Memory Organisation of 8051 (Memory Mapping)

8051 operates on 4 different memories :-

* Internal ROM
* Internal RAM
* External ROM
* External RAM

Being based on harvard model, 8051 stores programs & data in separate memory spaces. Programs are stored in ROM, whereas data is stored in RAM.

⇒ Microcontrollers are used in day to day appliances like microwave oven, remote controllers and washing machines etc. All these devices have inbuilt programs. These programs are generally permanent and very rarely need to be modified. Also, these programs must be retained even after the device is completely switched off. Hence programs are stored in permanent (non-volatile) memory like ROM.

⇒ Data on the otherhand is continuously changed at runtime.

for eg: In micro wave oven, we have different modes of cooking, such as

such as, convection, Grill, Autocook etc, The Programming to run these modes has already been done & Programs are stored in ROM. Whereas, cooking time, and temperature etc reqd. is different for different foods which we usually give after selecting the mode. This input is nothing but the data. Such data is not permanent in nature and will be different every time we use the device. Such type of data is stored in writeable memory like RAM.

Note:- Sometimes, there is a permanent data, such as ASCII codes or 7-segment display codes, which is also stored in ROM (we will discuss it in detail when required)

Let us study ROM first :

ROM / Code Memory / Program memory Organization :

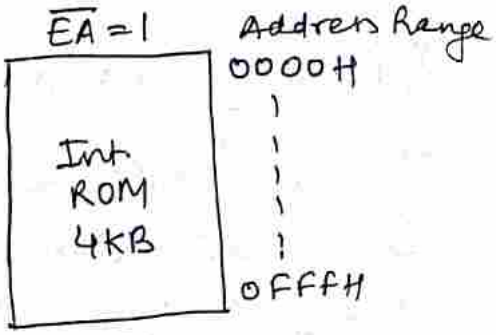
We have two types of ROM : internal ROM & external ROM. These memories can accessed by the programmer in three different ways. (choice is given to programmer)

1) Only Internal ROM :-

$4KB = 2^2 KB = 2^2 2^{10}$ Byte
$= 2^{12}$ Bytes

0000H 0000 0000 0000 0000
⋮
FFFFH 0000 1111 1111 1111

(∴ address range is 0000H — 0FFFH)

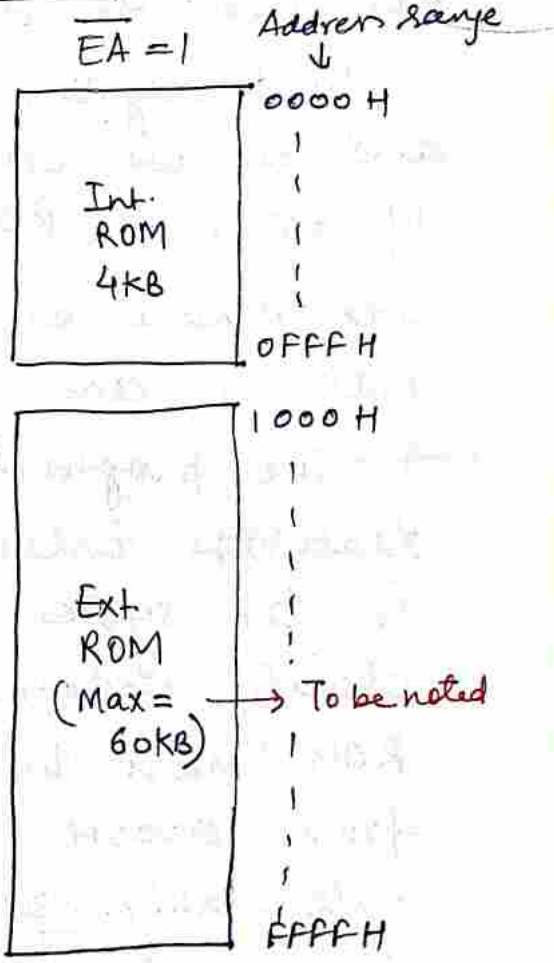


- Any address in this range is valid and out of this range is invalid.
- In many cases, this size is sufficient and there is no need for connecting external ROM.
- In such systems $\overline{EA}$ will be "1" as internal ROM is being used.

2) Internal & External ROM :-

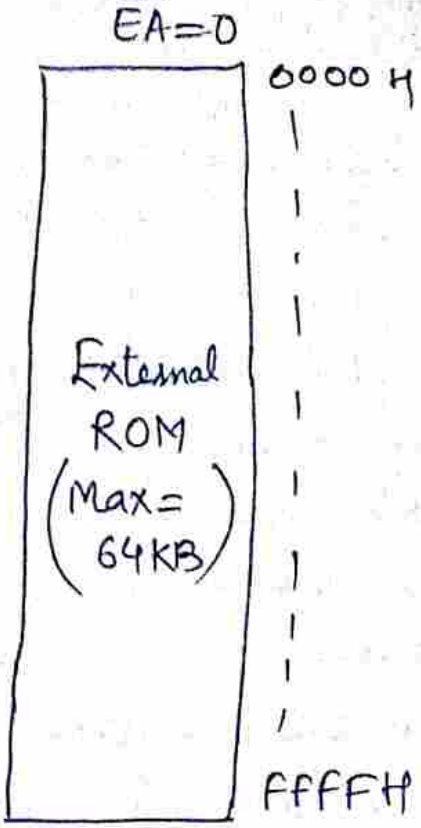
Such systems uses a combination of internal ROM and External ROM. The total ROM that can be accessed is 64 KB. Since we are using the internal ROM of 4KB, the max. amount of Ext. ROM that can be connected is 60KB.

All addresses from 0000H --- 0FFFH will be accessed from internal ROM & from 1000H to FFFFH will be accessed from external ROM. $\overline{EA}$ will also be "1" as internal ROM is being used.



V. Imp (4)

3) Only External ROM:



Though 8051 has 4KB of internal ROM, the user may choose to discard it and connect only external ROM. This may happen due to several seasons, for eg: The programs stored in the internal ROM may have become invalid or out-dated, or the system need to be upgraded etc, there comes the need to discard the internal ROM.

Such system use only external ROM, and we can connect up to 64 KB of external ROM.

All addresses from 0000H --- FFFFH will be accessed from external ROM.

→ The programmer must keep it mind, that the internal ROM is still present in the system (8051), he/she need to clearly indicate to 8051 that the internal ROM must be ignored & every address from 0000H ---- FFFFH must be accessed externally. This is done by using $\overline{EA}$. By making $\overline{EA}=0$, we inform 8051 that

the internal ROM must be discarded & all ROM must be accessed externally.

NOTE :-

8051 checks $\overline{EA}$ pin during every ROM operation where the addres is from 0000H ---- FFFFH.

If $\overline{EA}$ = 1, then location is accessed from Int. ROM.

If $\overline{EA}$ = 0, then Location is accessed from Ext. ROM.

⇒ If the addres is 1000H or more, 8051 does not check $\overline{EA}$ pin .... Why ?

Think about it.....

Let us Discuss RAM now :-

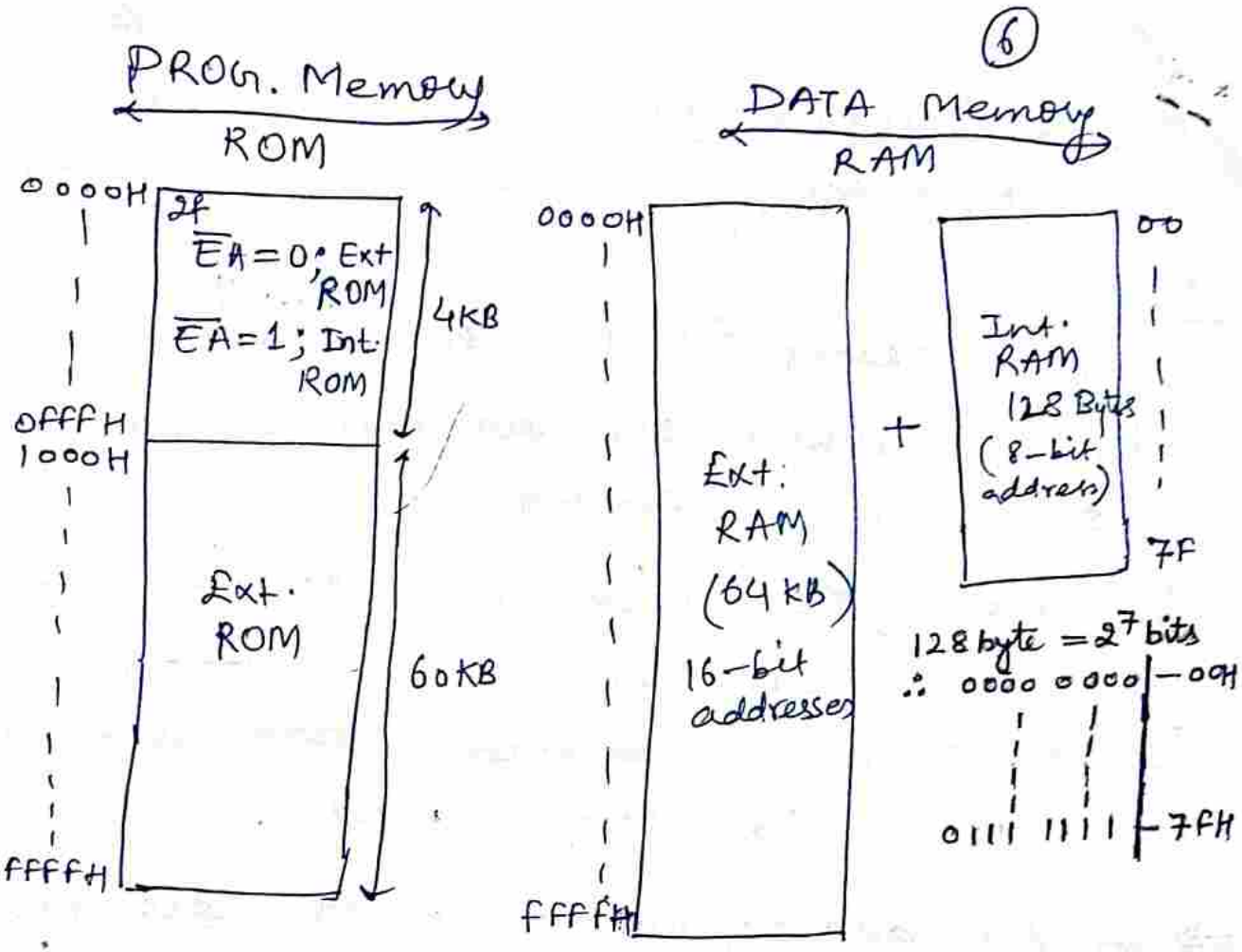
Before going into the details of RAM, Let's see the difference between the organizaton of ROM & RAM.

V. Imp Note :. Prog Memory (ROM)

Total = Int + Ext = 64 KB.

Data Memory (RAM)

Total = Int (128 B) + Ext (64 KB)



V. Imp :-

Note : ① In ROM, Internal ROM occupies the space of Ext. ROM, only if, internal ROM is discarded, whole 64 KB of Ext. ROM will be used.

But this does not happen with RAM, Ext. RAM & Int. RAM does not occupy each other space, rather they both have their own space & can be used independently.

② Ext. RAM being 64 KB, uses 16-bit address ranging from 0000H to FFFFH, whereas Int. RAM is 128 Bytes, uses 8-bit addresses ranging from 00H to 7FH. So there is never a confusion between Ext. RAM & Int. RAM.

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