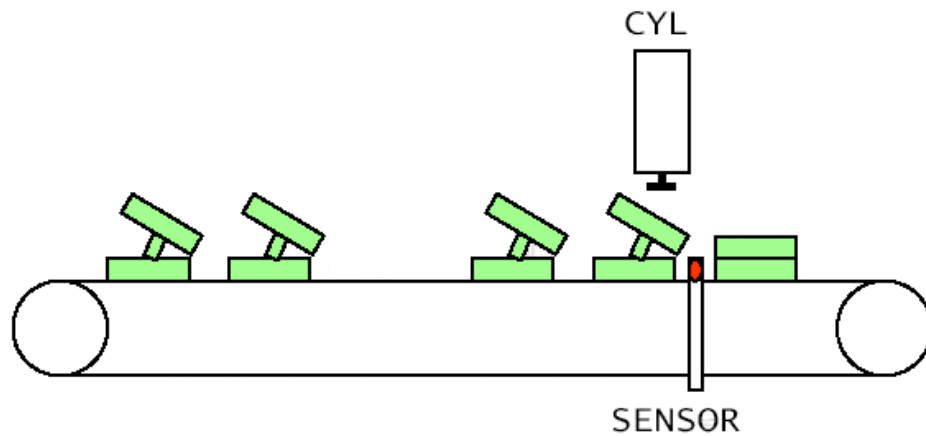
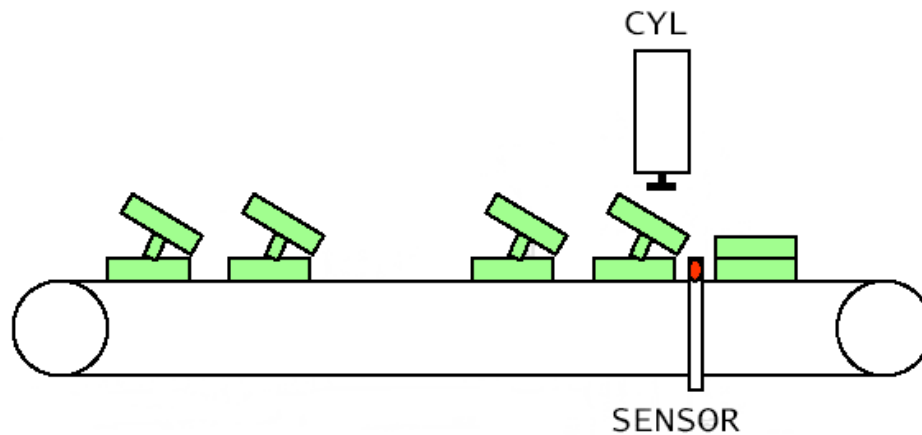


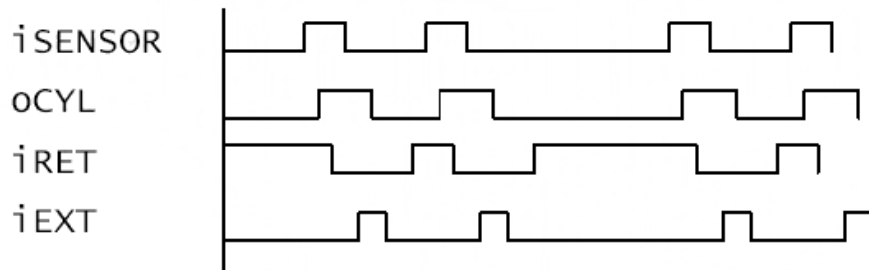
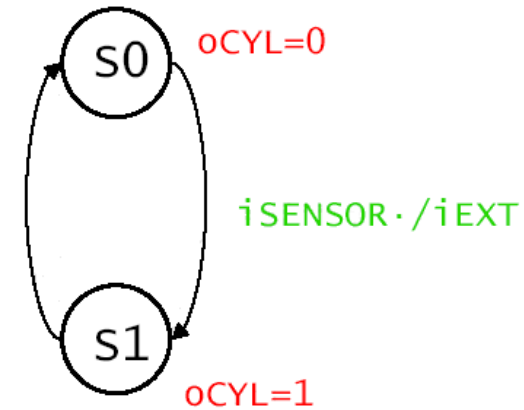
State Machine Example #2



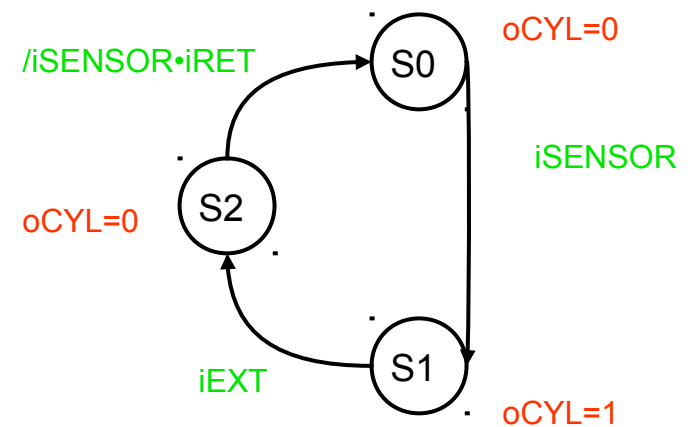
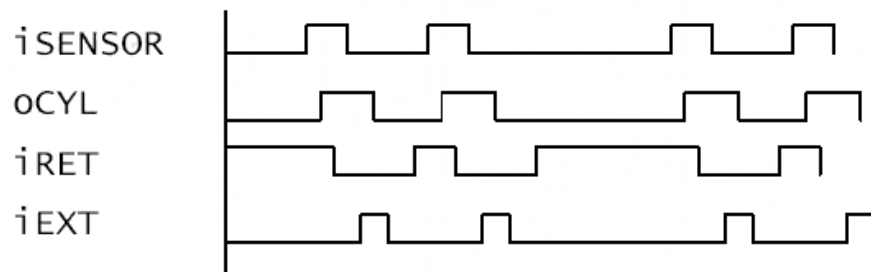
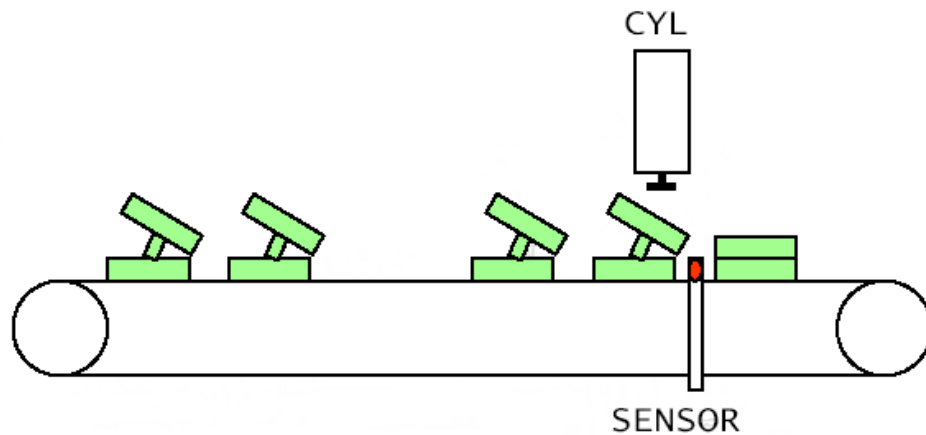
State Machine Example #2



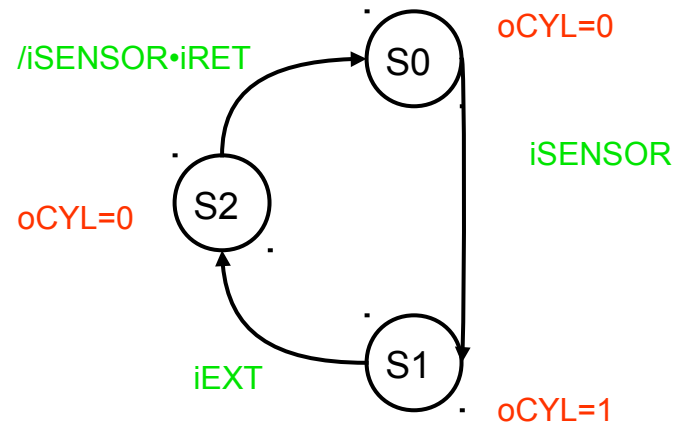
$i_{EXT} +$
 $/i_{SENSOR} \cdot i_{RET}$



State Machine Example #2

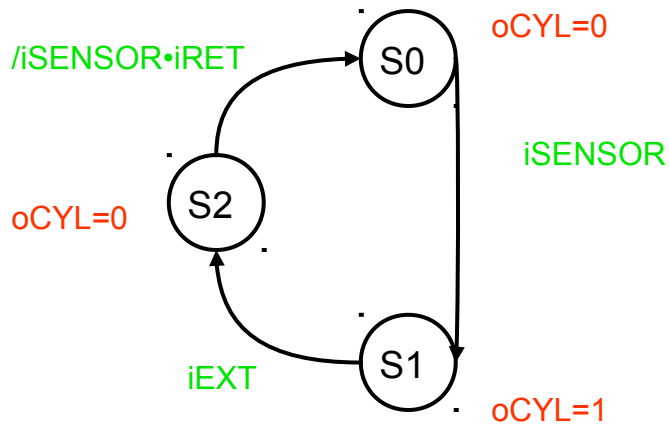


Example #2 State Diagram



CurrSt	iSENSOR	iEXT	iRET	NextSt
S0	0	X	X	S0
S0	1	X	X	S1
S1	X	0	X	S1
S1	X	1	X	S2
S2	0	X	0	S2
S2	0	X	1	S0
S2	1	X	X	S2

Example #2 State Diagram



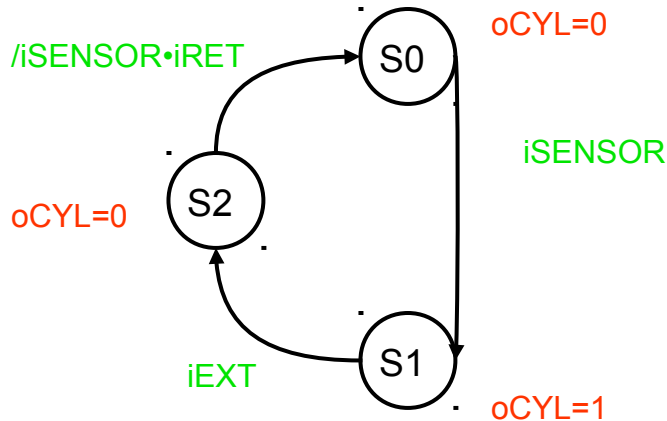
CurrSt	iSENSOR	iEXT	iRET	NextSt
S0	0	X	X	S0
S0	1	X	X	S1
S1	X	0	X	S1
S1	X	1	X	S2
S2	0	X	0	S2
S2	0	X	1	S0
S2	1	X	X	S2

$$cS0 = cS2 \cdot /iSENSOR \cdot iRET + cS0 \cdot /iSENSOR + /cS0 \cdot /cS1 \cdot /cS2$$

$$cS1 = cS0 \cdot iSENSOR + cS1 \cdot /iEXT$$

$$\begin{aligned}
 cS2 &= cS1 \cdot iEXT + cS2 \cdot (/iSENSOR \cdot iRET) \\
 &= cS1 \cdot iEXT + cS2 \cdot (iSENSOR + /iRET)
 \end{aligned}$$

Example #2 State Diagram



$$cS0 = cS2 \cdot /iSENSOR \cdot iRET$$

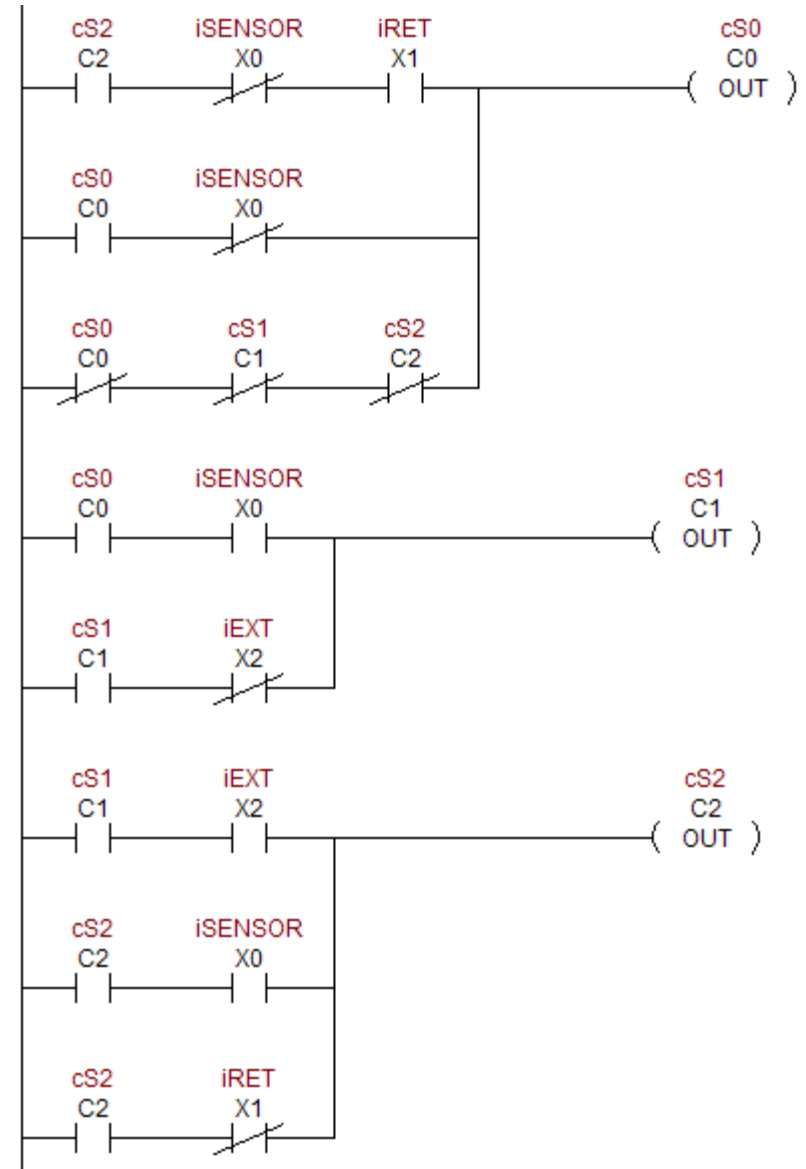
$$+ cS0 \cdot /iSENSOR$$

$$+ /cS0 \cdot /cS1 \cdot /cS2$$

$$cS1 = cS0 \cdot iSENSOR + cS1 \cdot /iEXT$$

$$cS2 = cS1 \cdot iEXT + cS2 \cdot iSENSOR$$

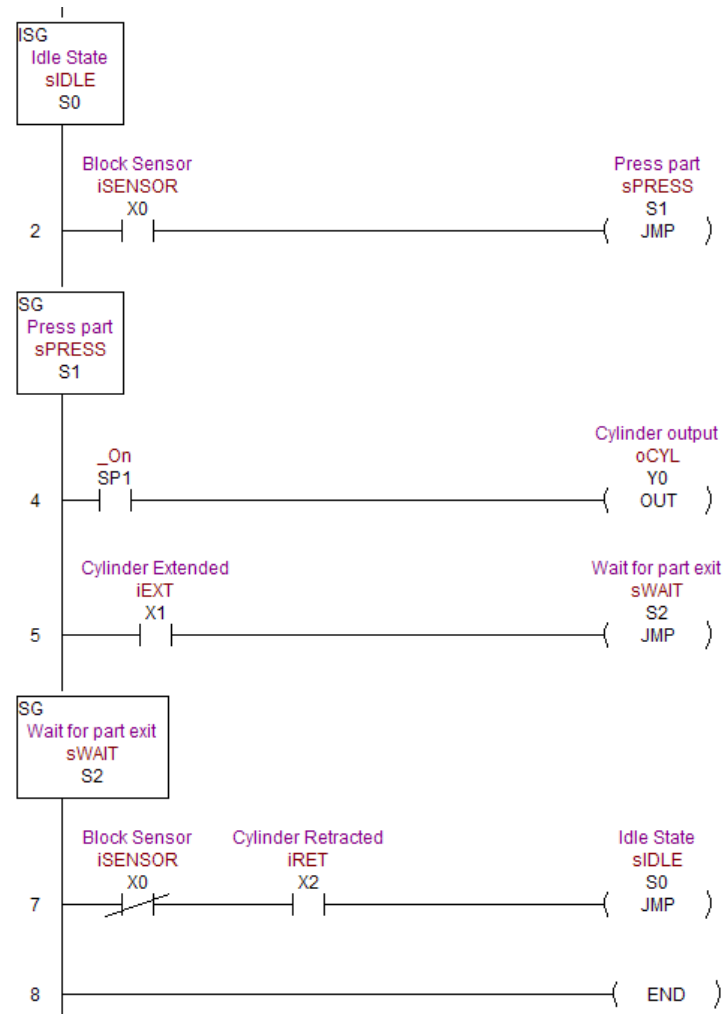
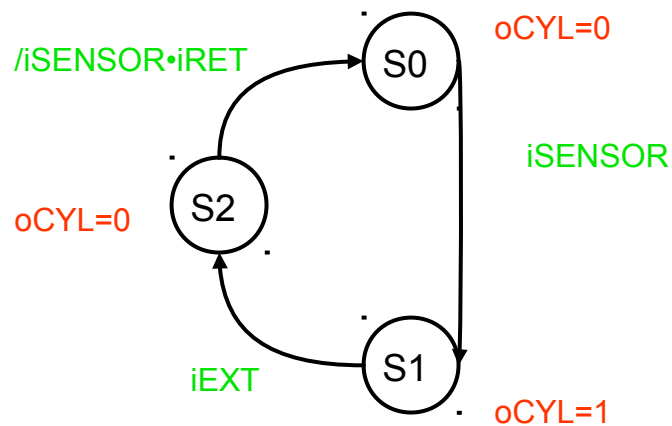
$$+ cS2 \cdot /iRET)$$



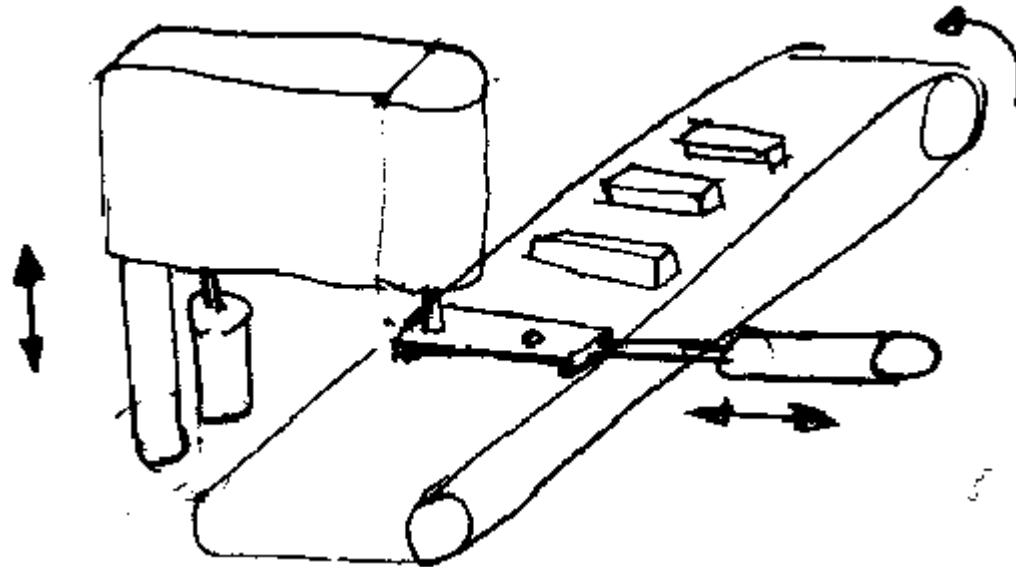
State Machines in Ladder Logic

- Pure relay logic - traditional design:
 - 2 states = 1 coil
 - 3-4 states = 2 coils
 - 5-8 states = 3 coils, etc.
 - difficult to debug, modify and document
- Pure relay logic - “one-hot” design
 - 1 coil per state
 - easier to debug, modify, and document
 - watch out for “illegal” states
- RLL-Plus
 - “Stages”
 - JMP “coils”
 - easiest to write and maintain
 - not available in all brands of PLC’s

Ex #2 - RLL-Plus Stages



Multi-state Example



- When sensor detects block; clamp block, drill hole, shift, drill 2nd hole, shift back, release clamp

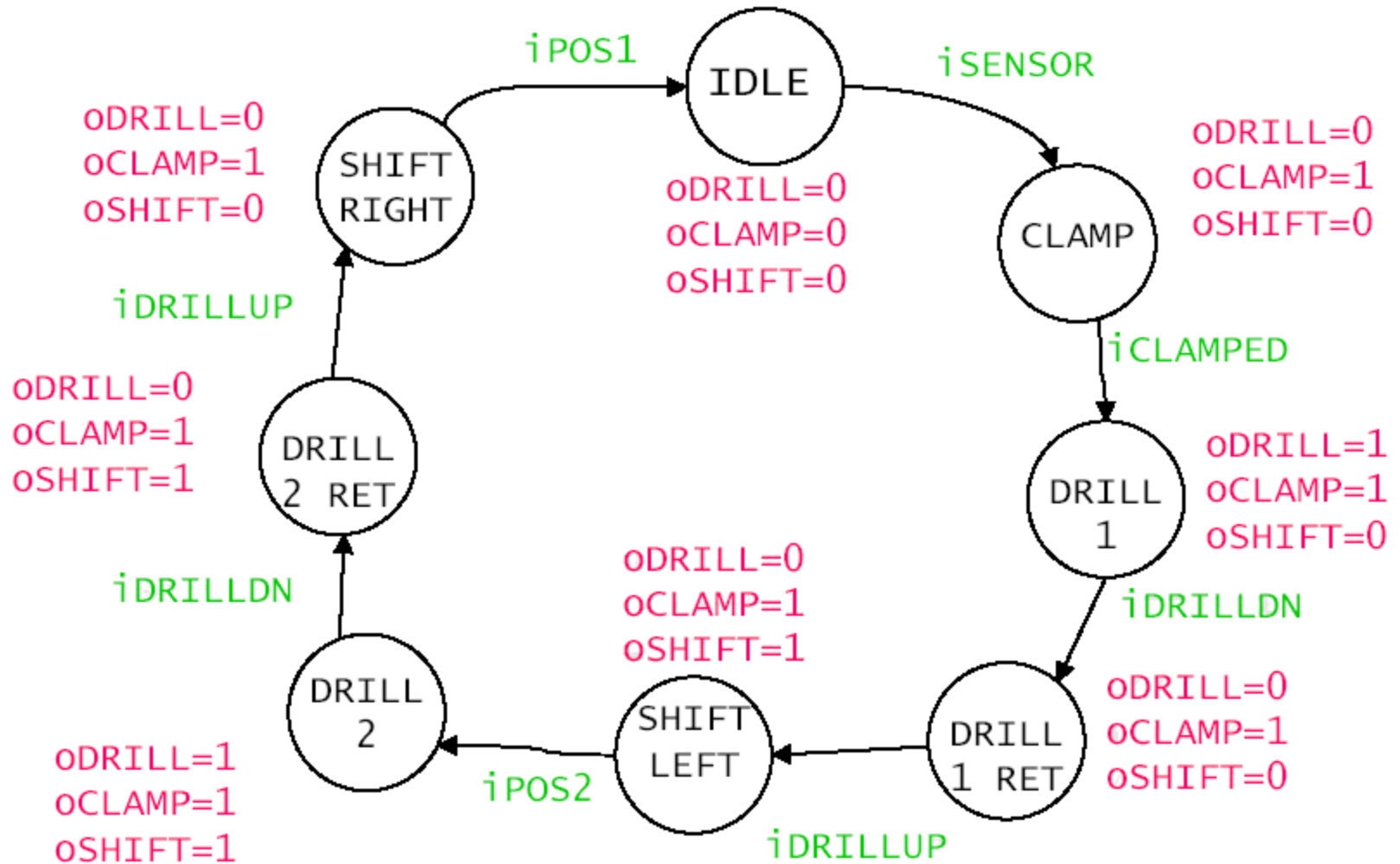
Inputs and Outputs

- iSENSOR block present
- iDRILLDN drill is down
- iDRILLUP drill is up
- iCLAMPED fully clamped
- iRELEASED fully unclamped
- iPOS1 unshifted
- iPOS2 shifted
- oDRILL start drilling
- oCLAMP activate clamp
- oSHIFT shift block holder

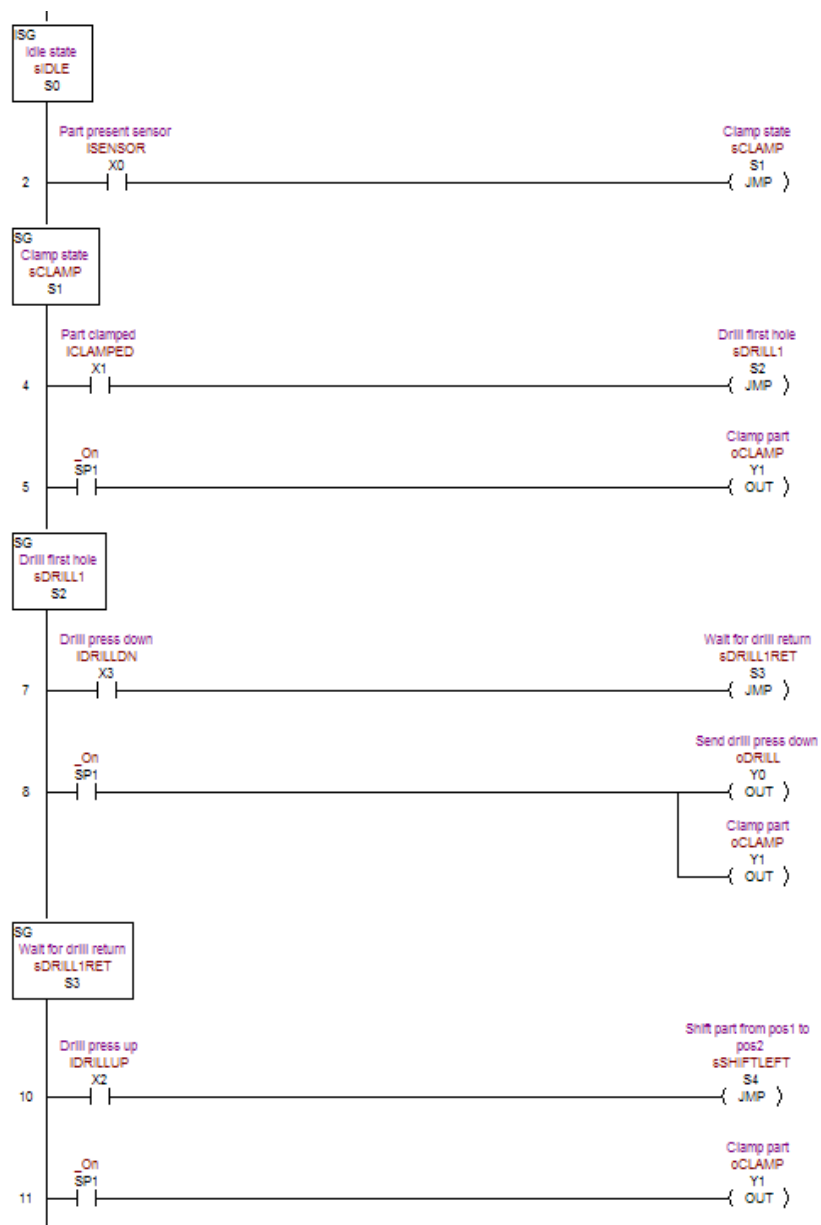
State Diagrams

- One state per “action”
- Look for “wait” states needed

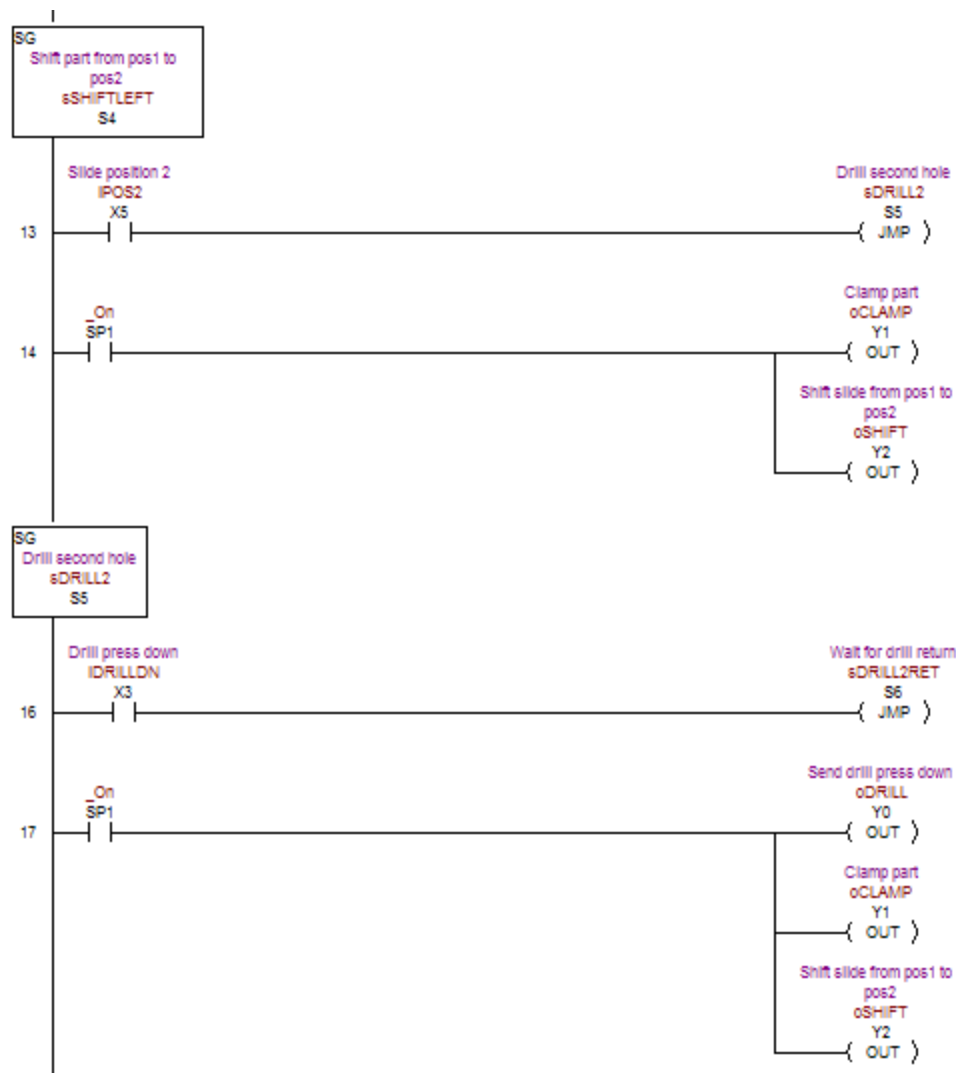
State Diagram



RLL-Plus



RLL-Plus



RLL-Plus

