RCSL: 51-VB702
Author: Allan Giese
Edited: January 1970

TEST OF

MICRO ORDERS

FOR THE RC 4000 COMPUTER

A/S REGNECENTRALEN
Falkoneralle 1
2000 Copenhagen F

C O N T E N T S

Page

NOTATION

SMI	Activate the Single Micro Instruction pushbutton on the Technical Control Panel.
SI	Activate the Single Instruction pushbutton on the Technical Control Panel.
MCC	Activate the MAR COMPUTER CONTROLLED pushbutton.
X:= Y	Set X equal to Y.
X = Y	If the test is correct X should be equal to Y.
X:= -1	Set X equal to all ones.

INTRODUCTION

The testpatterns for almost all micro orders are collected in this paper. The only exceptions are the input/output, interrupt, and the adder micro orders, - more specificcally:

```
IO Phase A
IO Phase B
IO Timing
Test IO
BUS(0:23):= IO Data

BUS(0:23):= 18ext0conITRno(18:22)con0; IR(ITRno):= 0
BUS(0:23):= IR
IR:= IR ∧ -,SB

Add, Sub, AddE, SubE
Carry 24, Carry 36
BUS(0:23):= SUM(-1:23)
AF(-1:37):= if -,MC(10) then SUM(-1:37)
                        else SUM(-1:35)con0con0
BUS(0:23):= AND(0:23)
AR(-1:23):= if MC(11) then BUS(-1:23)
                      else BUS(0,0:23)
```

A complete list of micro orders is found in THE MICROPROGRAM FOR THE RC 4000 COMPUTER.

Each micro order is tested in a separate section, and the operator must not diverge from the test schedule.

BUS(0:23):= W(fr)

MAR:= x3y15 (SB:= W(fr))

```
SB:= -1; W(1):= W(2):= W(3):= -1;
W(0):=  0; FR(6,7):= 0; SMI; SB =  0;
W(0):= -1;              SMI; SB = -1;
W(1):=  0; FR(6,7):= 1; SMI; SB =  0;
W(1):= -1;              SMI; SB = -1;
W(2):=  0; FR(6,7):= 2; SMI; SB =  0;
W(2):= -1;              SMI; SB = -1;
W(3):=  0; FR(6,7):= 3; SMI; SB =  0;
W(3):= -1;              SMI; SB = -1;
```

BUS(0:23):= 12extW(fr)(12)conW(fr)(12:23)

MAR:= x17y5 (SB:= 12ext W(fr)(12)conW(fr)(12:23))

```
SB(0:12):= -1; SB(13:23):= 0; W(1):= W(2):= W(3):= 0;
W(0):= -1; W(0)(12):= 0; FR(6,7):= 0; SMI; SB(0:12)=  0; SB(13:23)= -1;
W(0):=  0; W(0)(12):= 1;              SMI; SB(0:12)= -1; SB(13:23)=  0;
W(1):= -1; W(1)(12):= 0; FR(6,7):= 1; SMI; SB(0:12)=  0; SB(13:23)= -1;
W(1):=  0; W(1)(12):= 1;              SMI; SB(0:12)= -1; SB(13:23)=  0;
W(2):= -1; W(2)(12):= 0; FR(6,7):= 2; SMI; SB(0:12)=  0; SB(13:23)= -1;
W(2):=  0; W(2)(12):= 1;              SMI; SB(0:12)= -1; SB(13:23)=  0;
W(3):= -1; W(3)(12):= 0; FR(6,7):= 3; SMI; SB(0:12)=  0; SB(13:23)= -1;
W(3):=  0; W(3)(12):= 1;              SMI; SB(0:12)= -1; SB(13:23)=  0;
```

BUS(0:23):= W(pre); AR(-1:23):= BUS(0,0:23)

MAR:= x0y22 (AR:= Wa(pre))

```
AR:= -1; W(1):= W(2):= W(3):= -1;
W(0):=  0; FR(6,7):= 1; SMI; AR =  0;
W(0):= -1;              SMI; AR = -1;
W(1):=  0; FR(6,7):= 2; SMI; AR =  0;
W(1):= -1;              SMI; AR = -1;
W(2):=  0; FR(6,7):= 3; SMI; AR =  0;
W(2):= -1;              SMI; AR = -1;
W(3):=  0; FR(6,7):= 0; SMI; AR =  0;
W(3):= -1;              SMI; AR = -1;
```

BUS(0:23):= if index ≠ 0 then W(index) else 0; AR(-1:23):= BUS(0,0:23)

MAR:= x28y18 (AR:= if index ≠ 0 then Wa(index) else 0)

```
W(1):= W(2):= W(3):= -1;
AR:= -1; W(0):=  0; FR(10,11):= 0; SMI; AR =  0;
AR:= -1; W(0):= -1;                SMI; AR =  0;
AR:= -1; W(1):=  0; FR(10,11):= 1; SMI; AR =  0;
AR:= -1; W(1):= -1;                SMI; AR = -1;
AR:= -1; W(2):=  0; FR(10,11):= 2; SMI; AR =  0;
AR:= -1; W(2):= -1;                SMI; AR = -1;
AR:= -1; W(3):=  0; FR(10,11):= 3; SMI; AR =  0;
AR:= -1; W(3):= -1;                SMI; AR = -1;
```

if -,FR(8) then AR(-1:23):= BUS(0,0:23)

MAR:= x4y18 (AR:= if -,FR(8) then begin if index ≠ 0 then Wa(index)
else 0 end)

```
AR(-1:11):= 0; AR(12:23):= -1; W(0):= W(1):= -1;
FR(8):= 1;                          SMI; AR(-1:11)= 0; AR(12:23)= -1;
FR(8):= 0; FR(10,11):= 0; AR:= -1; SMI; AR =  0;
           FR(10,11):= 1;           SMI; AR = -1;
```

W(fr)(0:11):= BUS(0:11)

MAR:= x17y20 (W(fr)(0:11):= 0)

```
W(0):= W(1):= W(2):= W(3):= -1;
FR(6,7):= 0; SMI; W(0)(0:11)= 0; W(0)(12:23)= -1;
FR(6,7):= 1; SMI; W(1)(0:11)= 0; W(1)(12:23)= -1;
FR(6,7):= 2; SMI; W(2)(0:11)= 0; W(2)(12:23)= -1;
FR(6,7):= 3; SMI; W(3)(0:11)= 0; W(3)(12:23)= -1;
```

W(fr)(12:23):= BUS(12:23)

MAR:= x31y22 (W(fr)(12:23):= SB(12:23))

```
SB:= 0; W(0):= W(1):= W(2):= W(3):= -1;
FR(6,7):= 0; SMI; W(0)(12:23)= 0;
FR(6,7):= 1; SMI; W(1)(12:23)= 0;
FR(6,7):= 2; SMI; W(2)(12:23)= 0;
FR(6,7):= 3; SMI; W(3)(12:23)= 0;
```

W(fr)(0:23):= BUS(0:23)

MAR:= x1y9 (W(fr):= SB)

```
SB:= -1; W(0):= W(1):= W(2):= W(3):= 0;
FR(6,7):= 0; SMI; W(0):= -1;
FR(6,7):= 1; SMI; W(1):= -1;
FR(6,7):= 2; SMI; W(2):= -1;
FR(6,7):= 3; SMI; W(3):= -1;
```

W(pre):= BUS(0:23); BUS(0:23):= SB

MAR:= x1y21 (W(pre):= SB)

```
W(0):= W(1):= W(2):= W(3):= -1;
SB:=  0; FR(6,7):= 1; SMI; W(0)= 0;
         FR(6,7):= 2; SMI; W(1)= 0;
         FR(6,7):= 3; SMI; W(2)= 0;
         FR(6,7):= 0; SMI; W(3)= 0;

SB:= -1; FR(6,7):= 1; SMI; W(0)= -1;
         FR(6,7):= 2; SMI; W(1)= -1;
         FR(6,7):= 3; SMI; W(2)= -1;
         FR(6,7):= 0; SMI; W(3)= -1;
```

SB(12:23):= BUS(12:23)

MAR:= x16y19 (SB(12:23):= AR(12:23))

```
SB:= -1; AR:=  0; SMI; SB(0:11)= -1; SB(12:23)=  0
SB:=  0; AR:= -1; SMI; SB(0:11)=  0; SB(12:23)= -1
```

SB(0:11):= BUS(0:11)

MAR:= x16y27 (SB:= AR)

```
SB:= -1; AR:=  0; SMI; SB =  0;
         AR:= -1; SMI; SB = -1;
```

SB(0:11):= BUS(12:23)

MAR:= x16y3 SB(0:11):= AR(12:23))

```
AR:= 0; SB:= -1;     SMI; SB(0:11)= 0;                    SB(12:23)= -1;
AR:= 0; AR(23):= 1; SMI; SB(0:10)= 0;       SB(11)= 1; SB(12:23)= -1;
AR:= 0; AR(22):= 1; SMI; SB(0:9) = 0;       SB(10)= 1; SB(12:23)= -1;
AR:= 0; AR(21):= 1; SMI; SB(0:8,10:12)= 0; SB(9) = 1; SB(12:23)= -1;
  ...
AR:= 0; AR(12):= 1; SMI; SB(1:11)= 0;       SB(0) = 1; SB(12:23)= -1;
```

SB(0:11):= 12extSB(0)

MAR:= x31y14 (SB(12:23):= SB(0:11); SB(0:11):= 12extSB(0))

```
SB:= -1; SB(0):= 0; SMI; SB(0:12)=  0; SB(13:23)= -1;
SB:=  0; SB(0):= 1; SMI; SB(0:12)= -1; SB(13:23)=  0;
```

SB(0:11):= 12extSB(12)

MAR:= x31y20 (SB(0:11):= 12extSB(12))

```
SB:=  0; SB(12):= 1; SMI; SB(0:12)= -1; SB(13:23)=  0;
SB:= -1; SB(12):= 0; SMI; SB(0:12)=  0; SB(13:23)= -1;
```

BUS(0:23):= 12ext0conSB(0:11)

MAR:= x31y14 (W(fr):= 12ext0conSB(0:11))

```
FR(6,7):= 0; W(0):= -1; SB(12:23):= -1
SB(0:11):= 0;                SMI; W(0)(0:11)= 0; W(0)(12:23)= 0;
SB(0:10):= 0;   SB(11):= 1; SMI; W(0)(0:11)= 0; W(0)(12:22)= 0;    W(0)(23)= 1
SB(0:9,11):= 0; SB(10):= 1; SMI; W(0)(0:11)= 0; W(0)(12:21,23)= 0; W(0)(22)= 1
  ...
SB(1:11):= 0;   SB(0):= 1;  SMI; W(0)(0:11)= 0; W(0)(13:23)= 0;    W(0)(12)= 1
```

BUS(0:23):= 5ext0conIC(5:22)con0

MAR:= x4y1 (AR:= 6ext0conICcon0)

```
IC:=  0; AR:= -1; SMI; AR = 0
IC:= -1; AR(-1:4,23):= -1; AR(5:22):= 0; SMI; AR(-1:4,23) = 0; AR(5:22):= -1;
```

IC:= BUS(5:22)

MAR:= x24y25 (IC:= SB(5:22))

SB:= -1; IC:= 0; SMI; IC = -1;
SB:= 0; IC:= -1; SMI; IC = 0;

BUS(0:23):= 12ext0conSC(12:23)

MAR:= x8y31 (AR:= 13ext0conSC(12:23))

AR:= -1; SC:= 0; SMI; AR = 0;
SC:= -1; SMI; AR(-1:11)= 0, AR(12:23)= -1;

SC:= BUS(11:23)

MAR:= x1y20 (SC:= SB(11:23))

SB:= -1; SC:= 0; SMI; SC = -1;
SB:= 0; SMI; SC = 0;

BUS(0:23):= SE(0:11)con12ext0

MAR:= x0y17 (SB(0:11):= SE(0:11))

SB:= 0; SE:= -1; SMI; SB(0:11)= -1;
SE:= 0; SMI; SB(0:11)= 0;

SE(0:13):= BUS(0:11)con0con0; SB(0:11):= 12extSB(12)

MAR:= x2y21 (SE:= SB(0:11)con0con0; SB(0:11):= 12extSB(12))

SB:= -1; SB(12):= 0; SE(0:11):= 0; SE(12:13):= -1;
SMI; SB(0:12)= 0; SB(13:23)= -1; SE(0:11)= -1; SE(12:13)= 0;
SB:= 0; SB(12):= 1; SE:= -1;
SMI; SB(0:12)= -1; SB(13:23)= 0; SE = 0;

BUS(-1:23):= AR(-1:23)

MAR:= x16y27 (SB:= AR(0:23))

SB:= -1; AR:= 0; SMI; SB = 0;
AR:= -1; SMI; SB = -1;

BUS(0:23):= if EX(21)= 0 then AE(0:11)con12ext0 else AE(0:9,9,9)con12ext0

```
MAR:= x16y22  (W(fr)(0:11):= if EX(21)= 0 then AE(0:11) else AE(0:9,9,9);
               W(fr)(12:23):= SC(12:23))

EX(21):= 0; FR(6,7):= 0; AE:=  0; AE(9):= 1;
          W(0):= -1; W(0)(9):= 0; SMI; W(0)(0:8,10:11)= 0; W(0)(9)= 1;
EX(21):= 1;                       SMI; W(0)(0:8)= 0; W(0)(9:11)= -1;
EX(21):= 0;             AE:= -1; AE(9):= 0;
          W(0):=  0; W(0)(9):= 1; SMI; W(0)(0:8,10:11)= -1; W(0)(9)= 0;
EX(21):= 1;                       SMI; W(0)(0:8)= -1; W(0)(9:11)= 0;
```

AE(0:13):= BUS(0:11)con0con0

```
MAR:= x4y23  (AE:= W(fr)(0:11)con0con0)

FR(6,7):= 0; W(0)(12:23):= -1;
    W(0)(0:11):=  0; AE:= -1; SMI; AE = 0;
    W(0)(0:11):= -1; AE(12:13):= -1; SMI; AE(0:11)= -1; AE(12:13)= 0;
```

BUS(0:23):= BR

```
MAR:= x28y28  (AR:= BRa)

AR:= 0; BR:= -1; SMI; AR = -1;
       BR:=  0; SMI; AR =  0;
```

BR:= BUS(0:23)

```
MAR:= x17y31  (BR:= SB)

BR:= -1; SB:=  0; SMI; BR =  0;
         SB:= -1; SMI; BR = -1;
```

BUS(0:23):= -2

```
MAR:= x0y24  (AR:= -2)

AR:=  0; SMI; AR(-1:22)= -1; AR(23)= 0;
AR:= -1; SMI; AR(-1:22)= -1; AR(23)= 0;
```

BUS(0:23):= 12

MAR:= x4y24 (SB:= 12)

SB:= 0; SMI; SB(0:19,22:23)= 0; SB(20:21)= -1;
SB:= -1; SMI; SB(0:19,22:23)= 0; SB(20:21)= -1;

BUS(0:11):= 0; BUS(12:23):= -2048

MAR:= x28y20 (W(fr)(0:11):= 0; W(fr)(12:23):= -2048)

FR(6,7):= 0; W(0):= 0; SMI; W(0)(0:11,13:23)= 0; W(0)(12)= 1;
W(0):= -1; SMI; W(0)(0:11,13:23)= 0; W(0)(12)= 1;

BUS(0:23):= 1

MAR:= x24y12 (AR:= BR + 1; Adder:= b 1111 100)

AR:= 0; BR:= 0; SMI; AR(-1:22)= 0; AR(23)= 1;

BUS(0:23):= -1

MAR:= x28y22 (W(fr):= -1)

FR(6,7):= 0; W(0):= 0; SMI; W(0)= -1;

BUS(0:23):= 48

MAR:= x17y30 (BR:= 48)

BR:= 0; SMI; BR(0:17,20:23)= 0; BR(18,19)= -1;
BR:= -1; SMI; BR(0:17,20:23)= 0; BR(18,19)= -1;

BUS(0:23):= 6

MAR:= x9y16 (BR:= 6)

BR:= 0; SMI; BR(0:20,23)= 0; BR(21:22)= -1;
BR:= -1; SMI; BR(0:20,23)= 0; BR(21:22)= -1;

BUS(0:23):= 23

MAR:= x17y18 (SB:= 23)

SB:= 0; SMI; SB(0:18,20)= 0; SB(19,21:23)= -1;
SB:= -1; SMI; SB(0:18,20)= 0; SB(19,21:23)= -1;

BUS(0:23):= 35

MAR:= x20y0 (AR:= 35)

AR:= 0; SMI; AR(-1:17,19:21)= 0; AR(18,22:23)= -1;
AR:= -1; SMI; AR(-1:17,19:21)= 0; AR(18,22:23)= -1;

BUS(0:35):= 2

MAR:= x0y19 (SB:= 2)

SB:= 0; SMI; SB(0:21,23)= 0; SB(22)= -1;
SB:= -1; SMI; SB(0:21,23)= 0; SB(22)= -1;

EX(21:23):= BUS(21:23)

MAR:= x31y24 (EX(21:23):= SB(21:23))

SB(0:20):= -1; SB(21:23):= 0; EX:= -1; SMI; EX = 0;
SB(21:23):= -1; SMI; EX = -1;

BUS(0:23):= 21ext0conEX

MAR:= x17y9 (BR:= 21ext0conEX)

EX:= 0; BR:= -1; SMI; BR = 0;
EX:= -1; SMI; BR(0:20)= 0; BR(21:23)= -1;

BUS(0:23):= BEcon12ext0

MAR:= x31y18 (SB(0:11):= BE)

BE:= -1; SB:= 0; SMI; SB(0:11)= -1; SB(12:23)= 0;
BE:= 0; SMI; SB = 0;

BE:= BUS(0:11)

MAR:= x20y16 (BE:= SB(0:11))

SB:= -1; BE:= 0; SMI; BE = -1;
SB:= 0; SMI; BE = 0;

FR:= BUS(0:11)

MAR:= x24y7 (FR:= SB(0:11))

SB:= -1; FR:= 0; SMI; FR = -1;
SB:= 0; SMI; FR = 0;

BUS(0:23):= 16ext0conPR

MAR:= x3y10 (AR:= 17ext0conPR)

PR(1:7):= -1; AR:= 0; SMI; AR(-1:15)= 0; AR(16:23)= -1;
PR(1:7):= 0; SMI; AR(-1:15,17:23)= 0, AR(16)= 1;

PR:= BUS(17:23)

MAR:= x31y21 (PR(1:7):= SB(17:23))

SB:= -1; PR(1:7):= 0; SMI; PR = -1;
SB:= 0; SMI; PR(0)= 1; PR(1:7)= 0;

PK:= BUS(21:23)

MAR:= x16y14 (PK:= W(fr)(21:23))

FR(6,7):= 0; W(0)(0:20):= -1;
W(0)(21:23):= 0; PK:= -1; SMI; PK = 0;
W(0)(21:23):= 1; SMI; PK = 1;
W(0)(21:23):= 2; SMI; PK = 2;
W(0)(21:23):= 4; SMI; PK = 4;

```
BUS(0:23):= 21ext0conPK

MAR:= x1y13  (W(fr):= 21ext0conPK)

FR(6,7):= 0;
W(0):= -1; PK:= -1; SMI; W(0)(0:20)= 0; W(0)(21:23)= -1;
          PK:=  1; SMI; W(0)(0:20)= 0; W(0)(21:23)=  1;
          PK:=  2; SMI; W(0)(0:20)= 0; W(0)(21:23)=  2;
          PK:=  4; SMI; W(0)(0:20)= 0; W(0)(21:23)=  4;


IM(1:23):= SB(1:23)

MAR:= x12y12  (IM(1:23):= SB(1:23))

SB:= 0;              SMI; IM(1:23)= 0;        IM(0)= 1;
SB:= 0; SB(23):= 1; SMI; IM(1:22)= 0;        IM(0,23)= -1;
SB:= 0; SB(22):= 1; SMI; IM(1:21,23)= 0;     IM(0,22)= -1;
SB:= 0; SB(21):= 1; SMI; IM(1:20,22:23)= 0; IM(0,21)= -1;
   ...
SB:= 0; SB(1):= 1;  SMI; IM(2:23)= 0;        IM(0,1)= -1;
SB:= 0; SB(0):= 1;  SMI; IM(1:23)= 0;        IM(0)= 1;


BUS(0:23):= IM

          (AR:= IMa)

SB:=  0; MAR:= x12y12; SMI; IM(0)= 1; IM(1:23)= 0;
AR:= -1; MAR:=  x3y12; SMI; AR(-1,0)= -1; AR(1:23)= 0;
SB:= -1; MAR:= x12y12; SMI; IM = -1;
AR:=  0; MAR:=  x3y12; SMI; AR = -1;


IR(0):= 1

          (IR(0):= 1)

MAR:=  x9y27; SMI; IR(0)= 0;
MAR:= x31y31; SMI; IR(0)= 1;
```

MMode:= PROTECT

MAR:= x16y4 (MMode:= PROTECT)

PR:= b 1000 0000; PK:= 0; SMI; MMode = 1;
PK:= 7; SMI; MMode = 0;

BUS(-1:23):= AR(-1:22)con0

MAR:= x20y17 (AR:= AR(-1:22)con0)

AR:= -1; SMI; AR(-1:22)= -1; AR(23)= 0;
AR:= 0; SMI; AR = 0;

IC:= IC + 1

MAR:= x4y8 (IC:= IC + 1)

The testpatterns are specified in TABLE 1.

if AR > 0 then IC:= IC + 1

MAR:= x28y25 (if AR > 0 then IC:= IC + 1)

AR:= 0; IC:= 0; SMI; IC = 0;
AR:= 1; SMI; IC(5:21)= 0; IC(22)= 1;

if AR(-1)= 1 then IC:= IC + 1

MAR:= x28y27 (if AR(-1)= 1 then IC:= IC + 1)

AR:= 0; IC:= 0; SMI; IC = 0;
AR:= -1; SMI; IC(5:21)= 0, IC(22)= 1;

if AR = 0 then IC:= IC + 1

MAR:= x28y29 (if AR = 0 then IC:= IC + 1)

AR:= -1; IC:= 0; SMI; IC = 0;
AR:= 0; SMI; IC(5:21)= 0; IC(22)= 1;

if AR ≠ 0 then IC:= IC + 1

MAR:= x28y31 (if AR ≠ 0 then IC:= IC + 1)

AR:= 0; IC:= 0; SMI; IC = 0;
AR:= -1; SMI; IC(5:21)= 0; IC(22)= 1;

if -,PROTECT then IC:= IC + 1

MAR:= x1y11 (if -,PROTECT then IC:= IC + 1)

PR:= b 1000 0000;
PK:= 0; IC:= 0; SMI; IC = 0;
PK:= 1; SMI; IC(5:21)= 0; IC(22)= 1;

SC:= SC + 1

MAR:= x20y28 (SC:= SC + 1; SB(0:11):= SB(12:23))

The testpatterns are specified in TABLE 2.

SC:= SC - 1

MAR:= x4y19 (SC:= SC - 1)

The testpatterns are specified in TABLE 3.

EX(22,23):= 0

MAR:= x2y24 (EX(22,23):= 0; AR:= -2)

EX(21:23):= -1; SMI; EX(21)= 1; EX(22,23)= 0;

ashr SF

MAR:= x8y4 (ashr SF)

SB:= 0; SB(1):= 1; SE:= 0; SMI; Continue to depress SMI until SBconSE = 0. Observe for each step that the single 1 bit is shifted correctly.
SB:= 0; SB(0):= 1; SE:= 0; SMI; SB(0:1)= 1; SB(2:23)= 0; SE = 0;

lshr BF

MAR:= x4y7 (lshrBF)

BR:= 0; BR(0):= 1; BE:= 0; SMI; Continue to depress SMI until BRconBE = 0. Observe for each step that the single 1 bit is shifted correctly.

lshl AF

MAR:= x31y25 (Adder:= b 1111 000; lshl AF)

AR:= 0; AE:= 0; AE(13):= 1; SMI;
Continue to depress SMI until AF = 0. Observe for each step that the single 1 bit is shifted correctly.

lshl ARconBR

MAR:= x6y15 (Adder:= b 1111 000; lshl ARconBR)

AR:= 0; BR:= 0; BR(23):= 1; SMI;
Continue to depress SMI until ARconBR = 0. Observe for each step that the single 1 bit is shifted correctly.

ashr AF

MAR:= x12y16 (Adder:= b 1111 000; ashr AF)

AR:= 0; AR(1):= 1; AE:= 0; SMI;
Continue to depress SMI until AF = 0. Observe for each step that the single 1 bit is shifted correctly.
AR:= 0; AR(-1):= 1; SMI; AR(-1,0)= -1; AR(1:23)= 0;

ashr ARconBR

MAR:= x12y3 (Adder:= b 1111 000; ashr ARconBR)

AR:= 0; AR(1):= 1; BR:= 0; SMI;
Continue to depress SMI until AF = 0. Observe for each step that the single 1 bit is shifted correctly.
AR:= 0; AR(-1):= 1; SMI; AR(-1,0)= -1; AR(1:23)= 0;

lshr ARconBR

MAR:= x2y23 (Adder:= b 1111 000; lshr ARconBR)

AR:= 0; AR(-1,0):= -1; BR:= 0; SMI; AR(-1:0,1:23)= 0; BR = 0;
Continue to depress SMI until ARconBR = 0. Observe for each step that the single 1 bit is shifted correctly.

ITRenable:= FR(5)

SB:= 0; MAR:= x12y12; SMI; comment IM(1:23)= 0;
MAR:= x9y27; SMI; IR(0)= 0;
FR(5):= 1; MAR:= x16y4; SMI; comment ITRenable = 1. Testpoint 189E;
MAR:= x4y0; MCC; SMI; MAR = x4y0 or x4y1;
MAR:= x31y31; SMI; IR(0)= 1;
MAR:= x4y0; MCC; SMI; MAR = x4y16 or x4y17;
FR(5):= 0; MAR:= x16y4; SMI; comment ITRenable = 0;
MAR:= x4y0; MCC; SMI; MAR = x4y0 or x4y1;

Read Instruction, Read Data, Read Split, Split Write, and Double.

A. Check the data paths from the W-registers to SB and FR. The test uses the micro command Read Instruction.

```
FR(5):= 0; MAR:= x16y4; SMI; comment Itr = 0. Testpoint 189F;
SThdc:= 0
comment Testpoint 507A. SThdc becomes 0 by making a short circuit between
testpoint 510L and 0 volt;
W(0):= W(1):= W(2):= W(3):= -1; PB(0):= PB(1):= PB(2):= PB(3):= -1; BR:= -1;
MAR:= x4y0;

IC:= 0; FR:= -1; SB:= -1; PK:= -1;
W(0)conPB(0):= 0;                SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
W(0)conPB(0):= 0; PB(0)(2):= 1; SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
W(0)conPB(0):= 0; PB(0)(1):= 1; SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
W(0)conPB(0):= 0; PB(0)(0):= 1; SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
W(0)conPB(0):= 0; W(0)(23):= 1; SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
W(0)conPB(0):= 0; W(0)(22):= 1; SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
   ...
W(0)conPB(0):= 0; W(0)(0):= 1;  SMI; SBconPK:= W(0)conPB(0); FR:= W(0)(0:11);
W(0)conPB(0):= -1;

IC:= 1; FR:= -1; SB:= -1; PK:= -1;
W(1)conPB(1):= 0;                SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
W(1)conPB(1):= 0; PB(1)(2):= 1; SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
W(1)conPB(1):= 0; PB(1)(1):= 1; SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
W(1)conPB(1):= 0; PB(1)(0):= 1; SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
W(1)conPB(1):= 0; W(1)(23):= 1; SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
W(1)conPB(1):= 0; W(1)(22):= 1; SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
   ...
W(1)conPB(1):= 0; W(1)(0):= 1;  SMI; SBconPK:= W(1)conPB(1); FR:= W(1)(0:11);
W(1)conPB(1):= -1;
```

```
IC:= 2; FR:= -1; SB:= -1; PK:= -1;
W(2)conPB(2):= 0;                SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
W(2)conPB(2):= 0; PB(2)(2):= 1; SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
W(2)conPB(2):= 0; PB(2)(1):= 1; SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
W(2)conPB(2):= 0; PB(2)(0):= 1; SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
W(2)conPB(2):= 0; W(2)(23):= 1; SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
W(2)conPB(2):= 0; W(2)(22):= 1; SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
   ...
W(2)conPB(2):= 0; W(2)(0):= 1;  SMI; SBconPK:= W(2)conPB(2); FR:= W(2)(0:11);
W(2)conPB(2):= -1;
```

```
IC:= 3; FR:= -1; SB:= -1; PK:= -1;
W(3)conPB(3):= 0;                SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
W(3)conPB(3):= 0; PB(3)(2):= 1; SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
W(3)conPB(3):= 0; PB(3)(1):= 1; SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
W(3)conPB(3):= 0; PB(3)(0):= 1; SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
W(3)conPB(3):= 0; W(3)(23):= 1; SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
W(3)conPB(3):= 0; W(3)(22):= 1; SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
   ...
W(3)conPB(3):= 0; W(3)(0):= 1;  SMI; SBconPK:= W(3)conPB(3); FR:= W(3)(0:11);
W(3)conPB(3):= -1;
```

B. Check the influence of Interrupt.

```
MAR:= x31y31; SMI; IR(0)= 1;
FR(5):= 1; MAR:= x16y4; SMI; comment Itr = 1.  Testpoint 189F;
FR:= 0; IC:= 0; W(0)conPB(0); SBconPK:= -1;
            MAR:= x4y0; SMI; SBconPK = -1;
FR(0:5):= 9; MAR:= x4y0; SMI; SBconPK =  0;
```

C. Check the selection of W-registers for Read Data.

```
FR:= 0; W(0):= W(1):= W(2):= W(3):= -1; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4;
SB:= 0; MAR:= x3y0; SMI; SB = -1; PK = 0; FR = 0;
SB:= 2; MAR:= x3y0; SMI; SB = -1; PK = 1; FR = 0;
SB:= 4; MAR:= x3y0; SMI; SB = -1; PK = 2; FR = 0;
SB:= 6; MAR:= x3y0; SMI; SB = -1; PK = 4; FR = 0;
```

D. Check the selection of W-registers for Read Data Double.

```
FR:= 0; W(0):= W(1):= W(2):= W(3):= -1; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4;
BR:= 0; MAR:= x4y10; SMI; SB = -1; PK = 0; FR = 0;
BR:= 2; MAR:= x4y10; SMI; SB = -1; PK = 1; FR = 0;
BR:= 4; MAR:= x4y10; SMI; SB = -1; PK = 2; FR = 0;
BR:= 6; MAR:= x4y10; SMI; SB = -1; PK = 4; FR = 0;
```

E. Check the selection of W-registers for Read Split - Split Write.

```
FR:= 0; W(0):= W(1):= W(2):= W(3):= -1; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4; PR:= -1;
SB:= 0;          MAR:= x0y30; SMI; SB = -1; PK = 0; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(0)= 0; PB(0)= -1;
SB:= 2;          MAR:= x0y30; SMI; SB = -1; PK = 1R; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(1)= 0; PB(1)= -1;
SB:= 4;          MAR:= x0y30; SMI; SB = -1; PK = 2; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(2)= 0; PB(2)= -1;
SB:= 6;          MAR:= x0y30; SMI; SB = -1; PK = 4; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(3)= 0; PB(3)= -1;
```

C. Check the selection of W-registers for Read Data.

```
FR:= 0; W(0):= W(1):= W(2):= W(3):= -1; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4;
SB:= 0; MAR:= x3y0; SMI; SB = -1; PK = 0; FR = 0;
SB:= 2; MAR:= x3y0; SMI; SB = -1; PK = 1; FR = 0;
SB:= 4; MAR:= x3y0; SMI; SB = -1; PK = 2; FR = 0;
SB:= 6; MAR:= x3y0; SMI; SB = -1; PK = 4; FR = 0;
```

D. Check the selection of W-registers for Read Data Double.

```
FR:= 0; W(0):= W(1):= W(2):= W(3):= -1; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4;
BR:= 0; MAR:= x4y10; SMI; SB = -1; PK = 0; FR = 0;
BR:= 2; MAR:= x4y10; SMI; SB = -1; PK = 1; FR = 0;
BR:= 4; MAR:= x4y10; SMI; SB = -1; PK = 2; FR = 0;
BR:= 6; MAR:= x4y10; SMI; SB = -1; PK = 4; FR = 0;
```

E. Check the selection of W-registers for Read Split - Split Write.

```
FR:= 0; W(0):= W(1):= W(2):= W(3):= -1; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4; PR:= -1;
SB:= 0;          MAR:= x0y30; SMI; SB = -1; PK = 0; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(0)= 0; PB(0)= -1;
SB:= 2;          MAR:= x0y30; SMI; SB = -1; PK = 1R; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(1)= 0; PB(1)= -1;
SB:= 4;          MAR:= x0y30; SMI; SB = -1; PK = 2; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(2)= 0; PB(2)= -1;
SB:= 6;          MAR:= x0y30; SMI; SB = -1; PK = 4; FR = 0;
SB:= 0; PK:= -1; MAR:= x16y8; SMI; W(3)= 0; PB(3)= -1;
```

F. Check the selection of W-registers for Read Split Double - Split Write. It is only necessary to check for one W-register, for example W(3).

```
FR:= 0; SB:= 0; PK:= -1;
PB(0):= 0; PB(1):= 1; PB(2):= 2; PB(3):= 4; PR:= -1;
BR = 6;    MAR:= x6y28; SMI; PK = 4; FR = 0;
PK:= -1;   MAR:= x16y8; SMI; PB(3)= -1;
```

G. Check the word selection in core store.

```
FR(5):= 0; MAR:= x16y4; SMI; comment Itr = 0. Testpoint 189F;
IC:= 0; MAR:= x4y0; MCC;
```

Insert the following Slang program in the W-registers:

```
W0:  rs  w3  x3  0  ;  code for rs is 23
W1:  ls  w3      1  ;  code for ls is 38
W2:  jl          0  ;  code for jl is 13
W3:              9  ;
```

Execute the program one instruction at a time by depressing Single Instruction. Continue to store the contents of w3 until the shifted number in w3 becomes greater than the available core store. For a 16K core store the last number to be stored should be

w3:= b 00000000 01001000 00000000

```
IC:= 0; MAR:= x4y0; MCC;
```

Insert the following Slang program in the W-registers:

```
W0:  rl  w3  x3  0  ;  code for rl is 20
W1:  ls  w3      1  ;
W2:  jl          0  ;
W3:              9  ;
```

Execute the program one instruction at a time by depressing Single Instruction. Check for each time the rl w3 x3 0 instruction is executed that the contents of w3 remain unaltered. Continue the program until the shifted number in w3 becomes greater than the available core store.

MAR:= x4y12; comment Read Data Double;
BR:= 9; SMI; SB = BR;
Shift BR manually one position to the left; SMI; SB = BR;
Shift BR manually one position to the left; SMI; SB = BR;
...
Continue until the shifted number in BR becomes greater than the available core store.

MAR:= x4y0; comment Read Instruction;
IC(5:22):= 4; SMI; SB = 9;
IC:= 9; SMI; SB = 18;
Shift IC manually one position to the left; SMI; SB = IC*2;
Shift IC manually one position to the left; SMI; SB = IC*2;
...
Continue until the shifted number in IC becomes greater than the available core store.

H. Check the variable Fixed Address.

PR:= b10000000; PK:= 7; MAR:= x16y4; SMI; MMode = 0;
IC:= 0; W(0):= 0; PB(0):= 7; MAR:= x4y0; MCC; SI; MAR = x0y0; MMode = 0;
IC:= 0; W(0):= 0; PB(0):= 0; MAR:= x4y0; MCC; SI; MAR = x31y31; MMode = 1;
IC:= 0; W(0):= 0; PB(0):= 0; MAR:= x4y0; MCC; SI; MAR = x0y0; MMode = 1;
IC:= 0; MAR:= x4y0; PB(0):= 0; PB(1):= 7; PB(2):= 0; MCC;

Insert the following Slang program in the W-registers.

```
W0:  rs  w3  12  ;
W1:  rl  w2   6  ;
W2:
W3:          0  ;
```

SI; IC = 1; MMode = 1; SI; IC = 2; MMode = 0; SI; IC = 3;
comment if IC = 1 then Fixed Address has erroneously been 1 in the execute part of the rl W2 6 instruction.

J. Address exceeds available core store.

```
IC:= insert an address > storage capacity;
MAR:= x4y0; MCC; SI; IC = 1;
SB:= insert an address > storage capacity;
MAR:= x1y8; IC:= 3; MCC; SI; IC = 1;
```

K. Check for illegal storing.

```
IC:= 2; MAR:= x4y0; PR:= b10000000; PB(1):= 0; PB(2):= 7; MCC;
Insert the following Slang program in the W-registers.

W1:          0  ; protected location
W2: rs  w3   2  ; unprotected instruction
W3:         -1  ;

SI; SI; IC = 1; W1 = 0;
```

Test Integer, Test Shift, and Test Exp.

```
IC:= 0; MAR:= x4y0; PR:= -1; MCC;
Insert the following Slang program in the W-registers.

W0:  rs  w1  12  ;
W1:          8  ;

SI; SI; comment Service Address equals now 8;
```

A. Test Integer

```
SB:= 0; SB(1):= 1; MAR:= x12y12; SMI; IM(0:1)= -1; IM(2:23)= 0;
MAR:= x9y27;  SMI; SMI; IR(0:1)= 0;
FR(5):= 1; MAR:= x16y4;  SMI; comment ITRenable = 1. Testpoint 189E;

EX:= 0; SB:= 0; AR:= 0; IC:= 0;
comment IM(1)= 1, SUM(-1)= SUM(0), Carry(0)= 0;
MAR:= x1y7; MCC; SI; IC(5:21)= 0; IC(22)= 1; EX = 0;

EX:= 0; SB:= -1; AR:= -1; IC:= 0;
comment IM(1)= 1, SUM(-1)= SUM(0), Carry(0)= 1;
MAR:= x1y7; MCC; SI; IC(5:21)= 0; IC(22)= 1; EX = b001; IR(1)= 0;

EX:= 0; AR:= 0; AR(-1):= 1; SB:= 0; IC:= 0;
comment IM(1)= 1, SUM(-1) ≠ SUM(0), Carry(0)= 0;
MAR:= x1y7; MCC; SI; IC(5:19,21,23)= 0; IC(20,22)= -1; EX = b010;

EX:= 0; AR:= 0; AR(-1):= 1; SB:= 0; IC:= 0;
comment IM(1)= 1, SUM(-1) ≠ SUM(0), Carry(0)= 0, ITRenable = 0;
MAR:= x1y7; MCC; SI; IC(5:21)= 0; IC(22)= 1; IR(1)= 1;

SB:= 0; MAR:= x12y12; SMI; IM(0)= 1; IM(1:23)= 0;
FR(5):= 1; MAR:= x16y4; SMI; comment ITRenable = 1;
EX:= 0; AR:= -1; AR(-1):= 0; SB:= 0; SB(23):= 1; IC:= 0;
comment IM(1)= 0, SUM(-1) ≠ SUM(0), Carry(0)= 1;
MAR:= x1y7; MCC; SI; IC(5:21)= 0; IC(22)= 1; EX = b011; IR(1)= 1;
```

B. Test Shift

```
SB:= 0; SB(1):= 1; MAR:= x12y12; SMI; IM(0:1)= -1; IM(2:23)= 0;
MAR:= x9y27;  SMI; SMI; IR(0:1)= 0;
FR(5):= 1; MAR:= x16y4;  SMI; comment ITRenable = 1. Testpoint 189E;

EX:= 0; AR:= 0; IC:= 0;
comment IM(1)= 1; AR(0)= AR(1);
MAR:= x4y15; MCC; SI; IC(5:21)= 0; IC(22)= 1; EX=0;
```

```
EX:= 0; AR:= 0; AR(0):= 1; IC:= 0;
comment IM(1)= 1; AR(0) ≠ AR(1);
MAR:= x4y15; MCC; SI; IC(5:19,21,23)= 0; IC(20,22)= -1; EX = b010;

SB:= 0; MAR:= x12y12; SMI; IM(0)= 1; IM(1:23)= 0; FR(5):= 1; MAR:= x16y4;
      SMI; ITRenable = 1;
EX:= 0; AR:= 0; AR(0):= 1; IC:= 0;
comment IM(1)= 0; AR(0) ≠ AR(1);
MAR:= x4y15; MCC; SI; IC(5:21)= 0; IC(22)= 1; EX = b010; IR(1)= 1;
```

C. Test Exp

```
SB:= 0; SB(2):= 1; MAR:= x12y12; SMI; IM(0,2)= -1, IM(1,3:23)= 0;
MAR:= x9y27; SMI; SMI; SMI; IR(0,2)= 0;
FR(5):= 1; MAR:= x16y4; SMI;

EX:= 0; SC:= 0; IC:= 0;
comment IM(2)= 1, SC(11)= SC(12)= 0;
MAR:= x17y1; MCC; SI; IC(5:21)= 0; IC(22)= 1; EX = 0; IR(2)= 0;

EX:= 0; SC:= 0; SC(11):= 1; IC:= 0;
comment IM(2)= 1, SC(11) ≠ SC(12);
MAR:= x17y1; MCC; SI; IC(5:19,21,23)= 0; IC(20,22)= -1; EX = b010;

SB:= 0; MAR:= x12y12; SMI; IM(0)= 1; IM(1:23)= 0; FR(5):= 1; MAR:= x16y4;
      SMI; comment ITRenable = 1; SC:= 0; SC(11):= 1; EX:= 0; IC:= 0;
comment IM(2)= 0; SC(11) ≠ SC(12);
MAR:= x17y1; MCC; SI; IC(5:21)= 0; IC(23)= 1; EX = b010; IR(2)= 1;
```

Test WD Sign

```
MAR:= x20y20  (Adder:= b1111000; Test WD Sign; lshlARconBR)

SB:= -1; SB(0):= 0; AR:= 0; SMI; Testpoint 158D = 1;
SB:= -1; AR:= -1; AR(-1):= 0; SMI; Testpoint 158D = 0;
SB:= -1; SB(0):= 0; AR:= 0; AR(-1):= -1; SMI; Testpoint 158D = 0;
SB:= -1; AR:= -1; SMI; Testpoint 158D = 1;
```

Test FD Sign

```
MAR:= x6y1  (AE:= W(fr)(0:11)con0con0; Adder:= b1111000; Test FD Sign)

SB:= -1; SB(0):= 0; AR:= 0; SMI; Testpoint 158E = 0; Testpoint 158F = 1;
SB:= -1; AR:= -1; AR(-1):= 0; SMI; Testpoint 158E = 1; Testpoint 158F = 0;
SB:= -1; SB(0):= 0; AR:= 0; AR(-1):= 1; SMI; Testpoint 158E = 1; Testpoint 158F= 0;
SB:= -1; AR:= -1; SMI; Testpoint 158E = 0; Testpoint 158F = 1;
```

Divide Integer

```
FR(5):= 1; MAR:= x16y4; SMI;
IC:= 0; MAR:= x4y0; MCC; PR:= b1111 1111; EX:= 0;
```

Insert the following Slang program in the W-registers.

```
W0:  wd  w3  2                                ;  code for wd is 23
W1:  b 000001   000000   111111   000000
W2:  b 000000   110000   111111   111111
W3:  b 000000   111111   010101   010101

SI; W2 = b 000000   110000   111111   111111;
    W3 = b 000000   111111   010101   010101;
    EX = 010;
```

Divide Floating

```
FR(5):= 1; MAR:= x16y4; SMI;

Insert the following numbers in the W-registers.

W0:  b 011111   111111   111111   111111
W1:  b 111111   111110   000000   000000
W2:  b 011000   000000   000000   000000
W3:  b 000000   000000   000000   111111

FR:= 0; FR(0:5):= 52; FR(7):= 1; SB:= 6; MAR:= x2y8; MCC;
SI; W0= 010101   010101   010101   010101
    W1= 010101   010100   111111   000010
```

TABLE 1

IC

IC(5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22)
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1
0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1
0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1
0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1
0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

IC + 1

IC(5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22)
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2

SC														SC + 1												
SC(1	1	1	1	1	1	1	1	1	2	2	2	2)		SC(1	1	1	1	1	1	1	1	1	2	2	2	2)
1	2	3	4	5	6	7	8	9	0	1	2	3		1	2	3	4	5	6	7	8	9	0	1	2	3
1	1	1	1	1	1	1	1	1	1	1	1	0		1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	0	1		1	1	1	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	0	1	1		1	1	1	1	1	1	1	1	1	1	1	0	0
1	1	1	1	1	1	1	1	1	0	1	1	1		1	1	1	1	1	1	1	1	1	1	0	0	0
1	1	1	1	1	1	1	1	0	1	1	1	1		1	1	1	1	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	1	0	1	1	1	1	1		1	1	1	1	1	1	1	1	0	0	0	0	0
1	1	1	1	1	1	0	1	1	1	1	1	1		1	1	1	1	1	1	1	0	0	0	0	0	0
1	1	1	1	1	0	1	1	1	1	1	1	1		1	1	1	1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	1	1	1	1	1	1	1	1		1	1	1	1	1	0	0	0	0	0	0	0	0
1	1	1	0	1	1	1	1	1	1	1	1	1		1	1	1	1	0	0	0	0	0	0	0	0	0
1	1	0	1	1	1	1	1	1	1	1	1	1		1	1	1	0	0	0	0	0	0	0	0	0	0
1	0	1	1	1	1	1	1	1	1	1	1	1		1	1	0	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	1	1	1	1	1		1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	1	0	0	1	0	0	1	0	0	0		1	0	0	1	0	0	1	0	0	1	0	0	1
0	0	0	0	0	0	0	0	0	0	1	1	1		0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	1	1	1	1	1	1	1	1		0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	1	1	0	1	1	0	1	1	0	1	0		0	0	1	1	0	1	1	0	1	1	0	1	1
0	0	0	0	0	0	0	0	1	0	1	1	1		0	0	0	0	0	0	0	1	1	0	0	0	0
0	0	0	0	0	1	0	1	1	1	1	1	1		0	0	0	0	0	1	1	0	0	0	0	0	0
0	0	1	0	1	1	1	1	1	1	1	1	1		0	0	1	1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1	1	1	1	1	1		0	0	1	0	0	0	0	0	0	0	0	0	0

TABLE 3

SC		SC - 1	
SC(1 1 1 1 1 1 1 1 1 2 2 2 2) 1 2 3 4 5 6 7 8 9 0 1 2 3		SC(1 1 1 1 1 1 1 1 1 2 2 2 2) 1 2 3 4 5 6 7 8 9 0 1 2 3	
0 0 0 0 0 0 0 0 0 0 0 0 0	1	0 0 0 0 0 0 0 0 0 0 0 0 0	0
0 0 0 0 0 0 0 0 0 0 0 0 1	0	0 0 0 0 0 0 0 0 0 0 0 0 1	1
0 0 0 0 0 0 0 0 0 0 0 1 0	0	0 0 0 0 0 0 0 0 0 0 0 1 1	1
0 0 0 0 0 0 0 0 0 0 1 0 0	0	0 0 0 0 0 0 0 0 0 0 1 1 1	1
0 0 0 0 0 0 0 0 0 1 0 0 0	0	0 0 0 0 0 0 0 0 0 1 1 1 1	1
0 0 0 0 0 0 0 0 1 0 0 0 0	0	0 0 0 0 0 0 0 0 1 1 1 1 1	1
0 0 0 0 0 0 0 1 0 0 0 0 0	0	0 0 0 0 0 0 0 1 1 1 1 1 1	1
0 0 0 0 0 0 1 0 0 0 0 0 0	0	0 0 0 0 0 0 1 1 1 1 1 1 1	1
0 0 0 0 0 1 0 0 0 0 0 0 0	0	0 0 0 0 0 1 1 1 1 1 1 1 1	1
0 0 0 0 1 0 0 0 0 0 0 0 0	0	0 0 0 0 1 1 1 1 1 1 1 1 1	1
0 0 0 1 0 0 0 0 0 0 0 0 0	0	0 0 0 1 1 1 1 1 1 1 1 1 1	1
0 0 1 0 0 0 0 0 0 0 0 0 0	0	0 0 1 1 1 1 1 1 1 1 1 1 1	1
0 1 0 0 0 0 0 0 0 0 0 0 0	0	0 1 1 1 1 1 1 1 1 1 1 1 1	1
1 0 0 0 0 0 0 0 0 0 0 0 0	0	1 1 1 1 1 1 1 1 1 1 1 1 1	0
1 1 1 1 1 1 1 1 1 1 1 1 1	1	1 1 1 1 1 1 1 1 1 1 1 1 0	0
0 1 1 0 1 1 0 1 1 0 1 1 1	1	0 1 1 0 1 1 0 1 1 0 1 1 0	0
1 1 1 1 1 1 1 1 1 1 1 0 0	0	1 1 1 1 1 1 1 1 1 0 1 1 1	1
1 1 1 1 1 1 1 1 0 0 0 0 0	0	1 1 1 1 1 1 1 0 1 1 1 1 1	1
1 1 1 1 0 0 0 0 0 0 0 0 0	0	1 1 1 0 1 1 1 1 1 1 1 1 1	1
1 1 0 0 1 0 0 1 0 0 1 0 1	1	1 1 0 0 1 0 0 1 0 0 1 0 0	0
1 1 1 1 1 1 1 1 1 0 1 0 0	0	1 1 1 1 1 1 1 1 1 0 0 1 1	1
1 1 1 1 1 0 1 0 0 0 0 0 0	0	1 1 1 1 1 1 0 0 1 1 1 1 1	1
1 1 0 1 0 0 0 0 0 0 0 0 0	0	1 1 0 0 1 1 1 1 1 1 1 1 1	1
1 1 1 1 1 1 1 1 1 1 1 1 1	0	1 1 1 1 1 1 1 1 1 1 1 1 0	1
1 1 1 1 1 1 1 1 1 0 0 0 0	0	1 1 1 1 1 1 1 1 0 1 1 1 1	1
1 1 1 1 1 1 0 0 0 0 0 0 0	0	1 1 1 1 1 0 1 1 1 1 1 1 1	1
1 1 1 0 0 0 0 0 0 0 0 0 0	0	1 1 0 1 1 1 1 1 1 1 1 1 1	1