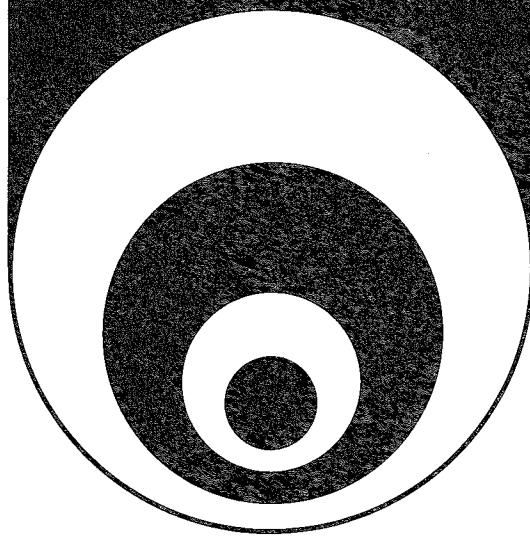


**Signetics**

**MICROPROCESSOR**



**SERIAL INPUT/OUTPUT.....AS50**

## 2650 MICROPROCESSOR APPLICATION MEMO

### INTRODUCTION

The Sense/Flag capability of the Signetics 2650 microprocessor can be used for serial I/O interfaces. The Sense input pin is directly connected to a bit in the microprocessor's Program Status Word. A high level on the Sense pin appears as a binary one while a low level appears as a binary zero. The Sense bit in the PSW can be stored or tested by the program. The Flag bit in the PSW is a simple latch that drives the Flag output pin. A program can set the Flag bit to a binary one, which causes a high level, one TTL load on the flag output pin. Setting the Flag bit to binary zero causes a low level on the Flag output pin.

### APPLICATIONS

The most common use for the Sense/Flag capability would be in interfacing to a keyboard based terminal where the data is received or transmitted as bit serial. All bit manipulation and timings such as 8-bit serial-to-parallel conversion can be done by software running on the 2650. The software works by storing or setting the two bits in the Program Status Word which reflect or control the levels at the pins of the chip. External hardware is required simply to interface with line levels. No clock synchronization or address decoding hardware is necessary, since the Sense and Flag pins are independent of the normal I/O bus structure.

Two examples of device interfaces and software are given below; for a 1200 baud RS232-type CRT terminal and for a 110 baud Teletype. Figure 1 shows the RS232 interface. Half of the Signetics 8T15 dual line driver is used to transmit to the terminal from the Flag pin, while half of a

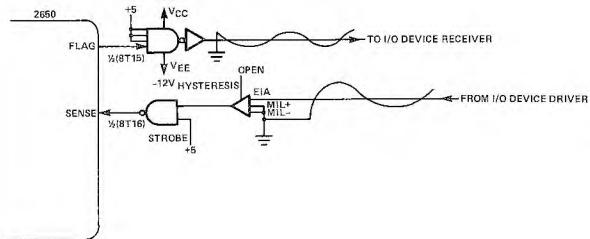


FIGURE I  
RS-232 INTERFACE

Signetics 8T16 dual line receiver is used to receive from the device into the Sense pin. The interface to a Teletype model 33 is shown in Figure II. A TTL open collector gate is used to provide the 20 milli-amp loop to the TTY

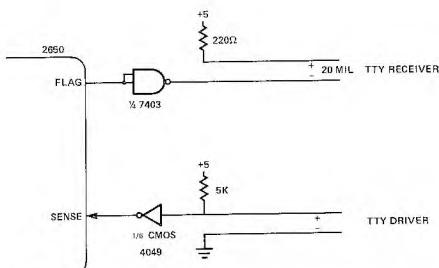


FIGURE II  
TTY MODEL 33 INTERFACE FULL DUPLEX

receiver. For receiving from the TTY a CMOS gate is used to provide the necessary noise immunity.

### SOFTWARE

All definitions of baud rate, character formats, and line characteristics are done in the software. For these examples, communication is asynchronous bit-serial over a full duplex line. Figure III shows the format of a 8-bit character (seven bits plus parity) headed by a start bit and followed by stop bits. The line levels are:

low = start bit or binary zero

high = stop bit or binary one

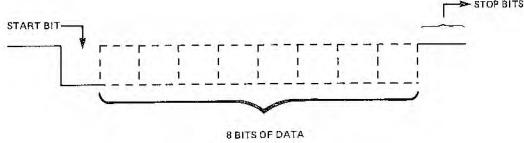


FIGURE III

```

1    0091      P   EQU      1
2    0092      Z   EQU      0
3    0093      LCOM  EQU      H102I  LOGICAL COMPARE
4    0094      CAK   EQU      H101I  CARRY
5    0095      SENS  EQU      H180I  SENSE
6    0096      FLAG  EQU      H100I  FLAG
7    0097      I1    EQU      H120I  INTERRUPT INHIBIT
8    0098      IDC   EQU      H120I
9    0099      OVF  EQU      H104I  INTR DIGIT CARRY
10   009A      H0   EQU      0
11   009B      X1   EQU      1
12   009C      X2   EQU      2
13   009D      R1   EQU      3
14   009E      UN   EQU      0
15   009F      EQ   EQU      2
16   00A0      LT   EQU      1
17   00A1      GT   EQU      0
18   00A2      NC   EQU      H108I
19   00A3      RS   EQU      H110I
20   00A4      ORG  EQU      H150I
21   00A5      CPSU EQU      WC
22   0500  0500  76 40      CHIO  CPSU  INPUT WITH A BIT BY BIT ECHO
23   0501  0501  76 08      CPSU  WC
24   0502  0502  05 00      LODI,R1  0
25   0503  0503  05 00      LODI,R2  8
26   0504  0504  05 08      TEST   BCTX,LT  LOOP TESTS FOR THE START BIT
27   0505  0505  16 70      SPSU  BCTX,LT
28   0506  0506  3F 05 29      TEST   BCTX,LT
29   0507  0507  16 40      BSTA,UN  DLAY  HALF A DELAY TO MIDDLE OF BIT
30   0508  0508  3F 05 2D      GDRX,UN  DLAY
31   0509  0509  16 40      BSTA,UN  DLAY
32   0510  0510  3F 05 2D      BIT    BSTA,UN  DELAY. THEN READ THE NEXT BIT
33   0511  0511  12 00      ANDI,R0  H180I
34   0512  0512  51 00      ANDI,R1  H180I
35   0513  0513  61        10HZ  R1
36   0514  0514  44 80      STRZ  R1
37   0515  0515  76 40      CPSU  BZERO  ECHO THE BIT
38   0516  0516  76 00      CPSU  BZERO
39   0517  0517  61        10HZ  R1
40   0518  0518  C1        STRZ  R1
41   0519  0519  76 40      CPSU  BZERO
42   0520  0520  76 00      CPSU  BZERO
43   0521  0521  16 02      BCTX,UN  NEXT
44   0522  0522  3F 05 2D      ZERO  BCTX,UN
45   0523  0523  3F 05 2D      BSTA,UN  DLAY
46   0524  0524  16 00      BSTA,UN  DLAY
47   0525  0525  45 7F      ANDI,R1  H17F
48   0526  0526  45 7F      RETC,UN
49   0527  0527  17        RETC,UN
50   0528  0528  05 00      DLY   LODI,R0  H159I
51   0529  0529  04 3A      DLY   LODI,R0  H159I
52   0530  0530  F8 7E      DLY   LODI,R0  H159I
53   0531  0531  F8 7E      DLY   LODI,R0  H159I
54   0532  0532  20 75      TDLA  BDRX,R0  H0
55   0533  0533  F8 7E      TDLA  BDRX,R0  H0
56   0534  0534  F8 7E      TDLY  BDRX,R0  H0
57   0535  0535  04 65      TDLY  BDRX,R0  H1E5I
58   0536  0536  04 65      TDLY  BDRX,R0  H1E5I
59   0537  0537  F8 7E      TDLY  BDRX,R0  H1E5I
60   0538  0538  11        TDLY  BDRX,R0  H1E5I
61   0539  0539  11        TDLY  BDRX,R0  H1E5I
62   053A  053A  11        TDLY  BDRX,R0  H1E5I
63   053B  053B  11        TDLY  BDRX,R0  H1E5I
64   053C  053C  11        TDLY  BDRX,R0  H1E5I
65   053D  053D  11        TDLY  BDRX,R0  H1E5I
66   053E  053E  11        TDLY  BDRX,R0  H1E5I
67   053F  053F  11        TDLY  BDRX,R0  H1E5I
68   0540  0540  11        TDLY  BDRX,R0  H1E5I
69   0541  0541  11        TDLY  BDRX,R0  H1E5I
70   0542  0542  11        TDLY  BDRX,R0  H1E5I
71   0543  0543  11        TDLY  BDRX,R0  H1E5I
72   0544  0544  11        TDLY  BDRX,R0  H1E5I
73   0545  0545  11        TDLY  BDRX,R0  H1E5I
74   0546  0546  11        TDLY  BDRX,R0  H1E5I
75   0547  0547  11        TDLY  BDRX,R0  H1E5I
76   0548  0548  11        TDLY  BDRX,R0  H1E5I
77   0549  0549  11        TDLY  BDRX,R0  H1E5I
78   054A  054A  11        TDLY  BDRX,R0  H1E5I
79   054B  054B  11        TDLY  BDRX,R0  H1E5I
80   054C  054C  11        TDLY  BDRX,R0  H1E5I
81   054D  054D  11        TDLY  BDRX,R0  H1E5I
82   054E  054E  11        TDLY  BDRX,R0  H1E5I
83   054F  054F  11        TDLY  BDRX,R0  H1E5I
84   0550  0550  11        TDLY  BDRX,R0  H1E5I
85   0551  0551  11        TDLY  BDRX,R0  H1E5I
86   0552  0552  11        TDLY  BDRX,R0  H1E5I
87   0553  0553  11        TDLY  BDRX,R0  H1E5I
88   0554  0554  11        TDLY  BDRX,R0  H1E5I
89   0555  0555  11        TDLY  BDRX,R0  H1E5I
90   0556  0556  11        TDLY  BDRX,R0  H1E5I
91   0557  0557  11        TDLY  BDRX,R0  H1E5I
92   0558  0558  11        TDLY  BDRX,R0  H1E5I
93   0559  0559  11        TDLY  BDRX,R0  H1E5I
94   055A  055A  11        TDLY  BDRX,R0  H1E5I
95   055B  055B  11        TDLY  BDRX,R0  H1E5I
96   055C  055C  11        TDLY  BDRX,R0  H1E5I
97   055D  055D  11        TDLY  BDRX,R0  H1E5I
98   055E  055E  11        TDLY  BDRX,R0  H1E5I
99   055F  055F  11        TDLY  BDRX,R0  H1E5I
100  0560  0560  11        TDLY  BDRX,R0  H1E5I
101  0561  0561  11        TDLY  BDRX,R0  H1E5I
102  0562  0562  11        TDLY  BDRX,R0  H1E5I
103  0563  0563  11        TDLY  BDRX,R0  H1E5I
104  0564  0564  11        TDLY  BDRX,R0  H1E5I
105  0565  0565  11        TDLY  BDRX,R0  H1E5I
106  0566  0566  11        TDLY  BDRX,R0  H1E5I
107  0567  0567  11        TDLY  BDRX,R0  H1E5I
108  0568  0568  11        TDLY  BDRX,R0  H1E5I
109  0569  0569  11        TDLY  BDRX,R0  H1E5I
110  056A  056A  11        TDLY  BDRX,R0  H1E5I
111  056B  056B  11        TDLY  BDRX,R0  H1E5I
112  056C  056C  11        TDLY  BDRX,R0  H1E5I
113  056D  056D  11        TDLY  BDRX,R0  H1E5I
114  056E  056E  11        TDLY  BDRX,R0  H1E5I
115  056F  056F  11        TDLY  BDRX,R0  H1E5I
116  0570  0570  11        TDLY  BDRX,R0  H1E5I
117  0571  0571  11        TDLY  BDRX,R0  H1E5I
118  0572  0572  11        TDLY  BDRX,R0  H1E5I
119  0573  0573  11        TDLY  BDRX,R0  H1E5I
120  0574  0574  11        TDLY  BDRX,R0  H1E5I
121  0575  0575  11        TDLY  BDRX,R0  H1E5I
122  0576  0576  11        TDLY  BDRX,R0  H1E5I
123  0577  0577  11        TDLY  BDRX,R0  H1E5I
124  0578  0578  11        TDLY  BDRX,R0  H1E5I
125  0579  0579  11        TDLY  BDRX,R0  H1E5I
126  057A  057A  11        TDLY  BDRX,R0  H1E5I
127  057B  057B  11        TDLY  BDRX,R0  H1E5I
128  057C  057C  11        TDLY  BDRX,R0  H1E5I
129  057D  057D  11        TDLY  BDRX,R0  H1E5I
130  057E  057E  11        TDLY  BDRX,R0  H1E5I
131  057F  057F  11        TDLY  BDRX,R0  H1E5I
132  0580  0580  11        TDLY  BDRX,R0  H1E5I
133  0581  0581  11        TDLY  BDRX,R0  H1E5I
134  0582  0582  11        TDLY  BDRX,R0  H1E5I
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137  0585  0585  11        TDLY  BDRX,R0  H1E5I
138  0586  0586  11        TDLY  BDRX,R0  H1E5I
139  0587  0587  11        TDLY  BDRX,R0  H1E5I
140  0588  0588  11        TDLY  BDRX,R0  H1E5I
141  0589  0589  11        TDLY  BDRX,R0  H1E5I
142  058A  058A  11        TDLY  BDRX,R0  H1E5I
143  058B  058B  11        TDLY  BDRX,R0  H1E5I
144  058C  058C  11        TDLY  BDRX,R0  H1E5I
145  058D  058D  11        TDLY  BDRX,R0  H1E5I
146  058E  058E  11        TDLY  BDRX,R0  H1E5I
147  058F  058F  11        TDLY  BDRX,R0  H1E5I
148  0580  0580  11        TDLY  BDRX,R0  H1E5I
149  0581  0581  11        TDLY  BDRX,R0  H1E5I
150  0582  0582  11        TDLY  BDRX,R0  H1E5I
151  0583  0583  11        TDLY  BDRX,R0  H1E5I
152  0584  0584  11        TDLY  BDRX,R0  H1E5I
153  0585  0585  11        TDLY  BDRX,R0  H1E5I
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155  0587  0587  11        TDLY  BDRX,R0  H1E5I
156  0588  0588  11        TDLY  BDRX,R0  H1E5I
157  0589  0589  11        TDLY  BDRX,R0  H1E5I
158  058A  058A  11        TDLY  BDRX,R0  H1E5I
159  058B  058B  11        TDLY  BDRX,R0  H1E5I
160  058C  058C  11        TDLY  BDRX,R0  H1E5I
161  058D  058D  11        TDLY  BDRX,R0  H1E5I
162  058E  058E  11        TDLY  BDRX,R0  H1E5I
163  058F  058F  11        TDLY  BDRX,R0  H1E5I
164  0580  0580  11        TDLY  BDRX,R0  H1E5I
165  0581  0581  11        TDLY  BDRX,R0  H1E5I
166  0582  0582  11        TDLY  BDRX,R0  H1E5I
167  0583  0583  11        TDLY  BDRX,R0  H1E5I
168  0584  0584  11        TDLY  BDRX,R0  H1E5I
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172  0588  0588  11        TDLY  BDRX,R0  H1E5I
173  0589  0589  11        TDLY  BDRX,R0  H1E5I
174  058A  058A  11        TDLY  BDRX,R0  H1E5I
175  058B  058B  11        TDLY  BDRX,R0  H1E5I
176  058C  058C  11        TDLY  BDRX,R0  H1E5I
177  058D  058D  11        TDLY  BDRX,R0  H1E5I
178  058E  058E  11        TDLY  BDRX,R0  H1E5I
179  058F  058F  11        TDLY  BDRX,R0  H1E5I
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184  0584  0584  11        TDLY  BDRX,R0  H1E5I
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189  0589  0589  11        TDLY  BDRX,R0  H1E5I
190  058A  058A  11        TDLY  BDRX,R0  H1E5I
191  058B  058B  11        TDLY  BDRX,R0  H1E5I
192  058C  058C  11        TDLY  BDRX,R0  H1E5I
193  058D  058D  11        TDLY  BDRX,R0  H1E5I
194  058E  058E  11        TDLY  BDRX,R0  H1E5I
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197  0581  0581  11        TDLY  BDRX,R0  H1E5I
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203  0587  0587  11        TDLY  BDRX,R0  H1E5I
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205  0589  0589  11        TDLY  BDRX,R0  H1E5I
206  058A  058A  11        TDLY  BDRX,R0  H1E5I
207  058B  058B  11        TDLY  BDRX,R0  H1E5I
208  058C  058C  11        TDLY  BDRX,R0  H1E5I
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210  058E  058E  11        TDLY  BDRX,R0  H1E5I
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212  0580  0580  11        TDLY  BDRX,R0  H1E5I
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221  0589  0589  11        TDLY  BDRX,R0  H1E5I
222  058A  058A  11        TDLY  BDRX,R0  H1E5I
223  058B  058B  11        TDLY  BDRX,R0  H1E5I
224  058C  058C  11        TDLY  BDRX,R0  H1E5I
225  058D  058D  11        TDLY  BDRX,R0  H1E5I
226  058E  058E  11        TDLY  BDRX,R0  H1E5I
227  058F  058F  11        TDLY  BDRX,R0  H1E5I
228  0580  0580  11        TDLY  BDRX,R0  H1E5I
229  0581  0581  11        TDLY  BDRX,R0  H1E5I
230  0582  0582  11        TDLY  BDRX,R0  H1E5I
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232  0584  0584  11        TDLY  BDRX,R0  H1E5I
233  0585  0585  11        TDLY  BDRX,R0  H1E5I
234  0586  0586  11        TDLY  BDRX,R0  H1E5I
235  0587  0587  11        TDLY  BDRX,R0  H1E5I
236  0588  0588  11        TDLY  BDRX,R0  H1E5I
237  0589  0589  11        TDLY  BDRX,R0  H1E5I
238  058A  058A  11        TDLY  BDRX,R0  H1E5I
239  058B  058B  11        TDLY  BDRX,R0  H1E5I
240  058C  058C  11        TDLY  BDRX,R0  H1E5I
241  058D  058D  11        TDLY  BDRX,R0  H1E5I
242  058E  058E  11        TDLY  BDRX,R0  H1E5I
243  058F  058F  11        TDLY  BDRX,R0  H1E5I
244  0580  0580  11        TDLY  BDRX,R0  H1E5I
245  0581  0581  11        TDLY  BDRX,R0  H1E5I
246  0582  0582  11        TDLY  BDRX,R0  H1E5I
247  0583  0583  11        TDLY  BDRX,R0  H1E5I
248  0584  0584  11        TDLY  BDRX,R0  H1E5I
249  0585  0585  11        TDLY  BDRX,R0  H1E5I
250  0586  0586  11        TDLY  BDRX,R0  H1E5I
251  0587  0587  11        TDLY  BDRX,R0  H1E5I
252  0588  0588  11        TDLY  BDRX,R0  H1E5I
253  0589  0589  11        TDLY  BDRX,R0  H1E5I
254  058A  058A  11        TDLY  BDRX,R0  H1E5I
255  058B  058B  11        TDLY  BDRX,R0  H1E5I
256  058C  058C  11        TDLY  BDRX,R0  H1E5I
257  058D  058D  11        TDLY  BDRX,R0  H1E5I
258  058E  058E  11        TDLY  BDRX,R0  H1E5I
259  058F  058F  11        TDLY  BDRX,R0  H1E5I
260  0580  0580  11        TDLY  BDRX,R0  H1E5I
261  0581  0581  11        TDLY  BDRX,R0  H1E5I
262  0582  0582  11        TDLY  BDRX,R0  H1E5I
263  0583  0583  11        TDLY  BDRX,R0  H1E5I
264  0584  0584  11        TDLY  BDRX,R0  H1E5I
265  0585  0585  11        TDLY  BDRX,R0  H1E5I
266  0586  0586  11        TDLY  BDRX,R0  H1E5I
267  0587  0587  11        TDLY  BDRX,R0  H1E5I
268  0588  0588  11        TDLY  BDRX,R0  H1E5I
269  0589  0589  11        TDLY  BDRX,R0  H1E5I
270  058A  058A  11        TDLY  BDRX,R0  H1E5I
271  058B  058B  11        TDLY  BDRX,R0  H1E5I
272  058C  058C  11        TDLY  BDRX,R0  H1E5I
273  058D  058D  11        TDLY  BDRX,R0  H1E5I
274  058E  058E  11        TDLY  BDRX,R0  H1E5I
275  058F  058F  11        TDLY  BDRX,R0  H1E5I
276  0580  0580  11        TDLY  BDRX,R0  H1E5I
277  0581  0581  11        TDLY  BDRX,R0  H1E5I
278  0582  0582  11        TDLY  BDRX,R0  H1E5I
279  0583  0583  11        TDLY  BDRX,R0  H1E5I
280  0584  0584  11        TDLY  BDRX,R0  H1E5I
281  0585  0585  11        TDLY  BDRX,R0  H1E5I
282  0586  0586  11        TDLY  BDRX,R0  H1E5I
283  0587  0587  11        TDLY  BDRX,R0  H1E5I
284  0588  0588  11        TDLY  BDRX,R0  H1E5I
285  0589  0589  11        TDLY  BDRX,R0  H1E5I
286  058A  058A  11        TDLY  BDRX,R0  H1E5I
287  058B  058B  11        TDLY  BDRX,R0  H1E5I
288  058C  058C  11        TDLY  BDRX,R0  H1E5I
289  058D  058D  11        TDLY  BDRX,R0  H1E5I
290  058E  058E  11        TDLY  BDRX,R0  H1E5I
291  058F  058F  11        TDLY  BDRX,R0  H1E5I
292  0580  0580  11        TDLY  BDRX,R0  H1E5I
293  0581  0581  11        TDLY  BDRX,R0  H1E5I
294  0582  0582  11        TDLY  BDRX,R0  H1E5I
295  0583  0583  11        TDLY  BDRX,R0  H1E5I
296  0584  0584  11        TDLY  BDRX,R0  H1E5I
297  0585  0585  11        TDLY  BDRX,R0  H1E5I
298  0586  0586  11        TDLY  BDRX,R0  H1E5I
299  0587  0587  11        TDLY  BDRX,R0  H1E5I
300  0588  0588  11        TDLY  BDRX,R0  H1E5I
301  0589  0589  11        TDLY  BDRX,R0  H1E5I
302  058A  058A  11        TDLY  BDRX,R0  H1E5I
303  058B  058B  11        TDLY  BDRX,R0  H1E5I
304  058C  058C  11        TDLY  BDRX,R0  H1E5I
305  058D  058D  11        TDLY  BDRX,R0  H1E5I
306  058E  058E  11        TDLY  BDRX,R0  H1E5I
307  058F  058F  11        TDLY  BDRX,R0  H1E5I
308  0580  0580  11        TDLY  BDRX,R0  H1E5I
309  0581  0581  11        TDLY  BDRX,R0  H1E5I
310  0582  0582  11        TDLY  BDRX,R0  H1E5I
311  0583  0583  11        TDLY  BDRX,R0  H1E5I
312  0584  0584  11        TDLY  BDRX,R0  H1E5I
313  0585  0585  11        TDLY  BDRX,R0  H1E5I
314  0586  0586  11        TDLY  BDRX,R0  H1E5I
315  0587  0587  11        TDLY  BDRX,R0  H1E5I
316  0588  0588  11        TDLY  BDRX,R0  H1E5I
317  0589  0589  11        TDLY  BDRX,R0  H1E5I
318  058A  058A  11        TDLY  BDRX,R0  H1E5I
319  058B  058B  11        TDLY  BDRX,R0  H1E5I
320  058C  058C  11        TDLY  BDRX,R0  H1E5I
321  058D  058D  11        TDLY  BDRX,R0  H1E5I
322  058E  058E  11        TDLY  BDRX,R0  H1E5I
323  058F  058F  11        TDLY  BDRX,R0  H1E5I
324  0580  0580  11        TDLY  BDRX,R0  H1E5I
325  0581  0581  11        TDLY  BDRX,R0  H1E5I
326  0582  0582  11        TDLY  BDRX,R0  H1E5I
327  0583  0583  11        TDLY  BDRX,R0  H1E5I
328  0584  0584  11        TDLY  BDRX,R0  H1E5I
329  0585  0585  11        TDLY  BDRX,R0  H1E5I
330  0586  0586  11        TDLY  BDRX,R0  H1E5I
331  0587  0587  11        TDLY  BDRX,R0  H1E5I
332  0588  0588  11        TDLY  BDRX,R0  H1E5I
333  0589  0589  11        TDLY  BDRX,R0  H1E5I
334  058A  058A  11        TDLY  BDRX,R0  H1E5I
335  058B  058B  11        TDLY  BDRX,R0  H1E5I
336  058C  0
```

**Signetics**

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