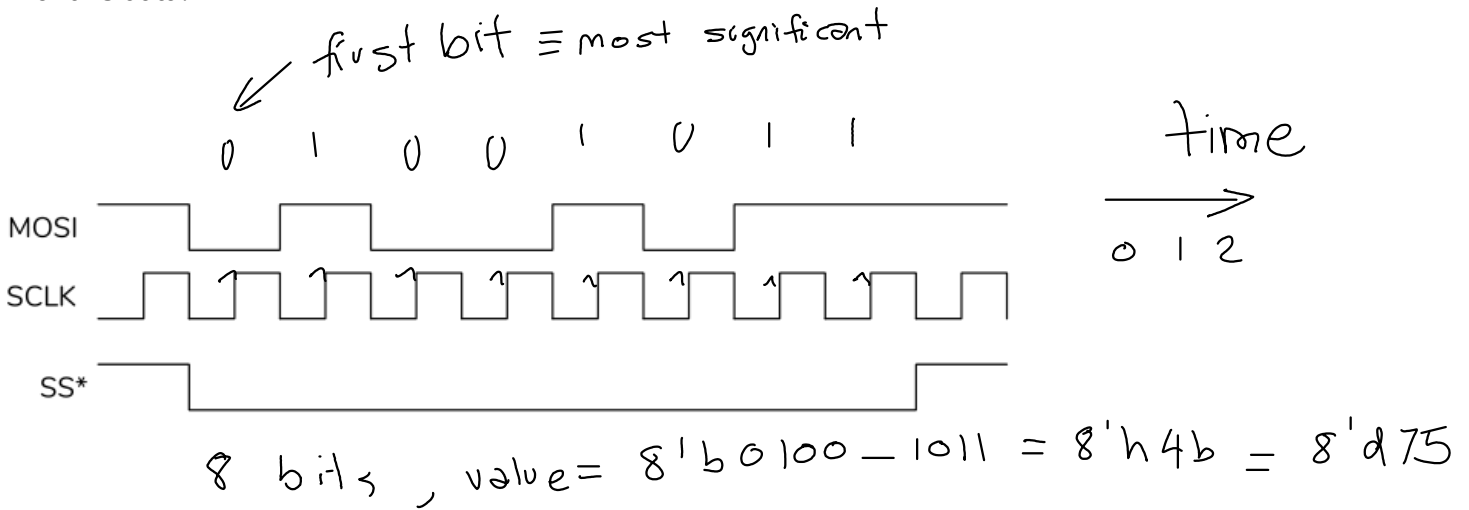
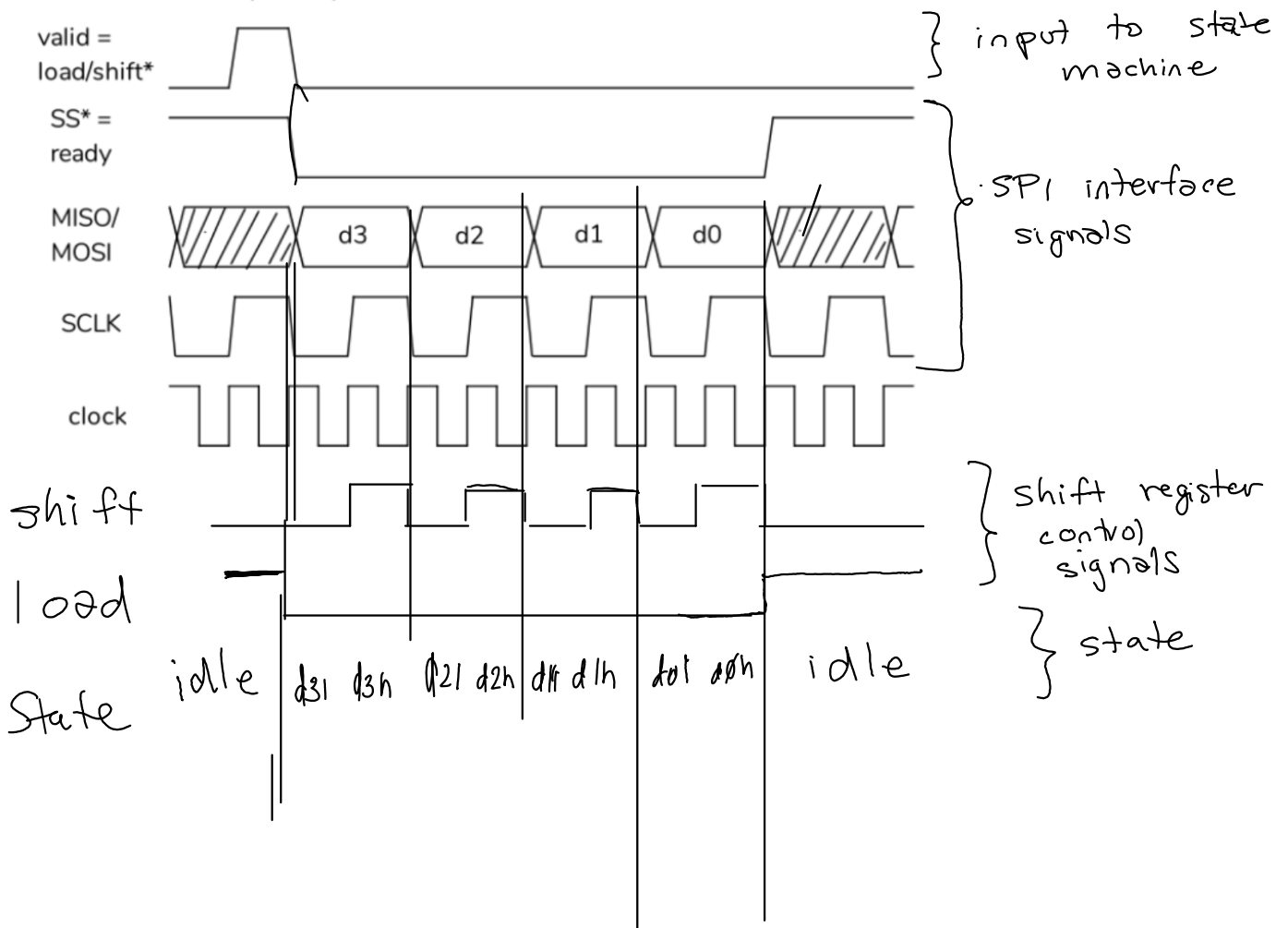


## Interfaces

**Exercise 1:** The diagram below shows a transfer over an SPI bus. How many bits of data are transferred and what is the decimal value of this data?



**Exercise 2:** Based on the diagram above, write a state transition table for an SPI interface controller that transfers four bits at a time. Include an idle state. In which states are SCLK and  $\overline{SS}$  asserted?



## state transition table

Current State	inputs valid	next state
idle	1	d3l
	0	idle
8 {	d3l	x
	d3h	x
	⋮	⋮
	d0h	x
		d3h d2l
		idle

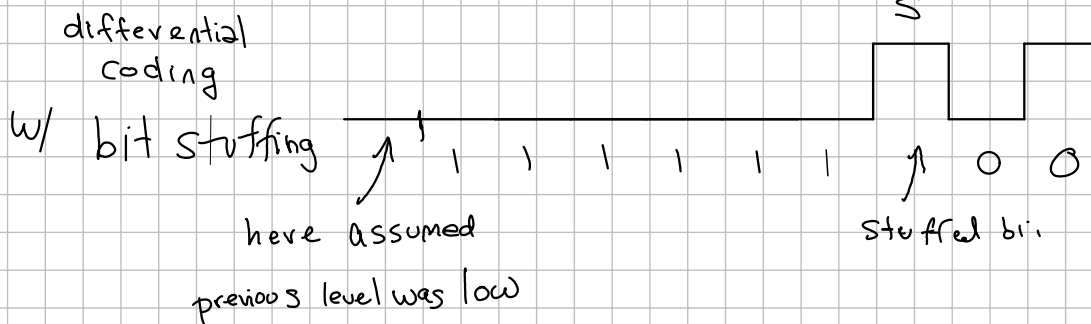
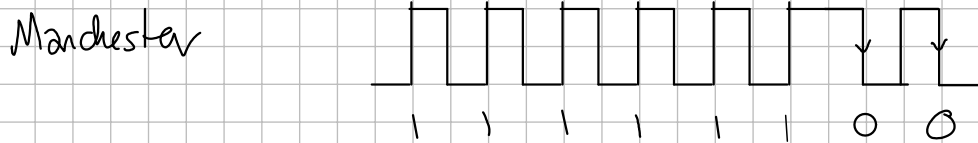
## outputs

State	sclk	ss	load	shift
idle	L	H	H	L
d3L	L	L	L	L
d3h	H	L	L	H
⋮	{ from diagram above                 }			

**Exercise 3:** Draw the RS-232, Manchester and USB 2 waveforms that would be transmitted for the byte value 8'h3f.

$$8'h\ 3f = 8'b\ 0011\ 1111$$

transmit least-significant bit first: 1 1 1 1 1 1 0 0



**Exercise 4:** The diagram above shows the voltages on a differential pair. The differential voltage is  $V_{\text{differential}} = D_+ - D_-$ . Draw the differential voltage waveform.

