L11 - Load and Store

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Load and Store

Data is stored in memory. It can be loaded and stored. Typically we'll have something like 4 GiB of memory. Loaded data can be stored in registers (32 bit)

Loading

32 Bit

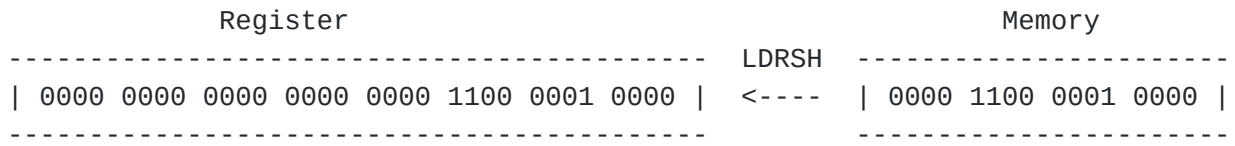
If a 32 bit number from memory is loaded into a register, the bits are just copied right over. This is done with `LDR` (load register). Because all bits are copied over as is, there is no need for padding.

16 Bit

For `uint16_t`, we load with `LDRH` (load half word). This zero-pads the number and copies it over. For `int16_t` it's a bit different. If the number is negative, then there should be `1` in the leftmost 16 bits. Copying over a 16 bit number with `LDRSH` will sign-extend (zero pad or one-pad, depending on the sign bit) the number so it's 32 bits.

```
For uint16_t (unsigned)
             Register                                    Memory
-----------------------------------------  LDRH   ----------------------
| 0000 0000 0000 0000 0000 1100 0001 0000 |  <----  | 0000 1100 0001 0000 |
-----------------------------------------         ----------------------

For int16_t (signed)
             Register                                    Memory
-----------------------------------------  LDRSH  ----------------------
| 1111 1111 1111 1111 1000 1100 0001 0000 |  <----  | 1000 1100 0001 0000 |
-----------------------------------------         ----------------------
```



8 Bit

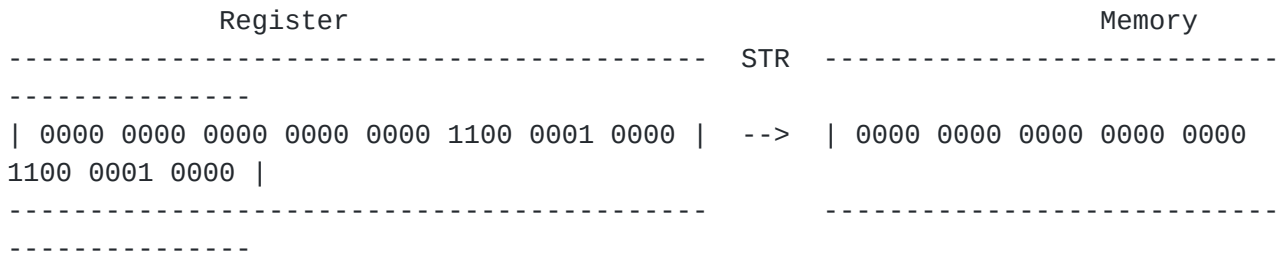
`uint8_t` and `int8_t` work the same way 16 bit numbers do, but it will pad with 24 bits instead of 16 (to get to 32). You load with `LDRB` (load register byte) and `LDRSB` (load register sign extend byte)

Storing

Storing works in much the same was as loading.

32 bit

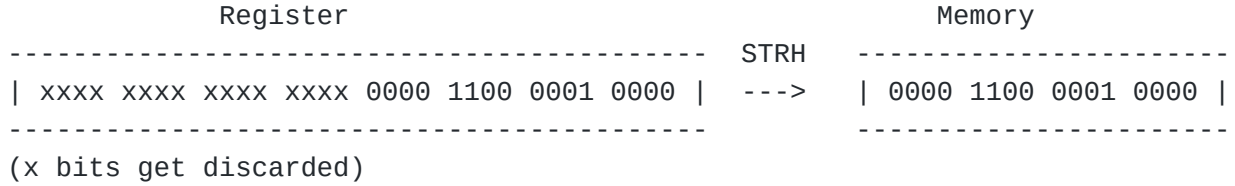
`STR` will store a 32 bit number in memory



There's no padding or loss of data.

16 bit

`STRH` will store a half word, discarding the upper bits.



8 Bit

`STRB` will store a byte

```
             Register                                    Memory
-----------------------------------------  STRB   -------------
| xxxx xxxx xxxx xxxx xxxx xxxx 0001 0000 |  --->  | 0001 0000 |
-----------------------------------------         -------------
(x bits get discarded)
```

How the Computer Stores things

Here's an example of `STR`, which equivalent `C` code

```
(assembly psuedocode)
R0 = 0x12345678
// This is the memory address of the first byte of a 32 bit number
R1 = 0x2000 0000
// We want to STR that number into R0

// This means "put the contents of R0 into the memory location of R1"
STR R0, [R1]
```

Here's that same thing in `C`

```
uint32_t x = 0x12345678;
uint32_t *p = 0x20000000;
*p = x;
```

Endianess

Big Endian

This will store the number like so

```
0x12 -> [0x2000 0000] (MSB)
0x34 -> [0x2000 0001]
0x56 -> [0x2000 0002]
0x78 -> [0x2000 0003] (LSB)
```

This is called **big endian** convention, where the big part, or most significant bit (MSB) goes at the lowest address. In this case, `0x12` (MSB) went to the lower address `0x2000 0000`.

Little Endian

This is the opposite of big endian, where the LSB is stored at the lowest address.

STRH

`STRH` will store half a word. The most significant half gets discarded ~~(that's what Losh said, but the example he wrote showed the least significant half being discarded)~~ (he corrected this, its the most significant bytes that get discarded).

```
R0 = 0x12345678
R1 = 0x2000 0000
STR R0, [R1]
// Store R0 -> [R1]

For Big Endian
    0x56 -> [0x2000 0000]
    0x78 -> [0x2000 0001]

For Little Endian
    0x78 -> [0x2000 0000]
    0x56 -> [0x2000 0001]
```

STRB

`STRB` stores a byte

```
R0 = 0x12345678
R1 = 0x2000 0000
STR R0, [R1]
```

```
0x78 -> [0x2000 0000]
```