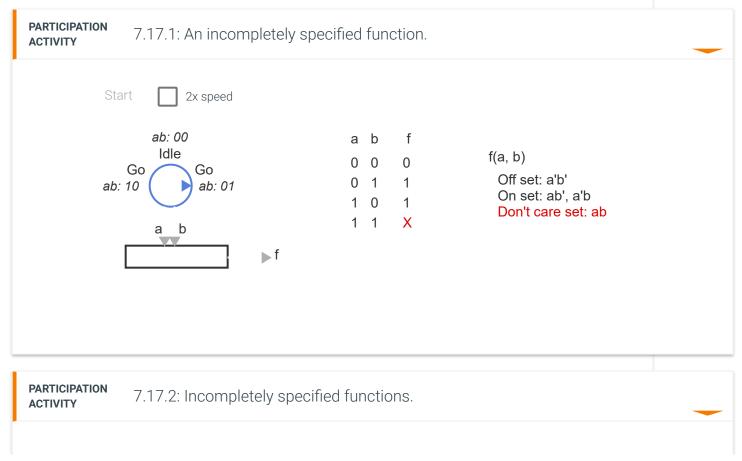# 7.17 Don't cares

Incompletely specified functions

An **incompletely specified function** does not define output values for every input combination. Ex: A 3-position knob may s 01, or 10. Combination 11 is not possible and thus f is not specified for that combination.

All possible minterms of a function can be divided into an **on set** (function is 1), **off set** (function is 0), and **don't care set** (function specified). In a truth table or on a K-map, don't cares are drawn with an X.
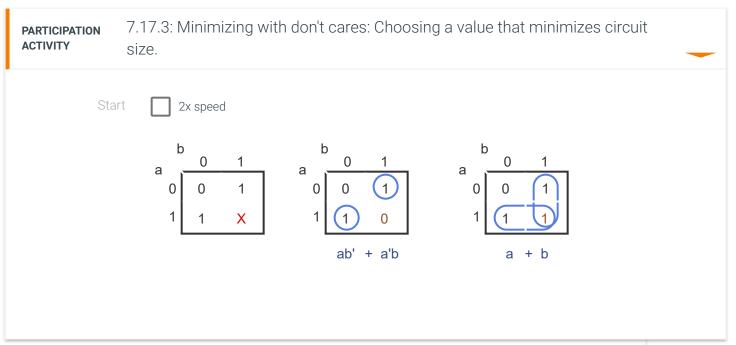
PARTICIPATION ACTIVITY	7.17.1: An incompletely specified function.

Start ☐ 2x speed

ab: 00
Idle
Go   Go
ab: 10   ab: 01

a   b

▶ f

a	b	f
0	0	0
0	1	1
1	0	1
1	1	X

f(a, b)

Off set: a'b'
On set: ab', a'b
Don't care set: ab

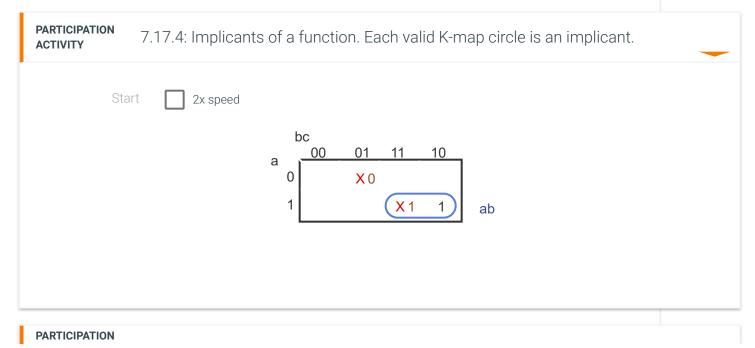| PARTICIPATION ACTIVITY	7.17.2: Incompletely specified functions.

Indicate whether the function f having inputs a, b is completely specified.

1) f is 1 for a'b', 1 for a'b, 1 for ab', and 0 for ab.

   ○ Complete

   ○ Incomplete

2) f is 1 for a'b', and 0 otherwise.

   ○ Complete

   ○ Incomplete

3) f is 1 for a'b', and for ab.

   ○ Complete

   ○ Incomplete

4) f is 1 for a'b', 1 for a'b, and 0 for ab'.

   ○ Complete

   ○ Incomplete

5) For a'b', f is 1. For ab, the output value doesn't matter. All other combinations output 0.

   ○ Complete

   ○ Incomplete

Minimizing with don't cares

Due to the nature of digital circuits, a circuit will output either 0 or 1 for every input value combination. Thus, even for an inc specified function, a designer must still choose whether to output 0 or 1 for each don't care input value combination. Comr make a choice that allows for greatest circuit minimization.

PARTICIPATION ACTIVITY   7.17.3: Minimizing with don't cares: Choosing a value that minimizes circuit size.

Start   ☐ 2x speed

	b	
a	0	1
0	0	1
1	1	X

	b	
a	0	1
0	0	(1)
1	(1)	0

ab' + a'b

	b	
a	0	1
0	0	1
1	1	1

a + b

A designer can decide whether to set a don't care output value X to 0 or 1 when drawing circles. If setting to a 1 allows for a then 1 is a better choice, leading to fewer literals in a term. Otherwise, setting to 0 is a better choice, leading to fewer terms

PARTICIPATION ACTIVITY   7.17.4: Implicants of a function. Each valid K-map circle is an implicant.

Start   ☐ 2x speed

	bc			
a	00	01	11	10
0		X 0		
1			X 1 1	

ab

PARTICIPATION

7.17.5: Minimizing with don't care minterms.

ACTIVITY

Indicate whether each X should be chosen to output 0 or 1.

i \ jk	00	01	11	10
0	0	0	Xa	1
1	0	Xb	1	1

i \ jk	00	01	11	10
0	0	Xc	1	0
1	0	Xd	1	0

1) Xa

    ○ 0

    ○ 1

2) Xb

    ○ 0

    ○ 1

3) Xc

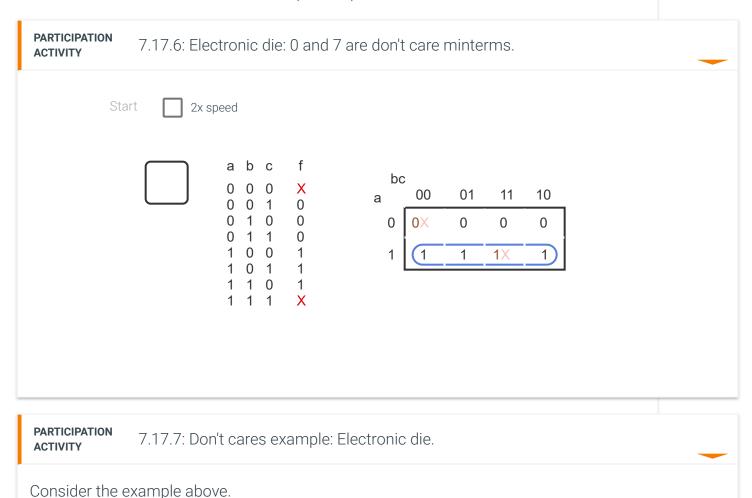   ○ 0

    ○ 1

4) Xd

    ○ 0

    ○ 1

Warning

Many designers recommend avoiding don't cares except in rare cases. Even though an input combination should never appear, the combination could possibly appear, even briefly—due to

electrical noise, due to glitches while switching, or during startup. If the output really does matter in that case, then a safe value should be chosen. Ex: For the earlier three-position knob example, if f = 1 turns on a device, then 11 is not really a don't care, because the device should not turn on. So f should be set to 0 for input 11, just in case a 11 accidentally appears.

Example: Electronic die

A die can display values 1-6. When rolled, a circuit lights an LED if a high-number is rolled, defined as 4-6. If the die's value i circuit in binary as 3 bits, then combinations 000 and 111 (0 and 7) can't occur. Thus, 000 and 111 are don't care values.

PARTICIPATION ACTIVITY   7.17.6: Electronic die: 0 and 7 are don't care minterms.

Start   ☐ 2x speed

a	b	c	f
0	0	0	X
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	X

a\bc	00	01	11	10
0	0X	0	0	0
1	1	1	1X	1

PARTICIPATION ACTIVITY   7.17.7: Don't cares example: Electronic die.

Consider the example above.

1) If the designer makes the X in cell 111 a 0, what is f after covering the 1's with circles?

- ○ ab'
- ○ ac
- ○ ab' + ac'

2) If the designer makes the X in cell 111 a 1, what is f after covering the 1's with circles?

- ○ a'
- ○ a
- ○ ab' + ab

3) If the designer makes the X in cell 000 a 1, what additional term would result?

- ○ b'c'
- ○ None

! **Provide feedback on this section**