BINARY SHIFTS

- In denary, what happens when a number is shifted to the left?
  - The value increase 10 times per shift position
  - Vice versa, if the number is shifted to the right, the value decrease 10 times
- Binary shift
  - Logical shift
  - An operation done on all the bits of a binary value in which they are moved by a specific number of places to either the left or right.
  - It is used in unsigned bit

Place values	10^3	10^2	10^1	10^0
	1000	100	10	1
Original number			1	3
Multiply by 10 – the digits are moved to the left and a 0 is added.		1	3	0

Place values	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	128	64	32	16	8	4	2	1
	0	0	0	1	0	1	0	0
Result of shift	0	1	0	1	0	0	0	0

Place values	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	128	64	32	16	8	4	2	1
	0	0	0	1	0	1	0	0
Result of shift	0	0	0	0	0	1	0	1

BINARY SHIFTS

- With the binary 00100 what would happen when:
  - Shift to the left 1 position
  - Shift to the left 2 positions
  - Shift to the left 3 positions
  - Shift to the right 1 position
  - Shift to the right 2 positions
  - Shift to the right 3 positions

BINARY SHIFTS

- Arithmetic shift
  - It is used with signed binary number
  - Like logical shift but the MSB remains the same because it represents positive or negative number
- Caution!
  - Be careful losing most or least significant bit while shifting bit in both logical and arithmetic shifts.

Worked example

Calculate the product of –36 * 2

–36 in two's complement format is:

36	0	0	1	0	0	1	0	0
Flip	1	1	0	1	1	0	1	1
Add 1	1	1	0	1	1	1	0	0

Therefore –36 in two's complement format is 11011100.

If this is multiplied by 2 there should be one shift to the left with a 0 added at the right.

Leaving the MSB in place and shifting the others to the left will produce

10111000

This should be equal to –72 in two's complement notation.

We can see if this is correct by proving that 10111000 is the negative of 72 in two's complement.

–72	1	0	1	1	1	0	0	0
Flip	0	1	0	0	0	1	1	1
Add 1	0	1	0	0	1	0	0	0

01001000 in binary is equal to 72 in denary.

Worked example

Calculate –72 / 2^2. That is –72 divided by 4. The result should be –18.

–72 in two's complement format is 10111000 – we showed this in the previous worked example.

Performing two right arithmetic shifts and adding the MSB at the left will give

11101110

This should be –18 in two's complement notation.

We can test it as before.

–18	1	1	1	0	1	1	1	0
Flip	0	0	0	1	0	0	0	1
Add 1	0	0	0	1	0	0	1	0

The result is 00010010, which is equivalent to (1 * 16) + (1 * 2) = 18.

BINARY SHIFTS

- With the binary 10100 what would happen when:
  - Shift to the left 1 position
  - Shift to the left 2 positions
  - Shift to the right 1 position
  - Shift to the right 2 positions
  - Shift to the right 3 positions

MAXIMUM AND MINIMUM BINARY VALUES OF 8-BIT BINARY

	Place Value	sign bit	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Values
			64	32	16	8	4	2	1	
Sign bit system	Lowest	1	1	1	1	1	1	1	1	-127
	Highest	0	1	1	1	1	1	1	1	127
	Lowest positive	0	0	0	0	0	0	0	1	1
	Highest positive	1	1	1	1	1	1	1	1	127
	Lowest negative	1	1	1	1	1	1	1	1	-127
	highest negative	1	0	0	0	0	0	0	1	-1

	Place Value	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Values
		-128	64	32	16	8	4	2	1	
Two's complement system	Lowest	1	0	0	0	0	0	0	0	-128
	Highest	0	1	1	1	1	1	1	1	127
	Lowest positive	0	0	0	0	0	0	0	1	1
	Highest positive	0	1	1	1	1	1	1	1	127
	Lowest negative	1	0	0	0	0	0	0	0	-128
	highest negative	1	1	1	1	1	1	1	1	-1