# Memory Layout of common PICCs

To read and write from MIFARE PICCs, the MIFARE protocol is used after the PICC has been selected.

## Datasheet References

The **MIFARE Classic** chips and protocol is described in the datasheets:

* 1K: <https://www.mouser.com/ds/2/302/MF1S503x-89574.pdf>
* 4K: <https://datasheet.octopart.com/MF1S7035DA4,118-NXP-Semiconductors-datasheet-11046188.pdf>
* Mini: <http://www.idcardmarket.com/download/mifare_S20_datasheet.pdf>

The **MIFARE Ultralight** chip and protocol is described in the datasheets:

* Ultralight: <https://www.nxp.com/documents/data_sheet/MF0ICU1.pdf>
* Ultralight C: <https://www.nxp.com/documents/short_data_sheet/MF0ICU2_SDS.pdf>

## MIFARE Classic 1K (MF1S503x)

Has 16 sectors4 blocks/sector16 bytes/block = 1024 bytes.

The blocks are numbered 0-63.

Block 3 in each sector is the Sector Trailer. See https://www.mouser.com/ds/2/302/MF1S503x-89574.pdf sections 8.6 and 8.7:

Bytes 0-5: Key A

Bytes 6-8: Access Bits

Bytes 9: User data

Bytes 10-15: Key B (or user data)

Block 0 is read-only manufacturer data.

To access a block, an authentication using a key from the block's sector must be performed first.

Example: To read from block 10, first authenticate using a key from sector 3 (blocks 8-11).

All keys are set to FFFFFFFFFFFFh at chip delivery.

Warning: Please read section 8.7 "Memory Access". It includes this text: if the PICC detects a format violation the whole sector is irreversibly blocked.

To use a block in "value block" mode (for Increment/Decrement operations) you need to change the sector trailer. Use PICC\_SetAccessBits() to calculate the bit patterns.

## MIFARE Classic 4K (MF1S703x):

Has (32 sectors4 blocks/sector + 8 sectors16 blocks/sector)16 bytes/block = 4096 bytes.

The blocks are numbered 0-255.

The last block in each sector is the Sector Trailer like above.

## MIFARE Classic Mini (MF1 IC S20):

Has 5 sectors4 blocks/sector16 bytes/block = 320 bytes.

The blocks are numbered 0-19.

The last block in each sector is the Sector Trailer like above.

## MIFARE Ultralight (MF0ICU1):

Has 16 pages of 4 bytes = 64 bytes.

Pages 0 + 1 is used for the 7-byte UID.

Page 2 contains the last check digit for the UID, one byte manufacturer internal data, and the lock bytes (see https://www.nxp.com/documents/data\_sheet/MF0ICU1.pdf section 8.5.2)

Page 3 is OTP, One Time Programmable bits. Once set to 1 they cannot revert to 0.

Pages 4-15 are read/write unless blocked by the lock bytes in page 2.

## MIFARE Ultralight C (MF0ICU2):

Has 48 pages of 4 bytes = 192 bytes.

Pages 0 + 1 is used for the 7-byte UID.

Page 2 contains the last check digit for the UID, one byte manufacturer internal data, and the lock bytes (see https://www.nxp.com/documents/data\_sheet/MF0ICU1.pdf section 8.5.2)

Page 3 is OTP, One Time Programmable bits. Once set to 1 they cannot revert to 0.

Pages 4-39 are read/write unless blocked by the lock bytes in page 2.

Page 40 Lock bytes

Page 41 16 bit one way counter

Pages 42-43 Authentication configuration

Pages 44-47 Authentication key