

Logic Functions & Gates																																																																																																																																																																																																																															
Logic Gate	NOT	AND	OR	NAND	NOR	XOR	XNOR																																																																																																																																																																																																																								
Symbol																																																																																																																																																																																																																															
Description	Y is invert of A	Y = 1 if A AND B = 1	Y = 1 if A OR B = 1	Y = 0 if A AND B = 1	Y = 0 if A OR B = 1	Y = 1 if A OR B = 1, not if both = 1	Y = 0 if A OR B = 1, not if both = 1																																																																																																																																																																																																																								
Function	$Y = \bar{A}$	$Y = A \times B$	$Y = A + B$	$Y = \overline{A \times B}$	$Y = \overline{A + B}$	$Y = A \oplus B$ $Y = \bar{A}B + A\bar{B}$	$Y = \overline{A \oplus B}$ $Y = \bar{A}B + AB$																																																																																																																																																																																																																								
2-Input Truth Table Showing Enable & Inhibit	<table border="1"><tr><th>A</th><th>Y</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	A	Y	0	1	1	0	<table border="1"><tr><th>A</th><th>B</th><th>Y</th><th>E/I</th></tr><tr><td>0</td><td>0</td><td>0</td><td>(Y=0)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Inhibit</td></tr><tr><td>1</td><td>0</td><td>0</td><td>(Y=B)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Enable</td></tr></table>	A	B	Y	E/I	0	0	0	(Y=0)	0	1	0	Inhibit	1	0	0	(Y=B)	1	1	1	Enable	<table border="1"><tr><th>A</th><th>B</th><th>Y</th><th>E/I</th></tr><tr><td>0</td><td>0</td><td>0</td><td>(Y=B)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Enable</td></tr><tr><td>1</td><td>0</td><td>1</td><td>(Y=0)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Inhibit</td></tr></table>	A	B	Y	E/I	0	0	0	(Y=B)	0	1	1	Enable	1	0	1	(Y=0)	1	1	1	Inhibit	<table border="1"><tr><th>A</th><th>B</th><th>Y</th><th>E/I</th></tr><tr><td>0</td><td>0</td><td>1</td><td>(Y=1)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Inhibit</td></tr><tr><td>1</td><td>0</td><td>1</td><td>(Y=0)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Enable</td></tr></table>	A	B	Y	E/I	0	0	1	(Y=1)	0	1	1	Inhibit	1	0	1	(Y=0)	1	1	0	Enable	<table border="1"><tr><th>A</th><th>B</th><th>Y</th><th>E/I</th></tr><tr><td>0</td><td>0</td><td>1</td><td>(Y=0)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Enable</td></tr><tr><td>1</td><td>0</td><td>0</td><td>(Y=0)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Inhibit</td></tr></table>	A	B	Y	E/I	0	0	1	(Y=0)	0	1	0	Enable	1	0	0	(Y=0)	1	1	0	Inhibit	<table border="1"><tr><th>A</th><th>B</th><th>Y</th><th>E/I</th></tr><tr><td>0</td><td>0</td><td>0</td><td>(Y=B)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Enable</td></tr><tr><td>1</td><td>0</td><td>1</td><td>(Y=0)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Enable</td></tr></table>	A	B	Y	E/I	0	0	0	(Y=B)	0	1	1	Enable	1	0	1	(Y=0)	1	1	0	Enable	<table border="1"><tr><th>A</th><th>B</th><th>Y</th><th>E/I</th></tr><tr><td>0</td><td>0</td><td>1</td><td>(Y=0)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Enable</td></tr><tr><td>1</td><td>0</td><td>0</td><td>(Y=B)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Enable</td></tr></table>	A	B	Y	E/I	0	0	1	(Y=0)	0	1	0	Enable	1	0	0	(Y=B)	1	1	1	Enable																																																																																										
A	Y																																																																																																																																																																																																																														
0	1																																																																																																																																																																																																																														
1	0																																																																																																																																																																																																																														
A	B	Y	E/I																																																																																																																																																																																																																												
0	0	0	(Y=0)																																																																																																																																																																																																																												
0	1	0	Inhibit																																																																																																																																																																																																																												
1	0	0	(Y=B)																																																																																																																																																																																																																												
1	1	1	Enable																																																																																																																																																																																																																												
A	B	Y	E/I																																																																																																																																																																																																																												
0	0	0	(Y=B)																																																																																																																																																																																																																												
0	1	1	Enable																																																																																																																																																																																																																												
1	0	1	(Y=0)																																																																																																																																																																																																																												
1	1	1	Inhibit																																																																																																																																																																																																																												
A	B	Y	E/I																																																																																																																																																																																																																												
0	0	1	(Y=1)																																																																																																																																																																																																																												
0	1	1	Inhibit																																																																																																																																																																																																																												
1	0	1	(Y=0)																																																																																																																																																																																																																												
1	1	0	Enable																																																																																																																																																																																																																												
A	B	Y	E/I																																																																																																																																																																																																																												
0	0	1	(Y=0)																																																																																																																																																																																																																												
0	1	0	Enable																																																																																																																																																																																																																												
1	0	0	(Y=0)																																																																																																																																																																																																																												
1	1	0	Inhibit																																																																																																																																																																																																																												
A	B	Y	E/I																																																																																																																																																																																																																												
0	0	0	(Y=B)																																																																																																																																																																																																																												
0	1	1	Enable																																																																																																																																																																																																																												
1	0	1	(Y=0)																																																																																																																																																																																																																												
1	1	0	Enable																																																																																																																																																																																																																												
A	B	Y	E/I																																																																																																																																																																																																																												
0	0	1	(Y=0)																																																																																																																																																																																																																												
0	1	0	Enable																																																																																																																																																																																																																												
1	0	0	(Y=B)																																																																																																																																																																																																																												
1	1	1	Enable																																																																																																																																																																																																																												
Function		$Y = A \times B \times C$	$Y = A + B + C$	$Y = \overline{A \times B \times C}$	$Y = \overline{A + B + C}$	$Y = A \oplus B \oplus C$ $Y = \bar{A}BC + A\bar{B}C + ABC + \bar{A}\bar{B}\bar{C}$	$Y = \overline{A \oplus B \oplus C}$ $Y = \bar{A}BC + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$																																																																																																																																																																																																																								
3-Input Truth Table	Note: A 0 on the inputs or outputs represents active LOW	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table>	A	B	C	Y	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0	0	1	1	1	1	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table>	A	B	C	Y	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	1	1	0	0	1	1	0	1	1	1	1	0	1	1	1	1	1	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr></table>	A	B	C	Y	0	0	0	1	0	0	1	1	0	1	0	1	0	1	1	1	1	0	0	1	1	0	1	1	1	1	0	1	1	1	1	0	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr></table>	A	B	C	Y	0	0	0	1	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0	0	1	1	1	0	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table>	A	B	C	Y	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	0	1	0	0	1	1	0	1	0	1	1	0	0	1	1	1	1	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>Y</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr></table>	A	B	C	Y	0	0	0	1	0	0	1	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	1	1	1	1	0	1	1	1	1	0
A	B	C	Y																																																																																																																																																																																																																												
0	0	0	0																																																																																																																																																																																																																												
0	0	1	0																																																																																																																																																																																																																												
0	1	0	0																																																																																																																																																																																																																												
0	1	1	0																																																																																																																																																																																																																												
1	0	0	0																																																																																																																																																																																																																												
1	0	1	0																																																																																																																																																																																																																												
1	1	0	0																																																																																																																																																																																																																												
1	1	1	1																																																																																																																																																																																																																												
A	B	C	Y																																																																																																																																																																																																																												
0	0	0	0																																																																																																																																																																																																																												
0	0	1	1																																																																																																																																																																																																																												
0	1	0	1																																																																																																																																																																																																																												
0	1	1	1																																																																																																																																																																																																																												
1	0	0	1																																																																																																																																																																																																																												
1	0	1	1																																																																																																																																																																																																																												
1	1	0	1																																																																																																																																																																																																																												
1	1	1	1																																																																																																																																																																																																																												
A	B	C	Y																																																																																																																																																																																																																												
0	0	0	1																																																																																																																																																																																																																												
0	0	1	1																																																																																																																																																																																																																												
0	1	0	1																																																																																																																																																																																																																												
0	1	1	1																																																																																																																																																																																																																												
1	0	0	1																																																																																																																																																																																																																												
1	0	1	1																																																																																																																																																																																																																												
1	1	0	1																																																																																																																																																																																																																												
1	1	1	0																																																																																																																																																																																																																												
A	B	C	Y																																																																																																																																																																																																																												
0	0	0	1																																																																																																																																																																																																																												
0	0	1	0																																																																																																																																																																																																																												
0	1	0	0																																																																																																																																																																																																																												
0	1	1	0																																																																																																																																																																																																																												
1	0	0	0																																																																																																																																																																																																																												
1	0	1	0																																																																																																																																																																																																																												
1	1	0	0																																																																																																																																																																																																																												
1	1	1	0																																																																																																																																																																																																																												
A	B	C	Y																																																																																																																																																																																																																												
0	0	0	0																																																																																																																																																																																																																												
0	0	1	1																																																																																																																																																																																																																												
0	1	0	1																																																																																																																																																																																																																												
0	1	1	0																																																																																																																																																																																																																												
1	0	0	1																																																																																																																																																																																																																												
1	0	1	0																																																																																																																																																																																																																												
1	1	0	0																																																																																																																																																																																																																												
1	1	1	1																																																																																																																																																																																																																												
A	B	C	Y																																																																																																																																																																																																																												
0	0	0	1																																																																																																																																																																																																																												
0	0	1	0																																																																																																																																																																																																																												
0	1	0	0																																																																																																																																																																																																																												
0	1	1	1																																																																																																																																																																																																																												
1	0	0	0																																																																																																																																																																																																																												
1	0	1	1																																																																																																																																																																																																																												
1	1	0	1																																																																																																																																																																																																																												
1	1	1	0																																																																																																																																																																																																																												

Theorems of Boolean Algebra				
Commutative	Double Inversion	AND	OR	XOR
$x + y = y + x$	$\bar{\bar{x}} = x$	$x \times 0 = 0$	$x + 0 = x$	$x \oplus 0 = x$
$x \times y = y \times x$	DeMorgan	$x \times 1 = x$	$x + 1 = 1$	$x \oplus 1 = \bar{x}$
Associative	$\overline{xy} = \bar{x} + \bar{y}$	$x \times x = x$	$x + x = x$	$x \oplus x = 0$
$x + (y + z) = (x + y) + z$	$\overline{x + y} = \bar{x} \bar{y}$	$x \times \bar{x} = 0$	$x + \bar{x} = 1$	$x \oplus \bar{x} = 1$
$x(yz) = (xy)z$	Other Multivariable			
Distributive	$x + xy = x$			
$x(y + z) = xy + xz$	$(x + y)(x + z) = x + yz$			
$(x + y)(w + z) = xw + xz + yw + yz$	$\overline{x + \bar{y}} = x + y$			

Karnaugh Map (K-Map)										
Two Variable		Three Variable			Four Variable					
B	\bar{B}	B	C/CD		\bar{C}	C	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
A	0	1	AB	0	1	00	01	11	10	
\bar{A}	0		$\bar{A}\bar{B}$	00						
A	1		$\bar{A}B$	01						
			AB	11						
			$\bar{A}\bar{B}$	10						