-a
          idx sum
check     sas tf1
          jmp h1
          dzm sum
jpx       jmp ..
,
lead      100
tf1       12
tf12      340
ts2       ,temporary storage 2
inl       ,initial loaction stored here
fnl       ,final location stored here
len       ,block length stored here
jp1       ,jump location stored here
rcdio     dio a
rcendload           dio 15a + 12
```

```
loglead   dap lr
          idx check
          jsp ptf
          law tfl
          dap check
lr        jmp ..
punch-a   ppa '
punch-b   ppb '
,
,routine for program control of bin p+1 package
,
pb        ..        ,beginning of block stored here
          dzm rim?
          dap return
          idx return?         ,set control to return
          lac pb
          dac inl
          dio len
          lac rim?
          sza
          jmp rim
          jmp pbt
pbr       ..
          dap return
          idx rim?
          lac pbr
          dac pb
          jmp pb + 3
rim?
pj        dap return
          idx return?
          jmp jump
jmp end
```

```
,binary punch and load package  modified 19JAN61 for read in check and b
 ,
          org 7500
scontrol  dzm return?
control   lac jump?
          sza
          jmp pjp
          lac return?
          sza
return    jmp ..
clear     dzm sum
next      cli clf 1 cla
          szf 1
          jmp → + 2
          jmp → - 2
          tyi
          rcr s9
          rcr s9
          sad rc>
          jmp clear
          lio sum
          sad rc-b
          jmp begin
          sad rc-l
          jmp length
          sad rc-f
          jmp final
          sad rc-r
          jmp rim
          sad rc-p
          jmp pbt
          sad rc-j
          jmp jump
          sad rc-s
          jmp a
          ril s3
          rcr s3
          ril s3
          dio sum
          jmp next
begin     dio inl
          dzm jump?
          jmp clear
length    dio len
          jmp clear
final     idx sum
          sub inl
          dac len
          jmp clear
jump      dio jpl
          idx jump?
          jmp control + 3
rc-l      43
rc-f      66
rc-r      51
rc-p      47
rc-b      62
rc-j      41
rc-s      22
rc>       56
return?
jump?
,binary format punch routine
```

```
pbt       jsp ptf   ,initial tape feed
          lio inl   ,lio starting address
          dio bwd
          jsp pws   ,punch location block containing initial location of
          lio len   ,program block, length of block and sum
          jsp pws
          dac fnl
          lio sum
          jsp pbw
,
jsp ptf   ,punch program block with check sum at end
b1        lio ' bwd
          jsp pws
          idx bwd
          sas fnl
          jmp b1
          lio sum
          jsp pbw
,
exit      jmp control
,
pbw       dap a1    ,punch binary word subroutine
          xct punch-b
          ril s6
          xct punch-b
          ril s6
          xct punch-b
a1        jmp ..
,
pws       dap d1
          dio tsl,  punch word and sum subroutine
          jsp pbw
          lac tsl
          add sum
          dac sum
d1        jmp ..
,
pjp       jsp ptf   ,punch jump pair subroutine
          lac jpl
          dap jpx
          lio jpx
          jsp pbw
          lio jpx
          jsp pbw
          jsp longlead
          dzm jump?
          jmp exit
,
ptf       dap jpx
          lio lead
          dzm sum
h1        xct punch-a
          idx sum
check     sas tfl
          jmp h1
          dzm sum
jpx       jmp ..
,
lead      100
tfl       12
tfl2      340
ts2       ,temporary stoage 2
inl       ,initial loaction stored here
fnl       ,final location stored here
len       ,block length stored here
```

```
jpl         ,jump location stored here
rcdio       dio a
rcendload               dio 15q + 13
longlead    dap lr
            idx check
            jsp ptf
            law tfl
            dap check
lr          jmp ..
punch-a     ppa '
punch-b     ppb '
,
,binary loader with check feature added
,19 JAN 61    BF
            org 7700
a           dzm sum     ,clear sum register
            jsp rbs     ,read binary word and sum
            dac b
            dap c
            spa
            jmp e       ,negative ac      -      assumed jump
            lac a + 2
            szs 20
            lac c-p
            dip c
            jsp rbs     ,read length
            add c       ,compute end
            dac tsl
            jsp rcs     ,read check sum and check
d           jsp rbs     ,read binary word and sum
c           ..          ,dac in memory or sad with memory
            jmp → + 3
            lac ' c
            hlt
            idx c       ,index store or check address
            sas tsl     ,checks for end of block
            jmp d       ,store or check next word
            jsp rcs     ,end of block  read check sum and check
rcjmp       jmp a
e           jsp rcs
            szs 10      ,ss 1 off jump to address; set  -  halt
            hlt
b           jmp ..
rbw         dap f       ,read binary word subroutine
            rpb '
            dio bwd
            lac bwd
f           jmp ..
rbs         dap g       ,read binary word and sum subroutine
            jsp rbw
            add sum
            dac sum
            lac bwd
g           jmp ..
rcs         dap h       ,read check sum and check subroutine
            jsp rbw
            lac sum
            sas bwd
            hlt
            dzm sum
h           jmp ..
c-p         sad ..
sum         ,           contains sum
bwd                     ,contains binary word
tsl                     .temporary storage
```

```
rim         jsp longlead
            lac rcdio
            dac bwd
15q         lio bwd
            jsp pbw
            lio ' bwd
            jsp pbw
            idx bwd
            sas rcendload
            jmp 15q
            lio rcjmp
            jsp pbw
            jmp pbt
            jmp scontrol
,
            org 7500 - 25
,routine for program control of bin p+l package
pb          ..          ,beginning of block stored here
            dzm rim?
            dap return
            idx return?          ,set control to return
            lac pb
            dac inl
            dio len
            lac rim?
            sza
            jmp rim
            jmp pbt
pbr         ..
            dap return
            idx rim?
            lac pbr
            dac pb
            jmp pb + 3
rim?
pj          dap return
            idx return?
            jmp jump
jmp end
```

```
ext loader          org loader
          dzm sum   ,clear sum register
          jsp rbs   ,read binary word and sum
1a        dac 1c    ,i nitialize load loop poointer
          spa
          jmp 1e    ,neagative ac  -  assumbed jump
          lac 1a    ,get dac instruction
          szs 20    ,load or compare?
          lac 1j    ,compare  -  fetch sad
          dip 1c    ,initialize instruction in load loop
          jsp rbs   ,read leangth
          add 1c
          dac fnl   ,compute end ck
          jsp rcs   ,read check sum and check
1d        jsp rbs   ,read binary word and sum
1c        ..        ,dac or sad
          jmp → + 3           lac ' 1c  ,tape differend so shoe memory
          hlt       ,comparison error
          idx 1c    ,index store or check address
          sas fnl   ,check for end of block
          jmp 1d
          jsp rcs   ,end of block  - read check sum
          jmp loader
1e        jsp rcs   ,jump block so read check sum
          szs 10    ,ss1 off - jump to address;  set - halt
          hlt       ,
          xct 1c    ,do the jump
rbw       dap r1    ,read binary word subroutine
          rpb '
          dio bwd
          lac bwd
ext r1    jmp ..
rbs       dap r2    ,rbw and sum subroutine
          jsp rbw
          add sum
          dac sum
          lac bwd
ext r2    jmp ..
rcs       dap r3    ,read check sum and check subroutine
          jsp rbw
          lac sum   ,to show computed sum in ac if halt
          sas bwd
          hlt       ,check sum error
          dzm sum
ext r3    jmp ..
ext clear           szs 20    ,don't clear if ss2 up
          jmp loader
          dzm bwd
          cla
1j        sad =loader
          jmp loader
          dzm ' bwd
          idx bwd
          jmp 1j
ext =loader         loader
ext sum   ..
ext bwd   ..
ext fnl   ..
ext len   ..
```

```
ext zero-count          ..
ext loaderend           dio loader + 100
ext =dioloader          dio loader
ext p-order             ppb '
          jmp punchoff
          jmp end
```

```
,read binary test
,use tape with aii ones and zeroes
opd       jda 170000
org 0
start     szs ' 20
          jmp test3
          lat
          dac c
          rpb
          dio temp
          lac temp
          and a
          sas a
          hlt
          lac c
          jda count
          rpb
          dio temp
          lac temp
          and b
          sas b
          hlt
          lac c
          jda count
          jmp start
count     0
          dap z
          lac count
          cma
          dac count
g         isp count
          jmp g
z         jmp
temp      0
a         770077
b         007700
c         0
t5st3     lio temp
          ppb
          lio temp2
          ppb
k         szs ' 10
          jmp start
          cli
          ppa
          jmp k
temp1     770077
temp      007700
end
```

```
, Address checker test program
, 7/24/61
, S. Lambert
, Low checker
org 0
start     law 100    ,initial location
          dap → + 4
          dap check
          dap temp
          dzm ' → + 1
          dap
          idx → - 1
          sas finish          ,final location
          jmp start + 4
          lio temp   ,IO contains address
check     lac
          sas temp
          hlt        ,incorrect adress
          idx temp
          idx check
          sas trailend
          jmp check - 1
zhit      szs 10     ,check one reg. continuously
          jmp hit
          szs 20     ,read in new tape
          jmp start
read      rpb
          dio temp
          lac temp
          dap stop
          and stop
          sad stop
stop      jmp
          rpb
          dio ' temp
          jmp read
hit       lac start           ,clear memory
          dap → + 2
          dap x + 1
          dzm
          idx → - 1
          sas last
          jmp → - 3
          lat
          and stp
          sza '
          jmp zhit
          lat
          dap → + 1
x         dap
          lac        ,check all reg. to find the
          sza        ,location of test word + address
          jmp → + 6
          idx → - 3
          lio → - 4           ,IO has address of reg. being checked
          sas trailend
          jmp x + 1
          jmp zhit
```

```
          sas ' x
          hlt
          jmp zhit
temp      0
finish    dap 7777
stp       7700
last      dzm 7777
trailend  lac 7777
jmp start end .
```

```
...typewriter control, tyc, converted to Decal July 26, 1961,sjs
...
tyc'.a.         dac ac
          dio io
start:    jsp get1
          law mm    ...mm is location 2 preceding tables
          dap mg
mloop:    idx mg
          idx mg
          sad mgmax
          jmp start
          lac'mg
          sas ss1
          jmp mloop
          idx mg
          lac'mg
          dac exec
m3:       lac ac
          lio io
exec.     loc
          jmp nosk
          dac ac
          dio io
          lio cs
          tyo'
          jmp e3
nosk:     dac ac
          dio io
          jmp e3
a2:       jsp getn  ...handles a
fp4:      dio t1
          jmp start
c2:       jsp getn  ...handles c
          dio't1
          jsp step
          jmp c2    ...handles d
d2:       jsp get1
          dio'mgmax
          jsp getn
          idx mgmax
          dio'mgmax
          idx mgmax
          jmp start
emore:    jsp tcr
e2:       jsp getn  ...handles e
          dio exec
          jmp m3
e3:       szs 1
          jmp emore
          jmp start
f2:       cla       ...handles f
          dac fcount
          jsp getn
          dio beg1
          jsp getn
          dio value
begin:    lac'beg1
          xor value
          and mask
          sza
          jmp test
          idx fcount
          szs 1
          jmp test
```

```
            jsp tcr
d5:         lio beg1
            jsp type
            szs 2
            jmp test
            jsp ttab
            lio'beg1
            jsp type
test:       lac beg1
            sad max
            jmp prcount
            idx beg1
            jmp begin
prcount:    lio p
            tyo'
            lio fcount
            jsp type
            jmp start
            idx t1
            jmp ep4e:           lio't1
            jsp type
            jsp step
ep3:        jmp e
ep4:        jsp tcr
            lio t1
            jsp type
            jsp ttab
            jmp start
step:       dap tcrm1
            szs 1
            jmp →+2
            jmp start
            jsp tcr
            idx t1
            lio t1
            jsp type
            jsp ttab
tcrm1:      jmp ep3
tcr:        lio csp3
            dap →+2
            tyo'
            jmp tcr-1
ttab:       lio csp4
            jmp tcr+1
getn':      dap get1m1
            dzm mgp6
getnp2:     jsp get1
            lac ss1
            sad csm1
            jmp →+6
            and csp2
            ior mgp6
            ral 3
            dac mgp6
            jmp getnp2
            lio mgp6
            rir 3
get1m1:     jmp nosk+4
get1:       dap typem1
            lac ac
            lio io
            szf 1
            jmp →+2
            jmp →-2
            cli clf 1
            tyi
```

```
            dio ss1
            lac ss1
            sad cret
            jmp start
typem1:     jmp start+1
type':      dap .+7
            dio mgp7
            lac mgp7
            sza
            jmp .+4
            lio acm1
            tyo'
sm4:        jmp tcr-2
            cli
            dio mmm1
            dio mmp1
s:          lac mmm2
            and acm2
            sza
            jmp r
            lac mmp1
            sza
            jmp rm3
sp7:        lac mmm2
            ral 3
            dac mmm2
            idx mmm1
            sas csp1
            jmp s
            jmp sm4
rm3:        lio acm1
            tyo'
            jmp sp7
r:          lac mgp7
            cli
            rcl 3
            dac mgp7
            tyo'
            dio mmp1
            jmp r-7
csm1:       loc
cs:         loc 22
csp1:       loc 6
csp2:       loc 7
cret:csp3:              loc 77
csp4:       loc 36
acm2:       law 0
acm1:       loc 20
ac:         jmp a
io:         jmp a
mask:       loc 7777
t1.         loc t1
ss1:        loc 23
mg:         loc jmpe
mgp1:mgmax:             loc b2
fcount:     loc 2
beg1:       loc 7777
value:      loc jspgetn
max.        loc 7777
mgp6:       loc 12010
mmm2:mgp7:              loc
mmm1:       loc 6
mm:         loc
qp2:mmp1:               loc 1
            loc 61
            jmp a2
```

```
p:      loc 63
        jmp a2+3
        loc 64
        jmp d2
        loc 65
        jmp e3-3
        loc 66
        jmp e3+3
        loc 71
        jmp e-2
        loc 23
jmpe:   jmp e
        loc 26
        jmp e+4
        loc 27
        jmp t
        loc 30
        jmp tp7
        loc 31
        jmp u
b2.     loc 41
        ral 3
        loc 41
        ral 3
        loc 42
        ral 3
        loc 43
        rar 3
v:      loc a
        loc d5
        loc 4201
        loc d5
        loc 4300
        jmp t
        loc 30
        jmp tp7
t:      jsp getn
        dio v
        jsp getn
        dio v+1
jspgetn: jsp getn
        dio v+2
        jmp start
tp7:    lio v
        dio v+3
        lio v+2
        dio v+4
        lio'v+3
        dio'v+4
        lac v+3
        sad v+1
        jmp start
        idx v+3
        idx v+4
        jmp →-7
u:      lio v
        dio v+3
        lio v+2
        dio v+4
        lac'v+3
        sas'v+4
        jmp →+7
        lac v+3
        sad v+1
        jmp start
        idx v+3
```

```
            idx v+4
            jmp →-10
            jsp tcr
            lio v+3
            jsp type
            jsp ttab
            lio'v+3
            jsp type
            jmp →-14
fin
```

```
/codeword display -

cwd,        0
            dap cwx
            lac i cwd
            dac cw
            idx cwd
            xct i cwx
            dac x
            idx cwx
            xct i cwx
            lio i cwd
            spi
            sub 2dl
            dac y
            idx cwx
            setup ctr, 22
            setup cty, 7

d,          setup ctx, 5

c,          lio cw
            ril 1s
            dio cw
            spi
            jmp plt

a,          isp ctr
            jmp b
            lac i cwd
            dac cw
            setup ctr, 22
b,          isp ctx
            jmp inx
            isp cty
            jmp iny
cwx,        jmp .

inx,        lac x
            add del
            dac x
            jmp c

iny,        lac x
            sub 4dl
            dac x
            lac y
            add del
            dac y
            jmp d

plt,        lac x
            lio y
            dpy-i
            jmp a
```

law cw1
ida cwd
lac lx
lac ly

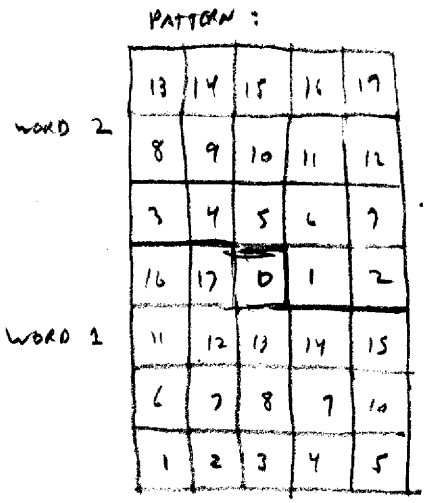
```
siz,del,  2000
          dap sex
          lac del
          sal 1s
          dac 2dl
          sal 1s
          dac 4dl
sex,      jmp .

variables
constants

start
```

```
/alphabetic codeword tables

lwr,    374200  -  000000    /space, printing
        561020     010604    /1
        774040     005056    /2
        564204     203056    /3
        420413     345122    /4
        164204     175037    /5
        564307     241056    /6
        604040     004077    /7
        564305     243056    /8
        564205     343056    /9
        0          0
        0          0
        0          0
        0          0
        0          0
        0          0
        144512     245114    /0
        602020     010101    //
        160231     016000    /s
        421220     010744    /t
        072245     122000    /u
        042506     142000    /v
        125326     142000    /w
        212421     242000    /x
        060235     522451    /y
        372020     276000    /z
        0          0
        440430     600000    /,
        0          0
        0          0
        001170     174200    /tab, printing
        0          0
        400000     214000    /.
        042410     614002    /j
        112461     222410    /k
        070410     204106    /l
        655326     164000    /m
        512245     124000    /n
        062245     114000    /o
        102071     522456    /p
        030472     645116    /q
        502041     124000    /r
        0          0
        0          0
        000174     000000    /-
        101010     204210    /)
        000000     000037    /
        021041     020202    /(
        0          0
        072234     114000    /a
        162245     134410    /b
        072041     016000    /c
        072245     116041    /d
        072075     114000    /e
        102161     020446    /f
        060235     522446    /g
```



WORD 1, BIT 0: DEPRESS 2.

```
        112245  134410  /h
        561020  030004  /i
        042555  224512  /l.c., printing
        061400  000000  /.
        122451  266504  /u.c., printing
        042175  010000  /bksp, printing
        0       0
        306020  204600  /c.r., printing

upr,    374200  000000  /space, printing
        000000  023562  /"    1
        000000  004304  /!    2
        000000  005250  /~    3
        760207  200000  /⊃    4
        042452  142000  /∨    5
        214251  210000  /∧    6
        010421  010101  /<    7
        101010  104210  />    8
        441020  052704  /↑    9
        0       0
        0       0
        0       0
        0       0
        0       0
        0       0
        040574  210000  /→
        040020  243056  /?
        564205  241056  /S
        441020  010237  /T
        164306  143061  /U
        042506  143061  /V
        125326  143061  /W
        612420  010521  /X
        441020  010521  /Y
        774040  004077  /Z
        0       0
        407603  300000  /=
        0       0
        0       0
        050774  312000  /tab, printing
        0       0
        007600  400000  /
        144410  204107  /J
        214523  051121  /K
        374102  041020  /L
        214306  153561  /M
        214306  353461  /N
        164306  143056  /O
        604103  243076  /P
        154526  143056  /Q
        614523  243076  /R
```

```
0           0
0           0
441174      010000      /+          ?
060410      204106      /]
441020      010204      /|
461020      010206      /[
0           0
214376      143056      /A
764307      243076      /B
164302      041056      /C
364306      143076      /D
774103      041037      /E
604103      041037      /F
164336      041056      /G
614307      343061      /H
561020      010216      /I
042555      224512      /l.c., printing
404250      025040      /x
122451      266504      /u.c., printing
042175      010000      /bksp, printing
0           0
306020      204600      /c.r., printing

start
```

```
/codeword digit display

cwd,    0
        dap cwx
        lac cwd
        sad (20
        law 12
        sad (54
        law 13
        ral 1s
        add (1wr
        dac cwd

cwe,    lac i cwd
        dac cw
        idx cwd
        lac y0
        dac y
        setup ctr, 22
        setup cty, 7

d,      setup ctx, 5

c,      lio cw
        ril 1s
        dio cw
        spi
        jmp plt

a,      isp ctr
        jmp b
        lac i cwd
        dac cw
        setup ctr, 22
b,      isp ctx
        jmp inx
        isp cty
        jmp iny
        lac x
        add 2dl
        dac x
cwx,    jmp .

inx,    lac x
        add del
        dac x
        jmp c

iny,    lac x
        sub 4dl
        dac x
        lac y
        add del
        dac y
        jmp d
```

```
plt,      lac x
          lio y
          dpy-i
          jmp a

siz,del,  2000
          dap sex
          lac del
          sal 1s
          dac 2dl
          sal 1s
          dac 4dl
sex,      jmp .

2dl,      4000
4dl,      10000

so,x,     0          /set origin
          dap sox
          dio y0
sox,      jmp .

y0,       0

variables
constants

/alphabetic codeword tables

lwr,      000000     000000     /space
          561020     010604     /1
          774040     005056     /2
          564204     203056     /3
          420413     345122     /4
          164204     175037     /5
          564307     241056     /6
          604040     004077     /7
          564305     243056     8
          564205     343056     /9
          144512      45114     /0
          000174     000000     /-

start
```