5 0 . Testing of digital circuits : S Ś >> 2 approaches for lesting a. Functional lesting exhaustive lesting ۵-0 b. Structural testing " non- exhoustive testing" 8 an exhoustive testing with "I GHz" speed of testing cpu, S tor example 3 if the circuit has 32 inputs: 3 232 4 4 10 9 then we need "4 sec" G Combination, or test vector, or lest patterns 9 3 3 ** IF the circuit has 64 input 3 264 lest vector = 585 year, using IGHE speed $(1 GH_{z} = 10^{9})$ ٠ **3**) 3 * Basic testing procedure : -- Applay test input to the input of the circuit -3 - Observe the output as compare then with expected values -3 -3) 37 10,00 OUAD CAMERA -

Ex: Half Adder Vac A B Jum Carry A Sum 0 0 0 B ... 0 ٥ a 0 Carry 1 1 1 => Assume the sum is short circuited with Vcc A B Jum Carry and the later 0 D The Pa in 0 1 0 IF A&B of or 10 has no effect, we should use I or oo ** the there all a Carry/ Vcc -> A B Sum/Nec > A B C C 0 1 1 1 C ()) REPHIRONESS 0 - CO-ATTOINADTOATAIERT

3 3 Q Gurry IG > A Sum/G A 6 0 0___ 1 . 3 we should choose: 9 1. 11, 'Sum/Va, Carry/6" * 11,01, 4/4 2. 01. " Sum 1 G. Carry / Vac" Foult modeling: 2 most common is the signal stuck at foults 1. Nod is short circuited with Vice " 3-a-1. Sat" 2. Nod is short circuited with ground, "s-a-o, sao" B i i . Path sensitization method (2. Value logic): procedure > 9 For each nod in the circuits a. Backtrace phate: drive the nod to the non. Poult Condition b. Propagation phase : Steave the contant of the pode to an 0 5 output where we can compare. = = 012/12/01

Example: D ß -E C > To test nod D: 65 * Assume D is 3- a- 0 a. Backtrace: put 1 on mod D AB II Scult œ. . . O : not foult b. Propagation: C. L ABC III IF E.O > Foully F F I as not Foully the i was set of loss put some * Assume D 13 3-a-1 a. Bucktrace: pul 0 on nod D AB. 00, 01, 10 b Brongalian : C.1 CO AL QUAD GAMERA

22				
2	-> ABC	if E.O., Foully	r 1	100
1				
6666	Foult	Test Vector ABC	Foult Free	Foulty
-	A-501	011	0	I.
3	B. 201	101	0	1
	C- 341	110	0	1
	D-Jul	001, 011, 101	0	1
	E-Jal	000, 001, 100, 011, 101, 110, 010	0	1
	A-340	111	1	0
	B-300	- 111	1	0
-	C- 340	11.1	1	0
-	D-Ju0	11.1	1	0
	E-300	111	1	0
-	+ 4 - 1	Est yedor 11, 01, 101, 110 (100x).		
-				
Ľ	· Exam	ple :		
5		A w		
	B	F		
C				
		S E E		
		NOTE 95 ND GAMERA		

		Ð
		Ĵ
a Backlauce : Assume B JaL	u=	6
> put 0 on B - 0; if no foully		S S
1 : 11 foully		5
A=1, Z.O ~ y.I, BC II		5
Bel	0.0	5
: Contradiction	1.27	
the second se	. (
Provide a set in la subort F	1.5	
Propagate: nod w to output F		J
		1. J
0		
TT I I I I I I I I I I I I I I I I I I		
	_ 1	
Wood all we de la	Lov .	
		and the Cl
and the second sec		

3 S S * D Algorithm (5- Value logic) S- Values - 1)- 1 : Normal logic 1 2). 0: Normal logic 0 3). X : Unknown 4). D: represent "1" uncler foult "3" condition, and o under foully Condition. 3-5). D: represent logic "o" under foult "3" Condition and "1" 2 under Poully condition. 3 + Example : 3 ADD 11) D B 3 ٤. с -3 D C 3 . Test A Jal > 3-3 puto in A (A, D) ABC IF FO No Poult -F =1 South 0 1 0 3 אייבאווואווואווואווואוווא A QUAD GAMERA

1. Inver	(Not)	Z	Ā)+L-11	1 I.m	Sec. 1.	1. 11	9
A	7							l		2	
00	1							n _e st	.U	14 - 11	
3. Sug	0 0	hline	<u> </u>	11,00	10	ta te				7.1	
0											-
x	x		lund	146	a de la	5	1-1-	le u	-	1	
	D . Z :										
	Z :										
						ā					
	, Z :	A.B		X X	D	ō ō					
	E I O	A.B 1	0 0	X X O	D D 0						
	Z: B I	A.B 1 0 X	0	X X O X	D D O X	D D X					
	B I O X D	A.B 1 0 X D	0 0	X X O	D D X D						
	A B I O X	A.B 1 0 X	0 0 0	X X O X	D D O X	D D X					
	B I O X D	A.B 1 0 X D	0 0 0 0	X X O X X	D D X D						

							· · · · · ·	
	(458)	S.L. Y	ħ.		7 = pEl altar	a anti-
9	BA	D	١	x	a	ā		
	D	0 11		×	D	ā	n	a ar su
3) 	1	١	2 1	I.	19	-T.		c lar
)	×	×	1	×	X	X		1. 1
)	D	D	1	X	a	1		
	ā	D	1	x	1.	a	1.5 525	1 1
	1	7						
+ Francis			6.1					
* Example								and an and a start of the
A		_)-	x	to u	,		
					Ľ.			
<u> </u>						-	D	
		-	$\mathbf{)}$	Ч	Z			
C						-1		
To test								
- put 0 or							6.27	11 LIST
. Use balk	(B	XWF)	, di-	1-1-1			I Hep
Asl	1.1	5	•	W =	D	Å.	1	L. E.F.
propagale	. Pro	m u	_to	7_	2.0	2 .	0 - y=1	1 - A
then BC								
Custinudi	alice.	on	the	Valu	e of	B	· Lucio	Al response
, SO A QUAD	GAME	RA						

- Use path ByZF : will faild (symmetry). Try path BxwF and ByZF together put o on B B B D All X D WOD S T.D. C=1 , y. D , w D + test vector ABC = 101 : 18 Fils no foult Feo - Poult * Example : - F 50 Z 4 6 C "Test B Jao , path BXF and ByZF together put 1 on B B.D All X.D F. F. BL, "Fals" $C = 1 \rightarrow y = D \rightarrow Z = D$ O pister al Ç I DUAD GAMIERA 0

D. Try path BxF:	
Dut Loo B . A.D	
$A \rightarrow A \rightarrow X \cdot D$	list a
a to propagale from nod x to output F	
\overrightarrow{BC} , \overrightarrow{Z} , \overrightarrow{Q} , \overrightarrow{Q} , \overrightarrow{BC} , \overrightarrow{H}	
" Contratichers Dally Paul	1
	and A
Try path Byzr:	7. 13
$Put 1 \text{ on } G \rightarrow G_{=}D$	
$C \longrightarrow y \cdot D \longrightarrow \overline{z} \cdot \overline{D} \longrightarrow [\overline{\Gamma} \cdot \overline{D}]$	
propagale from nod Z to output F X=0	
AB. 00, 01, 10 -> AB.01	N 10
Test vedor ABC 011	0

				200
				The second
+	Fault	Collapsing :	pl.	
			19.5	-
		icep1_i		-
1).	Toull	equivelance		-
_		a logities of a long with stopped is		-
0			1	-
	A B	-c		
	6			· L
->	A Jac	B 300 = C 300		L
	AB . 11	AB = II		-1
			1 1 1	
				G
b.	A			
	ß		Arg. 1	-
	0	B Da D = Cout 10 10	ng 104	
	<u> 11 - 29</u>			
	11	U 00		
<u> </u>	n	D_G		
	B			
L	A 50	$B \equiv B = C = C = C$		
		00 00		
-	0D			1
d				
	B	3-6		E
-	0			E
	AJal	B 3a1 = C 3a0		
Č	SO 110	NAME OF A TELET		2
			1	1

B e A A Dag = B Jul A 301 = B 300 2). Foult dominance Fi 13 side to dominule F2 if the test vector for Fa are subset of the test vector of Fi - C B B 50 1 B : C Jal dominat AJal dominal B. Jal - C 5 0 Band A 500 1 V 340 AB AB R B 0 | 10 01 ,10 (BUISCA: 3)

Example : 50 31 3031 30 31 3631 50 31 5031 2021 30 31 5051 3031 5.51 3051 30.31 (fr 5051 3031 . 6 1). Exchustive lest C 8 input 28 256 test vector **6**-2). Using foult model , 15 nod + 2 30 --2 mux 30 test vedor 3). Use foult collepsing max 15 JONSTEDNITY OF HER PAR CO AI QUAD CAMERA

* Boolean Difference 3 X. 2 Xb - 7 XE dz P(Xi=0) @ P(Xi=1) dxi 24 Untra a Z If Jensilive to Xi when dz =1 В E A When E is sensilive to A E = P(A,B,C) = A.B.CJA P (A. O) @ P (A. I) . 0 @ B.C - B.C E 13 Sensitive to A when dE = 1 (BC-1) BC = 11. ()(0) REPLICENCES (L. A) ALOUAD GAMERI 14 (15) A 1/5 11

	S
To lest Xi Jao	
X. dz =1	
To lest Xi Jak	
$(x_i)' \cdot \frac{dz}{dx_i} = 1$	S. S.
dXi	J.
· A . 30 (A) 301	
$A = \frac{\partial E}{\partial A} = 1$ $(A') = \frac{\partial E}{\partial A} = 1$	
$\frac{\partial A}{\partial B} = 1$ (BC) = 1	J.
ABC = III ABC = OII	
	۲
* Example :	
A B	
B	
B'	
10	
> To test nod B	
E sensitive to B when AC. 01	L.
$\rightarrow E = E (A + B) \cdot C T'$	C
$\partial E = F(B=0) \oplus F(B=1)$	(
(C').	t

	and the second sec	
-		
-		
0	i i i i i i i i i i i i i i i i i i i	
	A B (A.C)' - C' dE	1 I T
0		
	0	
-	0 1 0 1 0	
-		
-		
-		A
5		
-	E somestive to B where dE 1 AC=01	
-	A C (A.C)' C' (A.C)' O C'	
3	0 0 1 1 0	
-		
5	0 1 0 1	
1		
3	0 0	
3		
3		
-	E Jensilive to B when dE = 1 dB	1.10
3	AC-01	A State
-	(A.C)' @ C' = (A.C)'. C + (A.C)C'	
-	(A.c)', C	
3	= (A' + C'), C	
3_	= A'C = C'X°	
3	A'C = 1 " AC . 01" >	
-		
3	CO REDITI NOTE 98	0.1
3)0	D-AHOUADHGAMIERA	
-		

	A CONTRACTOR OF	
Test B 300	Test B sal	1
B. dE = 1 dB		
dB B. A'C : I	ABC = 001	
ABC - 011		
	1 0	
+ Example		
	the state of the state	
A		3 A 4
ß	F	
5		1
C		
* To test nod B		
	the state of the s	
		al al an
9 B	F(B=1)	
A O C		
->		
F 13 Senselive	to B where dF = 1 > A.O.C.	-
· A.C		
0_1_	The second secon	
1_0		
		_
CO ALQUAD GAMERA		
STUDENTS-HUB.com		Hamdan

B 30.0 B 301 B. (AOC) ... B'. (AOC) ... ABCABC 0 1 1 0 0 1 1.1.0 + To lest nod x T. X. B.C dF. F(X.0) @ F(X.1) d x B.C @ 1 = (BC)' F 13 sensitive to x when (BC) = 1 BC 00, 01, 10 1 (AB') (BC) = 1 1.1 1 A B C AD' (BC)' (AB'). (BC)' 10 0 0 0 1 18 0 10 0 3 0 0 1 0 7 0 0 0 0 1 0 0 1 1 0 1 1 1 1 0 0 1 15 10 0 AL QUAD GAMERA O 0 0

A B C .. 100, 101 the Distance of the OR: (AB), (BC)' $\frac{2}{3}$ AB' (B'+ c') 0.0' + 0.0'C' - AG' (1,C) $AB' \stackrel{?}{=} 1$ AB 10, " C X " Dont cure" ABC = 100 - ABC = 101 -* Example : - I Fooding F. X. Section . . JE FLX=DI @ F(X=1) 0-and the second second * Example : ()_____F . F= x. x' = 0 $dF = F(X,0) \oplus F(X,1)$ = 0 @ 0 . 0, imposible AI QUAD CAMIER

" Unlestable Toults · Completely untestable nods · Partially unlestable nods A). Completty unlestable foults × х C ø 9 1 0 1 , nod x is combletely unstable 7 7 7 Sao unlestable X Jal untestable X 2). X. C. X = 0 3 dw o not sensitive -3 B). Partially unlestable Poults -× .3 -3 -- 5 Cell/ Velloy VV

E AB B X 3-a-1 a. Backlace, AB, X.D 0 0 1011 6 cll 1 14.1 no all' 6 10 Contradiction b. propagation > B. OK > lest vector : 6 A B 0 6 1 0 U 6 -3-a-D. * X X D -- "Backfrace" . A B n file la 1 1 Contradiction - propagation" B.01 " No test vedor : untestable O ROULLOLS

444466666 ** Example : Boolean difference E. AB. B EXAB $\frac{\partial E}{\partial x} = P(x=0) \oplus P(x=1)$ BOL B' E is sensitive to x when B'al B.O 2 X3-a-0 X Jal 7 7 7 $\frac{dx}{dx}$ $\frac{dx}{dx}$ $\frac{dx}{dx}$ $\frac{dx}{dx}$ $A \cdot B = B' = 1$ (A, B)', B' = 1 $0 \quad \cancel{1} \quad (B' + B') \cdot B' \stackrel{\cancel{2}}{=} 1$ Ś Ś " untestable B'B' B' B' (1+A') 3 - B' Test vector B'al 3 B ... o ġ. 3 AB × 0 00 -Dent Core 10 3 3 -COO. REDNINOTE 75 CO-AN-ANADIGAMIERA