EMERSON
Industrial Automation

Application Note CTAN #140

The Application Note is pertinent to the Mentor II / Quantum III & Unidrive Family

Programmable Logic Gates

I have been asked on several occasions how exactly do you achieve a particular logic function with the built-in logic gates within our Unidrive or Quantum/Mentor.. The problem that most people have using the internal programmable logic blocks within our drives I believe, is that the manual does not exactly spell out how to achieve the various standard logic gates. The following discussion hopefully will help one to understand and use these useful programmable logic functions a little better.

There are 2 sets of dual input logic gates within the Unidrive and Quantum/Mentor drive intended to help with miscellaneous system logic. The fundamental building block of these gates use the AND gate. By placing selectable inverters before each input to the AND gate and an inverter after the AND gate, all four logic functions namely AND, NAND, OR and NOR can be achieved. Since there are 2 of these gates in each drive, 3 input AND, NAND, OR and NOR gates can also be achieved (see CTAN141 for more info on this topic).

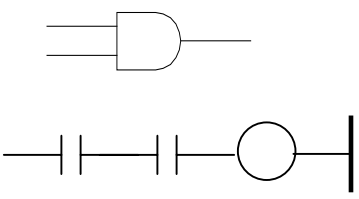
Click here → www.emersonct.com/pdProducts/downloads/appNotesPDF/ctan141.pdf

The AND gate

The AND gate is the simplest of the logic functions to realize. For this to be accomplished, one would simply not use the input or output inverters on this logic function. The Boolean equation for AND is Y= A•B or Y= AB (both read as Y= A and B).

Input A	Input B	Output Y
0	0	0
0	1	0
1	0	0
1	1	1

Standard Symbol

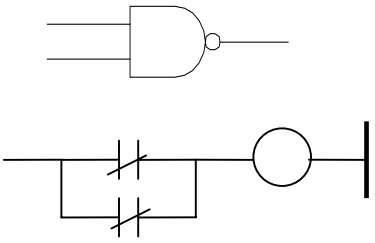


The NAND gate

The NAND gate is also easy to realize. The NAND is simply NOT AND or the inverse of AND. One would simply use the output inverter on this logic function to achieve the NAND function. The Boolean equation for NAND is Y= A•B or Y= $\overline{AB}$ (both read as Y= A and B not).

Input A	Input B	Output Y
0	0	1
0	1	1
1	0	1
1	1	0

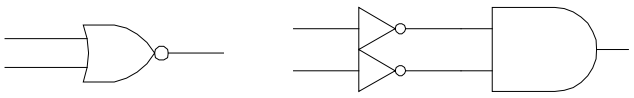
Standard Symbol



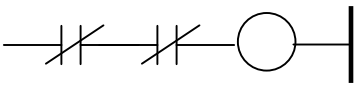
The NOR gate

The NOR function is not as intuitive to realize. The secret lies in knowing the alternate symbology for various gates. The Boolean equation for NOR function is Y= A+B (read as Y= A or B not). DeMorgan's[1] theorem states that the equivalent logic function can be realized removing the "overall inversion bar" by changing the OR operator to AND plus inverting the variables thus becoming Y= $\overline{A}$•$\overline{B}$ (read as Y = A not AND B not). Therefore we can easily achieve the NOR function on the drive logic functions by inverting the inputs before the AND gate.

Standard Symbol **Equivalent NOR**



Input A	Input B	Output Y
0	0	1
0	1	0
1	0	0
1	1	0

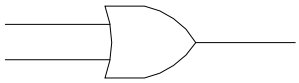


[1] *DeMorgan was a dude who was heavy into boolean logic and associated mathematics*

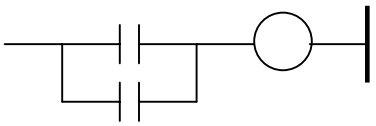
The OR gate

Once we have a NOR gate the OR function is easy- we simply invert the NOR using the inverter on the output of the logic function block.

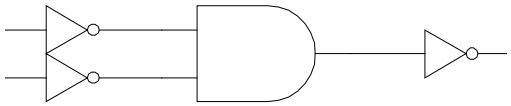
Standard Symbol



Input A	Input B	Output Y
0	0	0
0	1	1
1	0	1
1	1	1



Equivalent OR Symbol



In Summary, the tables listed below should help one achieve the desired logic gate using the drives programmable logic functions. Refer to Menu 9 of these drives when using these tables.

For Mentor II or Quantum III

Gate #1

LOGIC GATE TYPE	INPUT #1 INVERTER #9.08	INPUT #2 INVERTER #9.10	OUTPUT INVERTER #9.11	FINAL GATE OUTPUT #9.01
AND	0	0	0	
OR	1	1	1	
NAND	0	0	1	
NOR	1	1	0	

Gate #2

LOGIC GATE TYPE	INPUT #1 INVERTER #9.14	INPUT #2 INVERTER #9.16	OUTPUT INVERTER #9.17	FINAL GATE OUTPUT #9.02
AND	0	0	0	
OR	1	1	1	
NAND	0	0	1	
NOR	1	1	0	

For Unidrive

Gate #1

LOGIC GATE TYPE	INPUT #1 INVERTER #9.05	INPUT #2 INVERTER #9.07	OUTPUT INVERTER #9.08	FINAL GATE OUTPUT #9.01
AND	0	0	0	
OR	1	1	1	
NAND	0	0	1	
NOR	1	1	0	

Gate #2

LOGIC GATE TYPE	INPUT #1 INVERTER #9.15	INPUT #2 INVERTER #9.17	OUTPUT INVERTER #9.18	FINAL GATE OUTPUT #9.02
AND	0	0	0	
OR	1	1	1	
NAND	0	0	1	
NOR	1	1	0	

For More Information on this topic see CTAN 141 for discussion on Combinatorial Logic Functions
Click here → www.emersonct.com/pdProducts/downloads/appNotesPDF/ctan141.pdf

Also see Programmable Time Delays CTAN122
Click here → www.emersonct.com/pdProducts/downloads/appNotesPDF/ctan122.pdf

Questions ?? Ask the Author:

Author: **Ray McGranor** **e-mail :** ray.mcgranor@emersonct.com
(716)-774-0093