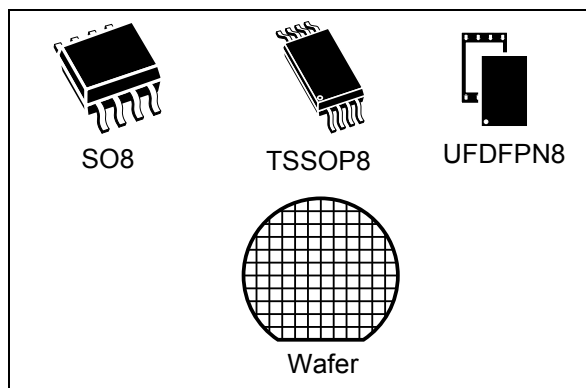


## Dynamic NFC/RFID tag IC with 2-Kbit EEPROM, NFC Forum Type 4 Tag and I<sup>2</sup>C interface

Datasheet - production data



### Package

- 8-lead small-outline package (SO8) ECOPACK2
- TSSOP8 ECOPACK2
- UDFPN8 ECOPACK2

### Digital pad

- GPO: configurable general purpose output
- RF disable: activation/deactivation of RF commands

### Temperature range

- From - 40 °C up to 85 °C

## Features

### I<sup>2</sup>C interface

- Two-wire I<sup>2</sup>C serial interface supports 1 MHz protocol
- Single supply voltage: 2.7 V to 5.5 V

### Contactless interface

- NFC Forum Type 4 Tag
- ISO/IEC 14443 Type A
- 106 Kbps data rate
- Internal tuning capacitance: 25 pF

### Memory

- 256-byte (2-kbit) EEPROM
- Support of NDEF data structure
- Data retention: 200 years
- Write endurance:
  - 1 million cycles at 25 °C
  - 600 k cycles at 85 °C
- Read: up to 246 bytes in a single command
- Write: up to 246 bytes in a single command
- 7-byte unique identifier (UID)
- 128-bit passwords protection

## Description

M24SR02-Y belongs to the ST25 family, which includes all STMicroelectronics NFC/RFID tag and reader products.

The M24SR02-Y device is a dynamic NFC/RFID tag IC with a dual interface embedding an EEPROM. It can be operated from an I<sup>2</sup>C interface or by a 13.56 MHz RFID reader or from an NFC phone.

The I<sup>2</sup>C interface uses a two-wire serial interface, consisting of a bidirectional data line and a clock line. It behaves as a slave in the I<sup>2</sup>C protocol.

The RF protocol is compatible with ISO/IEC 14443 Type A and NFC Forum Type 4 Tag.

# Contents

|          |                                                                          |           |
|----------|--------------------------------------------------------------------------|-----------|
| <b>1</b> | <b>Functional description</b>                                            | <b>9</b>  |
| 1.1      | Functional modes                                                         | 10        |
| 1.1.1    | I2C mode                                                                 | 10        |
| 1.1.2    | Tag mode                                                                 | 10        |
| 1.1.3    | Dual interface mode                                                      | 11        |
| <b>2</b> | <b>Description of signals</b>                                            | <b>12</b> |
| 2.1      | Serial clock (SCL)                                                       | 12        |
| 2.2      | Serial data (SDA)                                                        | 12        |
| 2.3      | Antenna coil (AC0, AC1)                                                  | 12        |
| 2.4      | Ground (VSS)                                                             | 12        |
| 2.5      | Supply voltage ( $V_{CC}$ )                                              | 12        |
| 2.5.1    | Operating supply voltage $V_{CC}$                                        | 12        |
| 2.5.2    | Power-up conditions                                                      | 13        |
| 2.5.3    | Device reset in I <sup>2</sup> C mode                                    | 13        |
| 2.5.4    | Power-down conditions                                                    | 13        |
| 2.6      | RF disable                                                               | 13        |
| 2.7      | General purpose output (GPO)                                             | 13        |
| 2.7.1    | Session Open configuration (GPO field = 0xX1 or 0x1X)                    | 14        |
| 2.7.2    | WIP Writing in Progress configuration (GPO field = 0xX2 or 0x2X)         | 15        |
| 2.7.3    | I <sup>2</sup> C answer ready configuration (GPO field = 0xX3)           | 16        |
| 2.7.4    | MIP NDEF Message writing in Progress configuration<br>(GPO field = 0x3X) | 17        |
| 2.7.5    | INT interrupt configuration (GPO field = 0xX4 or 0x4X)                   | 18        |
| 2.7.6    | State control configuration (GPO field = 0xX5 or 0x5X)                   | 19        |
| 2.7.7    | RF busy configuration (GPO field = 0x6X)                                 | 20        |
| <b>3</b> | <b>M24SR02-Y memory management</b>                                       | <b>21</b> |
| 3.1      | Memory structure                                                         | 21        |
| 3.1.1    | File identifier                                                          | 21        |
| 3.1.2    | CC file layout                                                           | 21        |
| 3.1.3    | NDEF file layout                                                         | 22        |
| 3.1.4    | System file layout                                                       | 23        |
| 3.2      | Read and write access rights to the memory                               | 25        |

|          |                                                                                       |           |
|----------|---------------------------------------------------------------------------------------|-----------|
| 3.2.1    | State of the Read and Write access rights .....                                       | 26        |
| 3.2.2    | Changing the read access right to NDEF files .....                                    | 27        |
| 3.2.3    | Changing the write access right to NDEF files .....                                   | 28        |
| 3.3      | Access right life time .....                                                          | 28        |
| 3.4      | NDEF file passwords .....                                                             | 28        |
| 3.5      | I2C password .....                                                                    | 29        |
| 3.5.1    | I <sup>2</sup> C password and I <sup>2</sup> C protect field of the System file ..... | 29        |
| <b>4</b> | <b>Communication mechanism .....</b>                                                  | <b>30</b> |
| 4.1      | Master and slave .....                                                                | 30        |
| 4.2      | M24SR02-Y session mechanism .....                                                     | 30        |
| 4.2.1    | RF token .....                                                                        | 30        |
| 4.2.2    | I <sup>2</sup> C token .....                                                          | 30        |
| <b>5</b> | <b>I<sup>2</sup>C and RF command sets .....</b>                                       | <b>31</b> |
| 5.1      | Structure of the command sets .....                                                   | 32        |
| 5.2      | I-Block format .....                                                                  | 32        |
| 5.2.1    | C-APDU: payload format of a command .....                                             | 33        |
| 5.2.2    | R-APDU: payload format of a response .....                                            | 33        |
| 5.3      | R-Block format .....                                                                  | 34        |
| 5.4      | S-Block format .....                                                                  | 35        |
| 5.5      | CRC of the I2C and RF frame .....                                                     | 36        |
| 5.6      | NFC Forum Type 4 Tag protocol .....                                                   | 37        |
| 5.6.1    | Command set .....                                                                     | 37        |
| 5.6.2    | Status and error codes .....                                                          | 37        |
| 5.6.3    | NDEF Tag Application Select command .....                                             | 38        |
| 5.6.4    | Capability Container Select command .....                                             | 38        |
| 5.6.5    | NDEF Select command .....                                                             | 39        |
| 5.6.6    | System File Select command .....                                                      | 40        |
| 5.6.7    | ReadBinary command .....                                                              | 41        |
| 5.6.8    | UpdateBinary command .....                                                            | 42        |
| 5.7      | ISO/IEC 7816-4 commands .....                                                         | 43        |
| 5.7.1    | Verify command .....                                                                  | 43        |
| 5.7.2    | Change Reference Data command .....                                                   | 44        |
| 5.7.3    | Enable Verification Requirement command .....                                         | 45        |
| 5.7.4    | Disable Verification Requirement command .....                                        | 46        |

|          |                                                                      |           |
|----------|----------------------------------------------------------------------|-----------|
| 5.8      | ST proprietary command set                                           | 47        |
| 5.8.1    | ExtendedReadBinary command                                           | 47        |
| 5.8.2    | EnablePermanentState command                                         | 48        |
| 5.8.3    | DisablePermanentState command                                        | 49        |
| 5.8.4    | UpdateFileType command                                               | 50        |
| 5.8.5    | SendInterrupt command                                                | 51        |
| 5.8.6    | StateControl command                                                 | 51        |
| 5.9      | Specific RF command set                                              | 52        |
| 5.9.1    | Anticollision command set                                            | 52        |
| 5.9.2    | RATS command and ATS response                                        | 52        |
| 5.9.3    | PPS command and response                                             | 54        |
| 5.10     | Specific I <sup>2</sup> C command set                                | 55        |
| 5.10.1   | GetI2Csession command                                                | 55        |
| 5.10.2   | KillRFsession command                                                | 55        |
| <b>6</b> | <b>RF device operation</b>                                           | <b>56</b> |
| 6.1      | Anticollision and Device activation command set for the RF interface | 56        |
| 6.2      | Open an RF session                                                   | 56        |
| 6.3      | Close an RF session                                                  | 56        |
| 6.4      | Applicative command set                                              | 56        |
| <b>7</b> | <b>I<sup>2</sup>C device operation</b>                               | <b>57</b> |
| 7.1      | I <sup>2</sup> C communication protocol                              | 57        |
| 7.2      | Start condition                                                      | 58        |
| 7.3      | Stop condition                                                       | 58        |
| 7.4      | I <sup>2</sup> C token release sequence                              | 58        |
| 7.5      | I <sup>2</sup> C timeout on clock period                             | 59        |
| 7.6      | Acknowledge bit (ACK)                                                | 59        |
| 7.7      | Data input                                                           | 59        |
| 7.8      | I <sup>2</sup> C device address                                      | 59        |
| 7.9      | I <sup>2</sup> C frame format                                        | 60        |
| 7.9.1    | Example of I <sup>2</sup> C frame commands                           | 60        |
| 7.10     | Open an I <sup>2</sup> C session                                     | 62        |
| 7.11     | Close the I <sup>2</sup> C session                                   | 62        |

|           |                                               |           |
|-----------|-----------------------------------------------|-----------|
| <b>8</b>  | <b>Functional procedures</b>                  | <b>63</b> |
| 8.1       | Selection of an NDEF message                  | 63        |
| 8.2       | Reading of an NDEF message                    | 63        |
| 8.3       | Reading a locked NDEF file                    | 63        |
| 8.4       | Locking an NDEF file                          | 64        |
| 8.5       | Unlocking an NDEF file                        | 64        |
| 8.6       | Reaching the read-only state for an NDEF file | 64        |
| 8.7       | Changing an NDEF password procedure           | 64        |
| 8.8       | Changing a File type Procedure                | 65        |
| 8.9       | Updating an NDEF file                         | 65        |
| <b>9</b>  | <b>UID: unique identifier</b>                 | <b>66</b> |
| <b>10</b> | <b>Maximum ratings</b>                        | <b>67</b> |
| <b>11</b> | <b>I2C DC and AC parameters</b>               | <b>68</b> |
| 11.1      | I2C timing measurement condition              | 73        |
| <b>12</b> | <b>GPO parameters</b>                         | <b>75</b> |
| <b>13</b> | <b>Write cycle definition</b>                 | <b>77</b> |
| <b>14</b> | <b>RF electrical parameters</b>               | <b>78</b> |
| <b>15</b> | <b>Package information</b>                    | <b>79</b> |
| 15.1      | SO8N package information                      | 79        |
| 15.2      | TSSOP8 package information                    | 81        |
| 15.3      | UFDFPN8 package information                   | 82        |
| <b>16</b> | <b>Ordering information</b>                   | <b>84</b> |
| <b>17</b> | <b>Revision history</b>                       | <b>85</b> |

## List of tables

|           |                                                                  |    |
|-----------|------------------------------------------------------------------|----|
| Table 1.  | Signal names . . . . .                                           | 10 |
| Table 2.  | Functional modes . . . . .                                       | 10 |
| Table 3.  | File identifier . . . . .                                        | 21 |
| Table 4.  | CC file layout for 1 NDEF file . . . . .                         | 22 |
| Table 5.  | NDEF file layout . . . . .                                       | 23 |
| Table 6.  | Field list. . . . .                                              | 23 |
| Table 7.  | Details about I2C watchdog . . . . .                             | 24 |
| Table 8.  | Details about the GPO field . . . . .                            | 24 |
| Table 9.  | Details about the RF session field . . . . .                     | 25 |
| Table 10. | Details about the ST reserved field. . . . .                     | 25 |
| Table 11. | Details about the RF enable field . . . . .                      | 25 |
| Table 12. | Read access right . . . . .                                      | 26 |
| Table 13. | Write access right . . . . .                                     | 26 |
| Table 14. | RF and I <sup>2</sup> C command sets . . . . .                   | 31 |
| Table 15. | I-Block format . . . . .                                         | 32 |
| Table 16. | PCB field of the I-Block format . . . . .                        | 33 |
| Table 17. | C-APDU format. . . . .                                           | 33 |
| Table 18. | R-APDU format. . . . .                                           | 34 |
| Table 19. | R-Block format . . . . .                                         | 34 |
| Table 20. | R-Block detailed format . . . . .                                | 35 |
| Table 21. | S-Block format . . . . .                                         | 35 |
| Table 22. | S-Block detailed format. . . . .                                 | 36 |
| Table 23. | Command set overview . . . . .                                   | 37 |
| Table 24. | Status code of the M24SR02-Y . . . . .                           | 37 |
| Table 25. | Error codes of the M24SR02-Y . . . . .                           | 37 |
| Table 26. | C-APDU of the NDEF Tag Application Select command . . . . .      | 38 |
| Table 27. | R-APDU of the NDEF Tag Application Select command . . . . .      | 38 |
| Table 28. | C-APDU of the Capability Container Select command. . . . .       | 39 |
| Table 29. | R-APDU of the Capability Container Select command. . . . .       | 39 |
| Table 30. | C-APDU of the NDEF Select command . . . . .                      | 40 |
| Table 31. | R-APDU of the NDEF Select command . . . . .                      | 40 |
| Table 32. | C-APDU of the System File Select command. . . . .                | 40 |
| Table 33. | R-APDU of the System File Select command. . . . .                | 41 |
| Table 34. | C-APDU of the ReadBinary command . . . . .                       | 41 |
| Table 35. | R-APDU of the ReadBinary command . . . . .                       | 41 |
| Table 36. | C-APDU of the UpdateBinary command . . . . .                     | 42 |
| Table 37. | R-APDU of the UpdateBinary command . . . . .                     | 42 |
| Table 38. | Verify command format. . . . .                                   | 43 |
| Table 39. | R-APDU of the Verify command . . . . .                           | 44 |
| Table 40. | Change reference data command format. . . . .                    | 44 |
| Table 41. | R-APDU of the Change Reference Data command . . . . .            | 45 |
| Table 42. | Enable Verification Requirement command format . . . . .         | 45 |
| Table 43. | R-APDU of the Enable Verification Requirement command. . . . .   | 46 |
| Table 44. | Disable Verification Requirement command format . . . . .        | 46 |
| Table 45. | R-APDU of the Disable Verification Requirement command . . . . . | 47 |
| Table 46. | C-APDU of the ExtendedReadBinary command . . . . .               | 47 |
| Table 47. | R-APDU of the ExtendedReadBinary command . . . . .               | 48 |
| Table 48. | EnablePermanentState command format. . . . .                     | 48 |

|           |                                                                                                              |    |
|-----------|--------------------------------------------------------------------------------------------------------------|----|
| Table 49. | R-APDU table of the EnablePermanentState command                                                             | 48 |
| Table 50. | DisablePermanentState command format                                                                         | 49 |
| Table 51. | R-APDU of the DisablePermanentState command                                                                  | 49 |
| Table 52. | UpdateFileType command format                                                                                | 50 |
| Table 53. | R-APDU of the UpdateFileType command                                                                         | 50 |
| Table 54. | SendInterrupt command format                                                                                 | 51 |
| Table 55. | R-APDU of the SendInterrupt command                                                                          | 51 |
| Table 56. | StateControl command format                                                                                  | 52 |
| Table 57. | R-APDU of the StateControl command                                                                           | 52 |
| Table 58. | Commands issues by the RF host                                                                               | 52 |
| Table 59. | RATS command                                                                                                 | 53 |
| Table 60. | Conversion from FDSI to FSD                                                                                  | 53 |
| Table 61. | ATS response                                                                                                 | 53 |
| Table 62. | PPS command                                                                                                  | 54 |
| Table 63. | Ascending and descending data rate coding                                                                    | 54 |
| Table 64. | PPS response                                                                                                 | 54 |
| Table 65. | Specific I <sup>2</sup> C commands                                                                           | 55 |
| Table 66. | GetI2Csession command format                                                                                 | 55 |
| Table 67. | KillRFsession command format                                                                                 | 55 |
| Table 68. | I <sup>2</sup> C device address format                                                                       | 59 |
| Table 69. | I <sup>2</sup> C frame format                                                                                | 60 |
| Table 70. | I2C host to M24SR02-Y                                                                                        | 60 |
| Table 71. | M24SR02-Y to I2C host                                                                                        | 61 |
| Table 72. | UID format                                                                                                   | 66 |
| Table 73. | Absolute maximum ratings                                                                                     | 67 |
| Table 74. | I <sup>2</sup> C operating conditions                                                                        | 68 |
| Table 75. | AC test measurement conditions                                                                               | 68 |
| Table 76. | Input parameters                                                                                             | 68 |
| Table 77. | I <sup>2</sup> C DC characteristics                                                                          | 69 |
| Table 78. | I <sup>2</sup> C AC characteristics (400 kHz)                                                                | 70 |
| Table 79. | I <sup>2</sup> C AC characteristics (1 MHz)                                                                  | 71 |
| Table 80. | Device select code                                                                                           | 74 |
| Table 81. | GPO timings measurement                                                                                      | 75 |
| Table 82. | Write cycle definition                                                                                       | 77 |
| Table 83. | Default operating conditions                                                                                 | 78 |
| Table 84. | RF characteristics                                                                                           | 78 |
| Table 85. | SO8N - 8-lead plastic small outline, 150 mils body width,<br>package data                                    | 79 |
| Table 86. | TSSOP8 – 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch,<br>package mechanical data             | 81 |
| Table 87. | UFDFPN8 - 8- lead, 2 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch<br>dual flat package mechanical data | 83 |
| Table 88. | Document revision history                                                                                    | 85 |

## List of figures

|            |                                                                                                              |    |
|------------|--------------------------------------------------------------------------------------------------------------|----|
| Figure 1.  | M24SR02-Y block diagram. . . . .                                                                             | 9  |
| Figure 2.  | 8-pin package connections. . . . .                                                                           | 10 |
| Figure 3.  | GPO configured as Session Open (GPO field = 0xX1 or 0x1X). . . . .                                           | 14 |
| Figure 4.  | GPO configured as WIP (GPO field = 0xX2 or 0x2X). . . . .                                                    | 15 |
| Figure 5.  | GPO configured as I <sup>2</sup> C answer ready (GPO field = 0xX3). . . . .                                  | 16 |
| Figure 6.  | GPO configured as MIP (GPO field = 0x3X). . . . .                                                            | 17 |
| Figure 7.  | GPO configured as INT (GPO field = 0xX4 or 0x4X). . . . .                                                    | 18 |
| Figure 8.  | GPO configured as State control (GPO field = 0xX5 or 0x5X). . . . .                                          | 19 |
| Figure 9.  | GPO configured as RF busy (GPO field = 0x6X). . . . .                                                        | 20 |
| Figure 10. | Changing the read access right to an NDEF file. . . . .                                                      | 27 |
| Figure 11. | Changing the write access right to an NDEF file. . . . .                                                     | 28 |
| Figure 12. | Command and response exchange. . . . .                                                                       | 57 |
| Figure 13. | I <sup>2</sup> C token release sequence. . . . .                                                             | 58 |
| Figure 14. | NDEF tag Application Select command. . . . .                                                                 | 61 |
| Figure 15. | AC test measurement I/O waveform. . . . .                                                                    | 68 |
| Figure 16. | I <sup>2</sup> C AC waveforms. . . . .                                                                       | 72 |
| Figure 17. | Maximum Rbus value with f <sub>C</sub> = 400 kHz. . . . .                                                    | 73 |
| Figure 18. | Maximum Rbus value with f <sub>C</sub> = 1 MHz. . . . .                                                      | 73 |
| Figure 19. | I2C bus protocol. . . . .                                                                                    | 74 |
| Figure 20. | SO8N - 8-lead plastic small outline, 150 mils body width, package outline. . . . .                           | 79 |
| Figure 21. | SO8N - 8-lead plastic small outline, 150 mils body width,<br>package recommended footprint. . . . .          | 80 |
| Figure 22. | TSSOP8 – 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch,<br>package outline. . . . .            | 81 |
| Figure 23. | UFDFPN8 - 8-lead, 2 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch<br>dual flat package outline. . . . . | 82 |

# 1 Functional description

The M24SR02-Y device is a dynamic NFC/RFID tag that can be accessed either from the I<sup>2</sup>C or the RF interface. The RF and I<sup>2</sup>C host can read or write to the same memory, as only one host can communicate at a given time with the M24SR02-Y. The management of the interface selection is controlled by the M24SR02-Y device itself.

The RF interface is based on the ISO/IEC 14443 Type A standard. The M24SR02-Y is compatible with the NFC Forum Type 4 Tag specifications and supports all corresponding commands.

The I<sup>2</sup>C interface uses a two-wire serial interface consisting of a bidirectional data line and a clock line. The devices carry a built-in 4-bit device type identifier code in accordance with the I<sup>2</sup>C bus definition.

The device behaves as a slave in the I<sup>2</sup>C protocol.

*Figure 1* displays the block diagram of the M24SR02-Y device.

**Figure 1. M24SR02-Y block diagram**

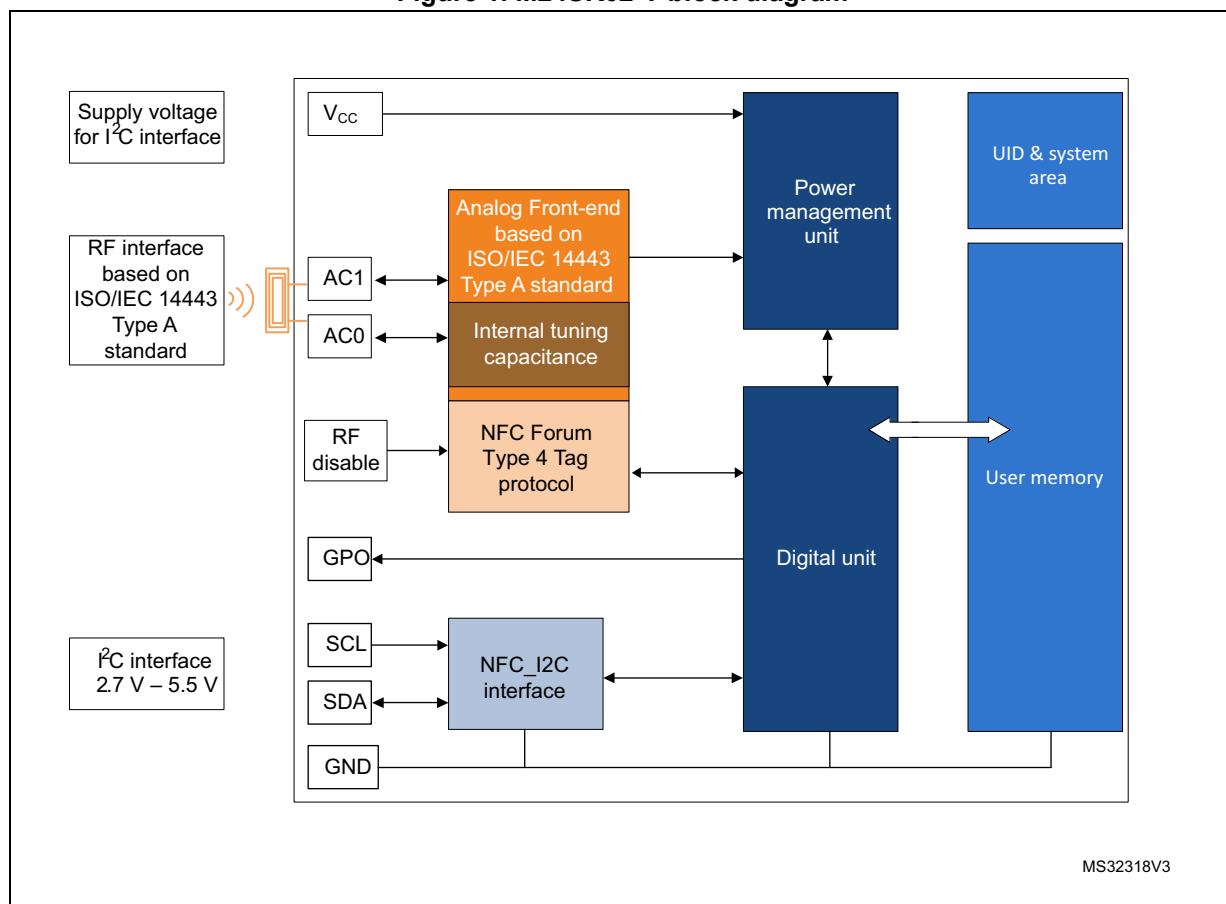


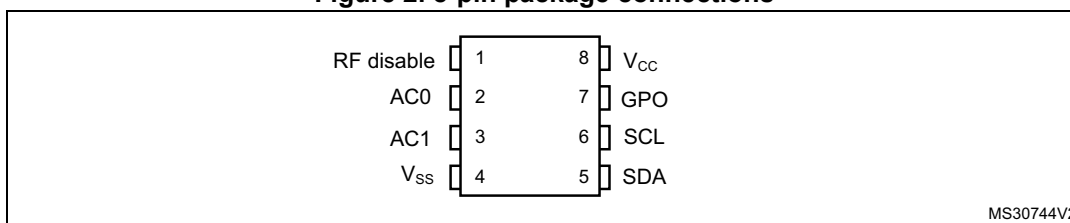
Table 1. Signal names

| Signal name     | Function                                     | Direction         |
|-----------------|----------------------------------------------|-------------------|
| SDA             | Serial data                                  | I/O               |
| SCL             | Serial clock                                 | Input             |
| AC0, AC1        | Antenna coils                                | -                 |
| V <sub>CC</sub> | Supply voltage                               | -                 |
| V <sub>SS</sub> | Ground                                       | -                 |
| GPO             | Interrupt output <sup>(1)</sup>              | Open drain output |
| RF disable      | Disables the RF communication <sup>(2)</sup> | Input             |

1. An external pull-up > 4.7 kΩ is required.

2. An external pull-down is required when the voltage on V<sub>CC</sub> is above its POR level.

Figure 2. 8-pin package connections



1. See [Section 15: Package information](#) for package dimensions, and how to identify pin 1.

## 1.1 Functional modes

The M24SR02-Y has two functional modes available. The difference between the modes lies in the power supply source (see [Table 2](#)).

Table 2. Functional modes

| Modes                 | Supply source               | Comments                                              |
|-----------------------|-----------------------------|-------------------------------------------------------|
| I <sup>2</sup> C mode | V <sub>CC</sub>             | The I <sup>2</sup> C interface is available           |
| Tag mode              | RF field only               | The I <sup>2</sup> C interface is disconnected        |
| Dual interface mode   | RF field or V <sub>CC</sub> | Both I <sup>2</sup> C and RF interfaces are available |

### 1.1.1 I<sup>2</sup>C mode

M24SR02-Y is powered by V<sub>CC</sub>. The I<sup>2</sup>C interface is connected to the M24SR02-Y. The I<sup>2</sup>C host can communicate with the M24SR02-Y device.

### 1.1.2 Tag mode

The M24SR02-Y is supplied by the RF field and can communicate with an RF host (RFID reader or an NFC phone). The User memory can only be accessed by the RF commands.

### 1.1.3 Dual interface mode

Both interfaces, RF and I<sup>2</sup>C, are connected to the M24SR02-Y and both RF or I<sup>2</sup>C host can communicate with the M24SR02-Y device. The power supply and the access management are carried out by the M24SR02-Y itself. For further details refer to [Section 4.2.1: RF token](#) and [Section 4.2.2: I2C token](#).

## 2 Description of signals

### 2.1 Serial clock (SCL)

This input signal is used to strobe all data in and out of the device. In applications where this signal is used by slave devices to synchronize the bus to a slower clock, the bus master must have an open drain output, and a pull-up resistor must be connected from Serial clock (SCL) to  $V_{CC}$ . (Figure 17 indicates how the value of the pull-up resistor can be calculated).

In most applications, though, this method of synchronization is not employed, and so the pull-up resistor is not necessary, provided that the bus master has a push-pull (rather than an open drain) output.

### 2.2 Serial data (SDA)

This bidirectional signal is used to transfer data in or out of the device. It is an open drain output that may be wire-OR'ed with other open drain or open collector signals on the bus. A pull-up resistor must be connected from Serial data (SDA) to  $V_{CC}$ . (Figure 17 indicates how the value of the pull-up resistor can be calculated).

### 2.3 Antenna coil (AC0, AC1)

These inputs are used to connect the device to an external coil exclusively. It is advised not to connect any other DC or AC path to AC0 or AC1.

When correctly tuned, the coil is used to access the device using NFC Forum Type 4 commands.

### 2.4 Ground ( $V_{SS}$ )

$V_{SS}$ , when connected, is the reference for the  $V_{CC}$  supply voltage for all pads, including AC0 and AC1.

### 2.5 Supply voltage ( $V_{CC}$ )

This pin can be connected to an external DC supply voltage.

*Note:* An internal voltage regulator allows the external voltage applied on  $V_{CC}$  to supply the M24SR02-Y.

#### 2.5.1 Operating supply voltage $V_{CC}$

Prior to selecting the M24SR02-Y and issuing instructions to it, a valid and stable  $V_{CC}$  voltage within the specified [ $V_{CC}(\min)$ ,  $V_{CC}(\max)$ ] range must be applied. To maintain a stable DC supply voltage, it is recommended to decouple the  $V_{CC}$  line with suitable capacitors (usually of the order of 10 nF and 100 pF) close to the  $V_{CC}$  /  $V_{SS}$  package pins.

This voltage must remain stable and valid until the end of the transmission of the instruction and, for a writing instruction (UpdateBinary, ChangeReferenceData,

EnableVerificationRequirement, DisableVerificationRequirement, EnablePermanentState, DisablePermanentState, until the completion of the internal I<sup>2</sup>C write cycle ( $t_W$ ).

## 2.5.2 Power-up conditions

When the power supply is turned on,  $V_{CC}$  rises from  $V_{SS}$  to  $V_{CC}$ . The  $V_{CC}$  rise time must not vary faster than 1 V/ $\mu$ s.

## 2.5.3 Device reset in I<sup>2</sup>C mode

In order to prevent inadvertent write operations during power-up, a power-on reset (POR) circuit is included. At power-up (continuous rise of  $V_{CC}$ ), the M24SR02-Y does not respond to any I<sup>2</sup>C instruction until  $V_{CC}$  has reached the power-on reset threshold voltage (this threshold is lower than the minimum  $V_{CC}$  operating voltage defined). When  $V_{CC}$  passes over the POR threshold, the device is reset and enters the Standby power mode. However, the device must not be accessed until  $V_{CC}$  has reached a valid and stable  $V_{CC}$  voltage within the specified [ $V_{CC}(\min)$ ,  $V_{CC}(\max)$ ] range.

In a similar way, during power-down (continuous decrease in  $V_{CC}$ ), as soon as  $V_{CC}$  drops below the power-on reset threshold voltage, the M24SR02-Y stops responding to any instruction sent to it.

## 2.5.4 Power-down conditions

During power-down (continuous decay of  $V_{CC}$ ), the M24SR02-Y must be in Standby power mode (mode reached after decoding a Stop condition, assuming that there is no internal operation in progress).

## 2.6 RF disable

This input signal is used to disable the RF communication. When the voltage on the  $V_{CC}$  pin is below the POR level or not connected, an internal pull-down resistor is connected on this pad. Thus, the RF disable pad is maintained to the low level and the RF analog front end is activated. When the voltage on the  $V_{CC}$  pin is higher than the POR level, the I<sup>2</sup>C host must set this pin to enable or disable the RF communication. In Dual interface mode, RF disable must not be left floating.

## 2.7 General purpose output (GPO)

The GPO pad is an open drain pad and an external pull-up resistor must be connected to it. This pad is a configurable output signal. On delivery, GPO is configured as Session opened. Its behavior is consistent with the I<sup>2</sup>C or RF session activated and with the mode chosen by the user. The GPO pad is enable when an RF or an I<sup>2</sup>C session is open. When neither an RF nor an I<sup>2</sup>C session is open, the GPO is high impedance.

The user can select one of these configurations<sup>(a)</sup>:

- SessionOpen: an RF or I<sup>2</sup>C session is ongoing.
- MIP (NDEF Message updating In Progress): the RF host is writing an NDEF length different from 0x0000. This mode can be used to detect when the RF host changes the NDEF message as defined by the NFC Forum.
- WIP (Writing In Progress): the M24SR02-Y is executing a writing operation.
- INT (interrupt): the I<sup>2</sup>C or RF host can force the M24SR02-Y to send a negative pulse on the GPO pin.
- I<sup>2</sup>C ready response: an I<sup>2</sup>C response is ready to be read by the I<sup>2</sup>C host.
- State mode: the I<sup>2</sup>C or RF host can control the state of the GPO pad during the RF session.
- RF busy: an RF host is communicating with the M24SR02-Y.

### 2.7.1 Session Open configuration (GPO field = 0xX1 or 0x1X)

When the GPO is configured as “Session Open”, it goes to the Low state when an RF or I<sup>2</sup>C session is ongoing (see [Figure 3](#)).

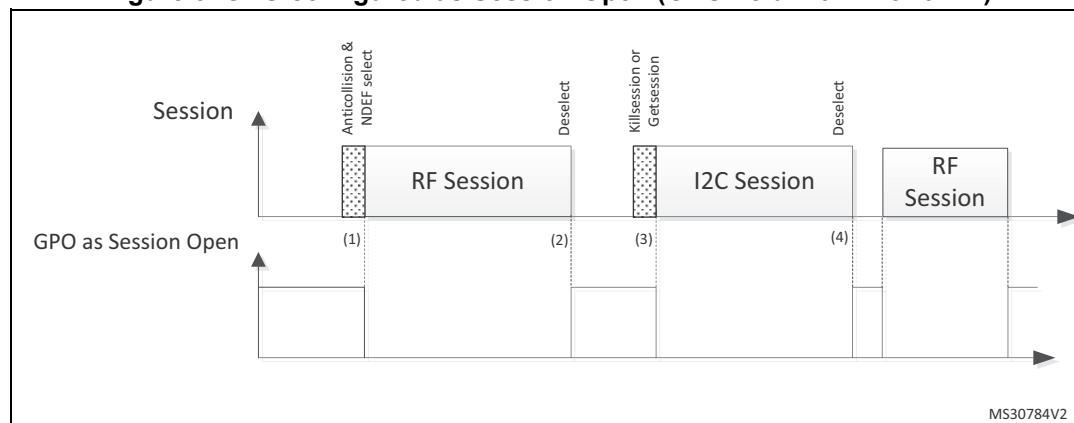
An RF session is taken when M24SR02-Y receives a valid Select Application. The session is released after M24SR02-Y has received a valid Deselect command, if M24SR02-Y has received a Kill RF session command in I<sup>2</sup>C or when the RF field became OFF.

An I<sup>2</sup>C session is taken when M24SR02-Y receives a valid Get session command or a valid Kill RF session command. The session is released after M24SR02-Y has received I<sup>2</sup>C token release sequence or after a power-off.

GPO is driven low after a delay (1) or (3) when the session is open.

GPO is released after a delay (2) or (4) when the session is released.

**Figure 3. GPO configured as Session Open (GPO field = 0xX1 or 0x1X)**



1. CmdEOFToGPlow (RF command End of frame to GPORF Session pad low)
2. CmdEOFToGPHZ (RF command End of frame to GPORF Session pad HZ)
3. CmdSTPtoGPlow (I2C command stop to GPO low)
4. AnswerlLBtoGPHZ (I2C answer last bit of last byte to GPO HZ)

a. See [Table 81](#) for more details.

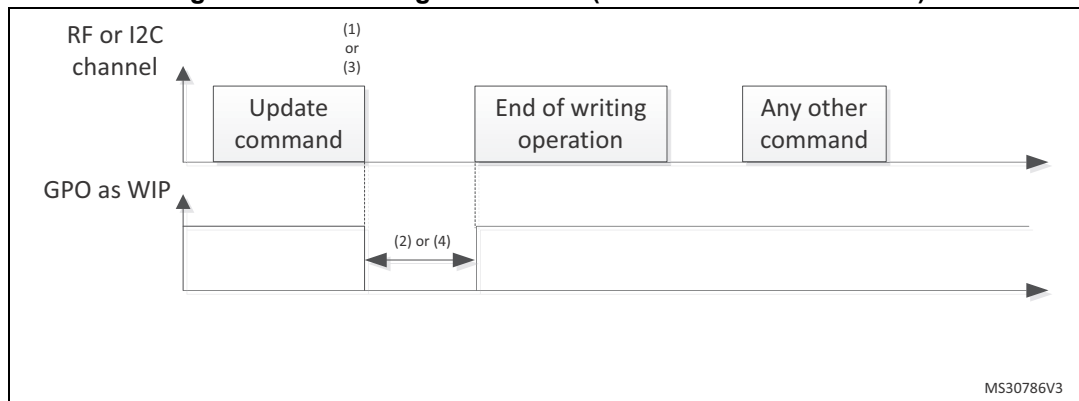
### 2.7.2 WIP Writing in Progress configuration (GPO field = 0xX2 or 0x2X)

When the GPO is configured as "WIP", it goes to the Low state during an I<sup>2</sup>C or RF writing operation.

During an RF or I<sup>2</sup>C session, when M24SR02-Y updates a file, GPO is driven low after a delay (1) or (3) following the beginning of the correspondent UpdateBinary command execution.

GPO will remain low during the writing time (2) or (4), before being released.

**Figure 4. GPO configured as WIP (GPO field = 0xX2 or 0x2X)**



1. CmdSTPtoGPlow (I2C Command Stop to GPO low)
2. Writing time duration
3. CmdEOFtoGPlow (RF Command End of frame to GPO low)
4. Writing time duration

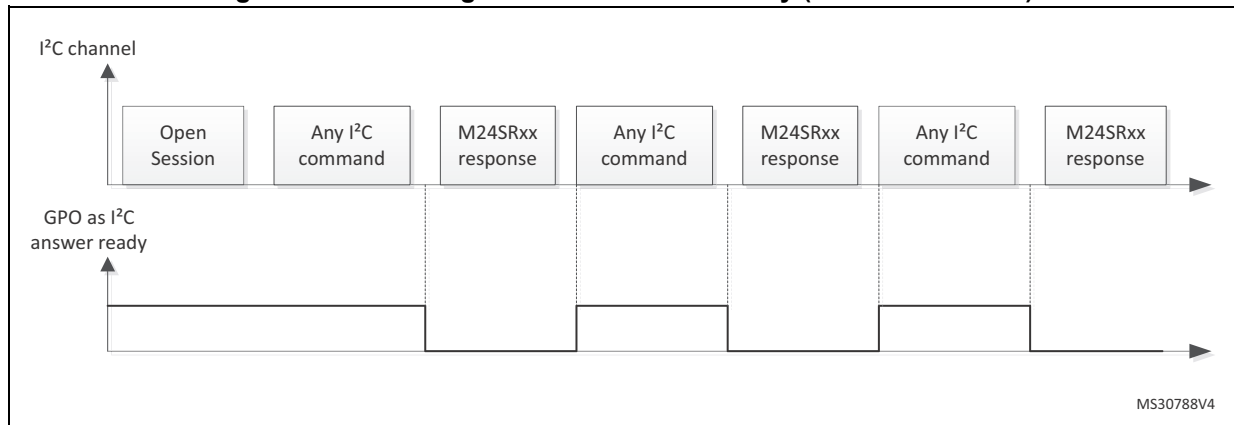
### 2.7.3 I<sup>2</sup>C answer ready configuration (GPO field = 0xX3)

When the GPO is configured as I<sup>2</sup>C answer ready, it goes to the low state when the M24SR02-Y has finished to treat the I<sup>2</sup>C command and is ready to send the I<sup>2</sup>C response.

During an I<sup>2</sup>C session, after receiving a valid I<sup>2</sup>C command, GPO pin is driven low after a delay when M24SR02-Y is ready to deliver a response on the I<sup>2</sup>C bus.

GPO is released when M24SR02-Y receives a new command.

**Figure 5. GPO configured as I<sup>2</sup>C answer ready (GPO field = 0xX3)**



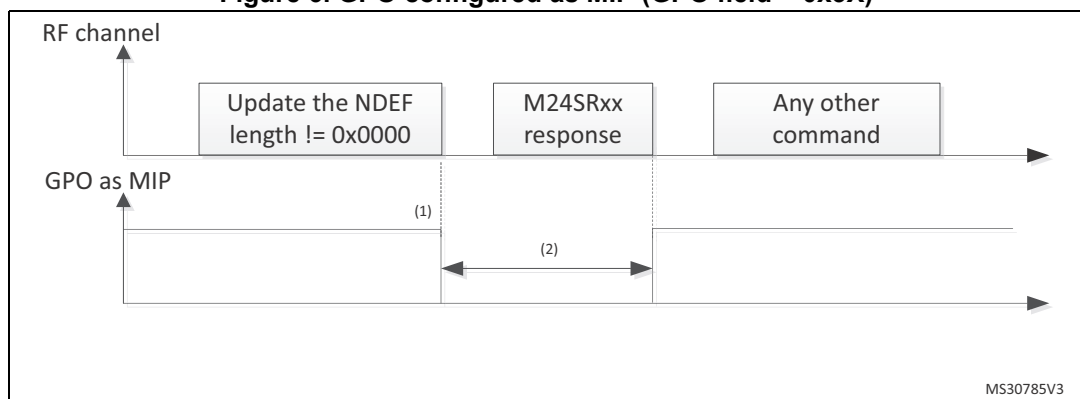
### 2.7.4 MIP NDEF Message writing in Progress configuration (GPO field = 0x3X)

When the GPO is configured as MIP, its state goes to the low state when the RF host writes the NDEF length to another value than 0x0000.

During an RF session, when M24SR02-Y changes an NDEF file and updates the NDEF length with a value different from 0x0000, GPO is driven low after a delay (1) following the beginning of the correspondent UpdateBinary command execution.

GPO will remain low during the writing time (2), before being released.

**Figure 6. GPO configured as MIP (GPO field = 0x3X)**



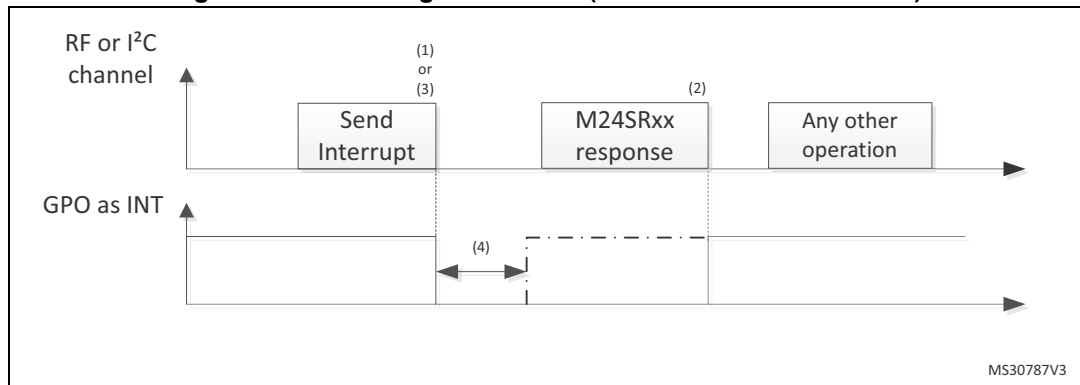
1. CmdEOFToGPIow (RF command End of frame to GPO low)
2. Writing time duration

### 2.7.5 INT interrupt configuration (GPO field = 0xX4 or 0x4X)

The I<sup>2</sup>C or RF host can send a negative pulse on the GPO pad. The GPO pad goes to the low state at the end of the command and goes to the high state at the end of the M24SR02-Y response.

During an RF or I<sup>2</sup>C session, when M24SR02-Y receives a valid Interrupt command, M24SR02-Y GPO pin is driven low after (1) or (3) for a duration of (4) in RF, or after responding in I2C (2). Then GPO pin is released.

**Figure 7. GPO configured as INT (GPO field = 0xX4 or 0x4X)**



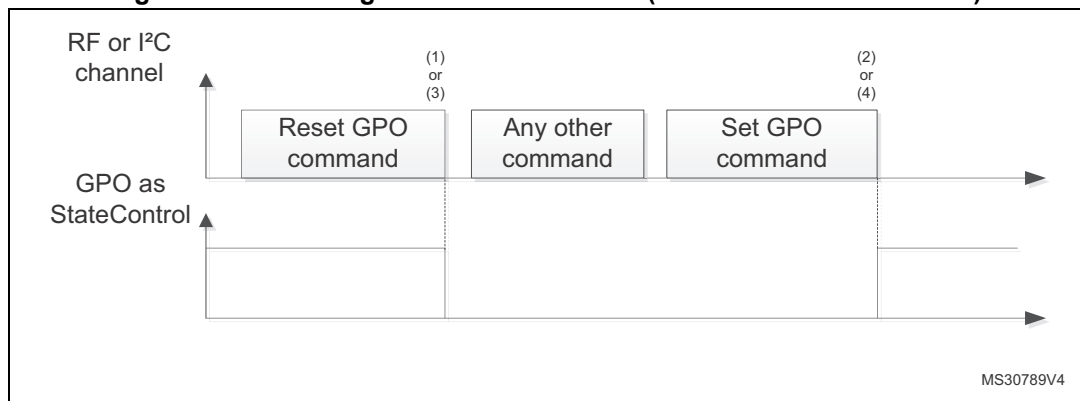
1. CmdSTPtoGPlow (I2C command Stop to GPO low)
2. After NewCmdIbFB (new I2C command last bit of first byte)  
or  
after AnswerIbFB (I2C answer last bit of first byte)
3. CmdEOFtoGPlow (RF command End of frame to GPO low)
4. GPO pulse duration

### 2.7.6 State control configuration (GPO field = 0xX5 or 0x5X)

When the GPO is configured as State control, the I<sup>2</sup>C or RF host can control the state of the GPO by sending a dedicated command.

During an RF or I<sup>2</sup>C session, the M24SR02-Y can control the GPO pin. After receiving a valid Set GPO command, GPO pin is driven low after a delay (1) or (3). GPO will be released after a valid Reset command or after a power-off or upon closing the RF session.

**Figure 8. GPO configured as State control (GPO field = 0xX5 or 0x5X)**



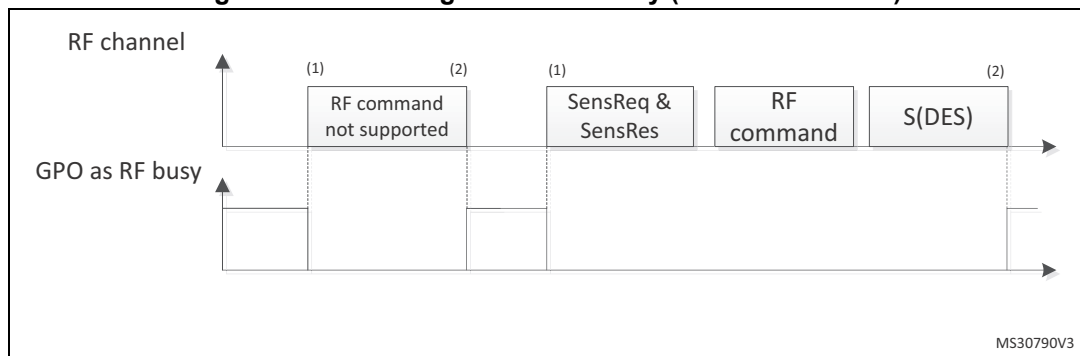
1. CmdSTPtoGPlow (I2C Set GPO command Stop to GPO low)
2. CmdSTPtoGPHZ (I2C Reset GPO command Stop to GPO HZ)
3. CmdEOFtoGPlow (RF Set GPO command End of frame to GPO low)
4. CmdEOFtoGPHZ (RF Reset GPO command End of frame to GPO HZ)

### 2.7.7 RF busy configuration (GPO field = 0x6X)

When the GPO is configured as RF busy, the GPO goes to the low state when the M24SR02-Y is processing an RF command or when an RF session is ongoing.

When an RF field is present, GPO is driven low after a delay (1) when M24SR02-Y detects the first command. If the RF session is ongoing and M24SR02-Y receives a not-supported command, GPO remains low. It will be released only at the end of the RF session, after (2).

**Figure 9. GPO configured as RF busy (GPO field = 0x6X)**



1. CmdSOFtoGPlow (RF command Start of frame to GPO low)
2. CmdEOFtoGPHZ (RF command End of frame to GPO HZ)

## 3 M24SR02-Y memory management

### 3.1 Memory structure

The M24SR02-Y supports the NDEF tag application as defined in the NFC Forum Type 4 Tag. The M24SR02-Y is composed of three files:

- a CC (capability container) file
- an NDEF file
- a System file: this is an ST-proprietary file

The System file contains information on the configuration of the M24SR02-Y device. The CC file gives information about the M24SR02-Y itself and the NDEF file. The NDEF file contains the User data.

#### 3.1.1 File identifier

The file identifier is the value used in the Select command to select a file.

**Table 3. File identifier**

| File identifier | Meaning     |
|-----------------|-------------|
| 0xE101          | System file |
| 0xE103          | CC file     |
| 0x0001          | NDEF file   |

#### 3.1.2 CC file layout

The CC file gives information about the M24SR02-Y and the NDEF file. This is a read-only file for the RF or I<sup>2</sup>C host and cannot be modified by issuing a write command.

The T field, Read Access and Write Access fields can be changed by the RF or I<sup>2</sup>C host by issuing a specific process (refer to [Section 8: Functional procedures](#)).

Table 4. CC file layout for 1 NDEF file

| File offset | Meaning                                     | Value               | Comments               |
|-------------|---------------------------------------------|---------------------|------------------------|
| 0x0000      | Number of bytes of CC file                  | 0x000F              | 15 bytes               |
| 0x0002      | Mapping version <sup>(1)</sup>              | 0x20 or 0x10        | V 2.0 or V 1.0         |
| 0x0003      | Maximum number of bytes that can be read    | 0x00F6              | 246 bytes              |
| 0x0005      | Maximum number of bytes that can be written | 0x00F6              | 246 bytes              |
| 0x0007      | NDEF file control TLV                       | 0x04 <sup>(2)</sup> | T field                |
| 0x0008      |                                             | 0x06                | L field                |
| 0x0009      |                                             | 0x0001              | FileID                 |
| 0x000B      |                                             | 0x0100              | Maximum NDEF file size |
| 0x000D      |                                             | 0x00 <sup>(2)</sup> | Read access            |
| 0x000E      |                                             | 0x00 <sup>(2)</sup> | Write access           |

1. According to the reader.

2. Delivery state.

### 3.1.3 NDEF file layout

The NDEF file contains the NDEF message, which contains the user data. The RF host or the I<sup>2</sup>C host can read and write data inside the file. The first two bytes (named NDEF message length) define the size of the NDEF message. The NDEF message length must be managed by the application and the M24SR02-Y device does not check if its value is relevant vs. the data written by the RF or I<sup>2</sup>C host. The M24SR02-Y device uses the NDEF message length, e. g. the standard read can be processed only inside the NDEF message; otherwise, the M24SR02-Y device returns an error code. For more details about the read command, refer to [Section 5.6.7: ReadBinary command](#).

Table 5. NDEF file layout

| File offset | Byte 0              | Byte 1    | Byte 2    | Byte 3    |
|-------------|---------------------|-----------|-----------|-----------|
| 0x0000      | NDEF message length |           | User data | User data |
| 0x0004      | User data           | User data | User data | User data |
| ...         | ...                 | ...       | ...       | ...       |
| ...         | ...                 | ...       | ...       | ...       |
| ...         | ...                 | ...       | ...       | ...       |
| 0x00FC      | ...                 | ...       | ...       | User data |

### 3.1.4 System file layout

The system file specifies the configuration of the M24SR02-Y. [Table 6](#) lists the different fields.

Table 6. Field list

| File offset | Field name                | Number of bytes | Read access            | Write access                    | Delivery state <sup>(1)</sup>        |
|-------------|---------------------------|-----------------|------------------------|---------------------------------|--------------------------------------|
| 0x0000      | Length system file        | 2               | I <sup>2</sup> C or RF | -                               | 0x0012                               |
| 0x0002      | I <sup>2</sup> C protect  | 1               | I <sup>2</sup> C or RF | I <sup>2</sup> C <sup>(2)</sup> | 0x01                                 |
| 0x0003      | I <sup>2</sup> C watchdog | 1               | I <sup>2</sup> C or RF | I <sup>2</sup> C <sup>(2)</sup> | 0x00                                 |
| 0x0004      | GPO                       | 1               | I <sup>2</sup> C or RF | I <sup>2</sup> C <sup>(2)</sup> | 0x11                                 |
| 0x0005      | ST reserved               | 1               | I <sup>2</sup> C or RF | I <sup>2</sup> C <sup>(2)</sup> | 0x00                                 |
| 0x0006      | RF enable                 | 1               | I <sup>2</sup> C or RF | I <sup>2</sup> C <sup>(2)</sup> | 0x xxxx xxx1 <sup>(3)</sup>          |
| 0x0007      | NDEF file number (RFU)    | 1               | I <sup>2</sup> C or RF | none                            | 0x00                                 |
| 0x0008      | UID                       | 7               | I <sup>2</sup> C or RF | none                            | 0x0282 xx xx xx xx xx <sup>(4)</sup> |
| 0x000F      | Memory size               | 2               | I <sup>2</sup> C or RF | none                            | 0x00FF                               |
| 0x0011      | Product code              | 1               | I <sup>2</sup> C or RF | none                            | 0x82                                 |

1. The delivery state for all passwords is 0x00000000000000000000000000000000.
2. The access is granted when the field I<sup>2</sup>C protect is set to the state Unprotected or when the right I<sup>2</sup>C password is correctly received (see [Section 3.5: I<sup>2</sup>C password](#)).
3. Refer to [Table 11](#).
4. x values are defined by ST to insure UID unicity.

Table 7. Details about I<sup>2</sup>C watchdog

| File offset | b7- b0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0x0003      | <p>The I<sup>2</sup>C watchdog ensures that the I2C host will not keep the session open while there is no more activity on the I<sup>2</sup>C bus (between the stop bit of the previous transaction and the start bit of the next one).</p> <ul style="list-style-type: none"> <li>– b7-b3: RFU</li> <li>– b2-b0<sup>(1)</sup>: <ul style="list-style-type: none"> <li>000: watchdog disabled</li> <li>001: N = 1 → 30 ms</li> <li>010: N = 2 → 60 ms</li> <li>011: N = 4 → 120 ms</li> <li>100: N = 8 → 240 ms</li> <li>101: N = 16 → 480 ms</li> <li>110: N = 32 → 960 ms</li> <li>111: N = 64 → 1920 ms</li> </ul> </li> </ul> |

1. If b2-b0 are programmed to a non null value (N), the watchdog is enabled and starts counting for the indicated (approximate) duration, before releasing the I<sup>2</sup>C session.

Table 8. Details about the GPO field

| File offset                               | b7 | b6-b4 | b3 | b2-b0 |
|-------------------------------------------|----|-------|----|-------|
| 0x0004                                    |    |       |    |       |
| RFU                                       |    |       |    |       |
| When an RF session is open:               |    |       |    |       |
| 0b000: High impedance                     |    |       |    |       |
| 0b001: Session opened                     |    |       |    |       |
| 0b010: WIP                                |    |       |    |       |
| 0b011: MIP                                |    |       |    |       |
| 0b100: Interrupt                          |    |       |    |       |
| 0b101: State control                      |    |       |    |       |
| 0b110: RF busy                            |    |       |    |       |
| 0b111: RFU                                |    |       |    |       |
| RFU                                       |    |       |    |       |
| When an I <sup>2</sup> C session is open: |    |       |    |       |
| 0b000: High impedance                     |    |       |    |       |
| 0b001: Session opened                     |    |       |    |       |
| 0b010: WIP                                |    |       |    |       |
| 0b011: I <sup>2</sup> C answer ready      |    |       |    |       |
| 0b100: Interrupt                          |    |       |    |       |
| 0b101: State control                      |    |       |    |       |
| 0b110: RFU                                |    |       |    |       |
| 0b111: RFU                                |    |       |    |       |

**Table 9. Details about the RF session field**

| File offset                                          | b7 | b6-b4 | b3-b0 |
|------------------------------------------------------|----|-------|-------|
| 0x0004                                               |    |       |       |
| RFU                                                  |    |       |       |
| When an RF session is open:<br>0b001: Session opened |    |       |       |
| RFU                                                  |    |       |       |

*Table 10* gives some details about the ST reserved field.

**Table 10. Details about the ST reserved field**

| File offset | b7-b0 |
|-------------|-------|
| 0x0005      |       |
| 0x00        |       |

*Table 11* gives some details about the RF enable field.

**Table 11. Details about the RF enable field**

| File offset                                                                                                                                        | b7 | b6-b4 | b3 | b2-b1 | b0 |
|----------------------------------------------------------------------------------------------------------------------------------------------------|----|-------|----|-------|----|
| 0x0006                                                                                                                                             |    |       |    |       |    |
| 0: the RF field is off <sup>(1)</sup><br>1: the RF field is on <sup>(1)</sup>                                                                      |    |       |    |       |    |
| RFU                                                                                                                                                |    |       |    |       |    |
| 0: the RF disable pad is at low state <sup>(1)</sup><br>1: the RF disable pad is at high state <sup>(1)</sup>                                      |    |       |    |       |    |
| RFU                                                                                                                                                |    |       |    |       |    |
| 0: the M24SR02-Y does not decode the command received from the RF interface<br>1: the M24SR02-Y decodes the command received from the RF interface |    |       |    |       |    |

1. this field is written by the M24SR02-Y.

## 3.2 Read and write access rights to the memory

An NDEF file can be locked for read or write accesses. It is also protected by a 128-bit password that the host must present before accessing the NDEF file. There are two 128-bit passwords, one for the read access and the other one for the write access.

An NDEF file can be permanently locked for read or write accesses. Thus, the host cannot access the NDEF file.

The read password must be sent to the M24SR02-Y device before reading a read-locked NDEF file.

The write password must be present on the M24SR02-Y device before writing a write-locked NDEF file. The write password must be sent to change the read or write access. The read or write access right is defined for the NDEF file.

### 3.2.1 State of the Read and Write access rights

Two bytes in the CC file are used to define the Read and Write access rights to the NDEF file. For more details refer to [Section 3.1.2: CC file layout](#).

**Table 12. Read access right**

| Value | Meaning                          |
|-------|----------------------------------|
| 0x00  | Read access without any security |
| 0x80  | Locked <sup>(1)</sup>            |
| 0xFE  | Read not authorized              |

1. The read password must be sent before reading in the NDEF file.

**Table 13. Write access right**

| Value | Meaning                           |
|-------|-----------------------------------|
| 0x00  | Write access without any security |
| 0x80  | Locked <sup>(1)</sup>             |
| 0xFF  | Write not authorized              |

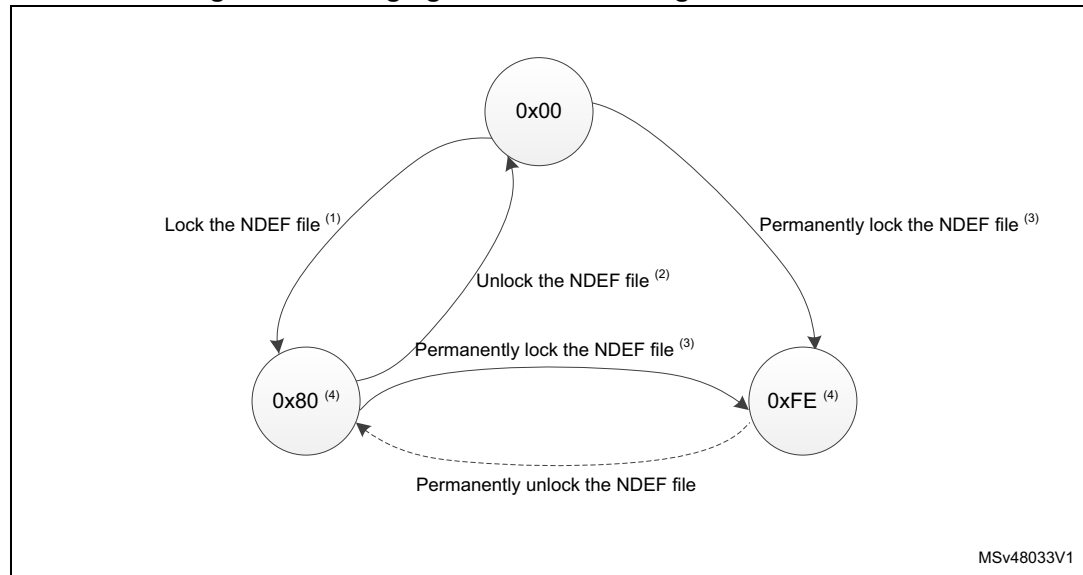
1. The write password must be sent before writing in the NDEF file.

The state 0xFF and 0xFE cannot be changed by using the Read or Write passwords.

### 3.2.2 Changing the read access right to NDEF files

The state diagram on [Figure 10](#) shows how to change the access right to read an NDEF file.

**Figure 10. Changing the read access right to an NDEF file**

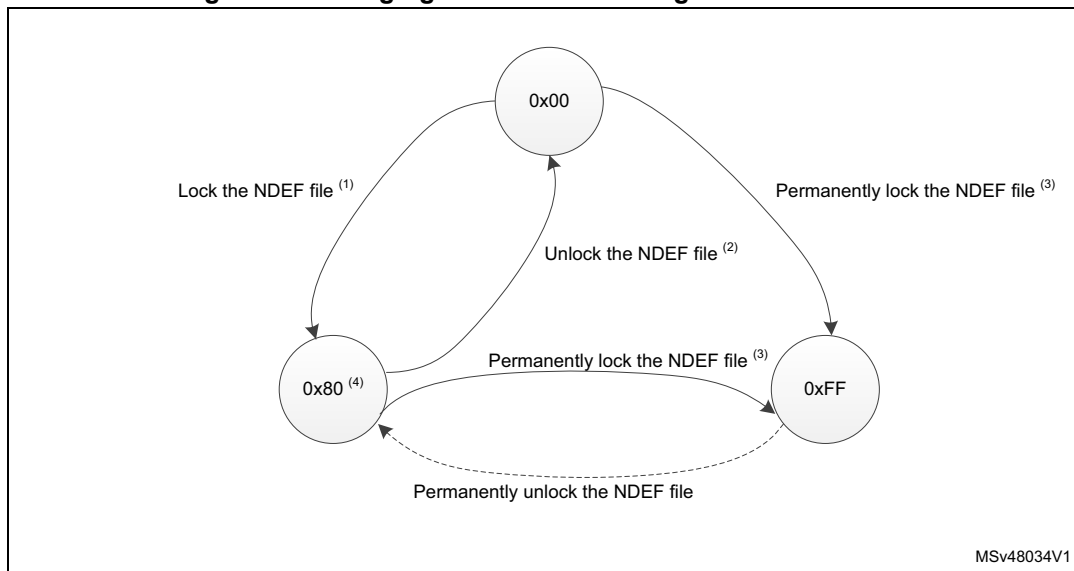


1. See the procedure to lock the read access ([Section 8.4: Locking an NDEF file](#)).
2. See the procedure to unlock the read access ([Section 8.5: Unlocking an NDEF file](#)).
3. See the procedure to permanently lock the read access ([Section 8.6: Reaching the read-only state for an NDEF file](#)).
4. Proprietary state, not defined by NFC Forum Type 4 Tag. For NFC Forum compatible tags, the only possible value of the read access rights are 0x00 (no restrictions on reads).

### 3.2.3 Changing the write access right to NDEF files

The state diagram on [Figure 1](#) shows how to change the write access right to an NDEF file.

**Figure 11. Changing the write access right to an NDEF file**



1. See the procedure to lock the write access.
2. See the procedure to unlock the write access.
3. See the procedure to permanently lock the write access ([Section 8.6: Reaching the read-only state for an NDEF file](#)).
4. Proprietary state, not defined by NFC Forum Type 4 Tag. For NFC Forum compatible tags, it is mandatory that the write access rights are set to either 0x00 (no restrictions on writes) or to 0xFF (permanently locked). 0x80 might not be fully decoded by some smart phones.

## 3.3 Access right life time

The access right life time is validated while the NDEF file is selected or until the end of the RF or I<sup>2</sup>C session. Once the read or write access right is granted, the host can send one or more ReadBinary or UpdateBinary commands.

At the end of a session or when the host selects another file, the read and write access rights are initialized.

## 3.4 NDEF file passwords

The NDEF file passwords protect the read or write access from an RF or I<sup>2</sup>C interface from/to an NDEF file.

Two NDEF file passwords are available for each NDEF file:

- Read password
- Write password

The length of a password is 128 bits (16 bytes).

## 3.5 I<sup>2</sup>C password

The I<sup>2</sup>C password can be sent only by the I<sup>2</sup>C host. It activates the SuperUser rights. The I<sup>2</sup>C host with the SuperUser rights can:

- access the NDEF file regardless of the right access and without sending the NDEF file passwords
- change the access rights regardless of the current state.

The length of the I<sup>2</sup>C password is 128 bits (16 bytes).

### 3.5.1 I<sup>2</sup>C password and I<sup>2</sup>C protect field of the System file

The I<sup>2</sup>C protect field in the system file can be set to:

- 0x00: the I<sup>2</sup>C host has the SuperUser right access without sending the I<sup>2</sup>C password
- 0x01: the I<sup>2</sup>C host has the SuperUser right access after sending the I<sup>2</sup>C password.

For more details about the system file layout, refer to [Section 3.1.4: System file layout](#).

## 4 Communication mechanism

This section describes the principle of communication between an RF or an I<sup>2</sup>C host and the M24SR02-Y device.

### 4.1 Master and slave

The M24SR02-Y acts as a slave device on either the I<sup>2</sup>C-bus or the RF channel and therefore waits for a command from the I<sup>2</sup>C master or the RF host before sending its response.

The RF host must generate the RF field and the RF commands.

The I<sup>2</sup>C host must supply the M24SR02-Y through the V<sub>CC</sub> pin and must generate the I<sup>2</sup>C clock on the SCL pad.

### 4.2 M24SR02-Y session mechanism

The M24SR02-Y is a dynamic NFC/RFID tag that can be accessed either from the RF or I<sup>2</sup>C interface. The M24SR02-Y implements a token system. This token has two possible values, RF or I<sup>2</sup>C. When the token exists and is assigned to one interface (RF or I<sup>2</sup>C), the M24SR02-Y cannot communicate with the other host.

#### 4.2.1 RF token

The token is given to the RF interface once the anticollision is done. The release condition can be either an RF field cut-off, or the reception of the command deselect, or when the I<sup>2</sup>C host sends the KillRFsession.

#### 4.2.2 I<sup>2</sup>C token

The token is given to the I<sup>2</sup>C interface when the I<sup>2</sup>C host has sent the correct device Select. The release condition can be either a power down condition on V<sub>CC</sub> pin or the reception of a I<sup>2</sup>C token release sequence from the I<sup>2</sup>C host, after which M24SR02-Y goes in Standby power mode.

## 5 I<sup>2</sup>C and RF command sets

The command sets of the M24SR02-Y can be split in different command families. Most commands are common between the RF and the I<sup>2</sup>C interface. Some commands are specific to the RF interface and some others are specific to the I<sup>2</sup>C interface. This section describes the M24SR02-Y command sets that can be issued by the RF or the I<sup>2</sup>C host.

There are three command families:

- the NFC Forum Type 4 Tag command set
- the ISO/IEC 7816-4 command set
- the proprietary command set

The NFC Forum Type 4 Tag command set and the ISO/IEC 7816-4 command set use the I-Block format. For more details about the I-Block format, refer to [Section 5.2](#).

Two other command formats exist:

- the commands using the R-Block format (refer to [Section 5.3](#))
- the commands using the S-Block format (refer to [Section 5.4](#)).

This section gives a brief description of the RF and I<sup>2</sup>C host common commands. The format of these command sets is the I-Block format.

[Table 14](#) lists the RF and I<sup>2</sup>C command sets.

**Table 14. RF and I<sup>2</sup>C command sets**

| Family command set   | Command name                   | Class byte | Instruction code | Brief description                                          |
|----------------------|--------------------------------|------------|------------------|------------------------------------------------------------|
| NFC Forum Type 4 Tag | NDEF Tag Application Select    | 0x00       | 0xA4             | NDEF Tag Application Select                                |
|                      | CC select                      | 0x00       | 0xA4             | Select the CC file                                         |
|                      | NDEF select                    | 0x00       | 0xA4             | Select the NDEF file                                       |
|                      | System select                  | 0x00       | 0xA4             | Select the system file                                     |
|                      | ReadBinary                     | 0x00       | 0xB0             | Read data from file                                        |
|                      | UpdateBinary                   | 0x00       | 0xD6             | Write or erase data to a NDEF file                         |
| ISO/IEC 7816-4       | Verify                         | 0x00       | 0x20             | Checks the right access of a NDEF file or sends a password |
|                      | ChangeReferenceData            | 0x00       | 0x24             | Change a Read or write password                            |
|                      | EnableVerificationRequirement  | 0x00       | 0x28             | Activate the password security                             |
|                      | DisableVerificationRequirement | 0x00       | 0x26             | Disable the password security                              |
| ST proprietary       | EnablePermanentState           | 0xA2       | 0x28             | Enable the Read only or Write only security state          |
|                      | ExtendedReadBinary             | 0xA2       | 0xB0             | Read data from file                                        |

## 5.1 Structure of the command sets

The exchange of data between the RF or the I<sup>2</sup>C host and the M24SR02-Y uses three kinds of data formats, called blocks:

- I-Block: to exchange the command and the response
- R-Block: to exchange positive or negative acknowledgment
- S-Block: to use either the Deselect command or the Frame waiting extension (WTX) command or response.

*Note:* *Max WTX value = 0x0B*

This section describes the structure of the I-Block, R-block and S-Block. This format is used for the application command set.

## 5.2 I-Block format

The I-Block is used to exchange data between the RF or the I<sup>2</sup>C host and the M24SR02-Y. It is composed of three fields. [Table 15](#) details the I-Block format.

**Table 15. I-Block format**

| Name                                             | SoD    |        | Payload        | EoD     |
|--------------------------------------------------|--------|--------|----------------|---------|
|                                                  | PCB    | DID    | 0              | CRC     |
| Length                                           | 1 byte | 1 byte | 1 to 251 bytes | 2 bytes |
| PCB field                                        |        |        |                |         |
| DID field (optional)                             |        |        |                |         |
| RF or I <sup>2</sup> C host to M24SR02-Y: C-APDU |        |        |                |         |
| M24SR02-Y to RF or I <sup>2</sup> C host: R-APDU |        |        |                |         |
| 2 CRC bytes                                      |        |        |                |         |

Table 16. PCB field of the I-Block format

|                          | b7-b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|--------------------------|-------|----|----|----|----|----|----|
| -                        | 0b00  | 0  | 0  | X  | 0  | 1  | X  |
| I-Block                  |       |    |    |    |    |    |    |
| RFU                      |       |    |    |    |    |    |    |
| Must be set to 0         |       |    |    |    |    |    |    |
| DID field, if bit is set |       |    |    |    |    |    |    |
| Must be set to 0         |       |    |    |    |    |    |    |
| Must be set to 1         |       |    |    |    |    |    |    |
| Block number             |       |    |    |    |    |    |    |

When the RF or I<sup>2</sup>C host sends a command to the M24SR02-Y the format of the payload is the C-APDU.

When the M24SR02-Y sends a command to the RF or I<sup>2</sup>C host, the format of the payload is the R-APDU.

### 5.2.1 C-APDU: payload format of a command

The C-APDU format is used by the RF or the I<sup>2</sup>C host to send a command to the M24SR02-Y. [Table 17](#) describes its format.

Table 17. C-APDU format

| Name                                                     | Payload field |        |        |        |        |         |        |
|----------------------------------------------------------|---------------|--------|--------|--------|--------|---------|--------|
|                                                          | CLA           | INS    | P1     | P2     | LC     | Data    | Le     |
| Length                                                   | 1 byte        | 1 byte | 1 byte | 1 byte | 1 byte | Lc byte | 1 byte |
| Class byte<br>0x00: standard command<br>0xA2: ST command |               |        |        |        |        |         |        |
| Instruction byte                                         |               |        |        |        |        |         |        |
| Parameter Byte 1                                         |               |        |        |        |        |         |        |
| Parameter Byte 2                                         |               |        |        |        |        |         |        |
| Number of bytes of the Data field                        |               |        |        |        |        |         |        |
| Data bytes                                               |               |        |        |        |        |         |        |
| Number of bytes to be read in the M24SR02-Y memory       |               |        |        |        |        |         |        |

### 5.2.2 R-APDU: payload format of a response

The M24SR02-Y uses the I-Block format to reply to a command that used the I-Block format. This format is described in [Table 18](#).

Table 18. R-APDU format

| Name          | Payload field   |        |        |
|---------------|-----------------|--------|--------|
|               | Data (optional) | SW1    | SW2    |
| Length        | Le byte         | 1 byte | 1 byte |
| Data          |                 |        |        |
| Status byte 1 |                 |        |        |
| Status byte 2 |                 |        |        |

### 5.3 R-Block format

The R-Block is used to convey positive or negative acknowledgment between the RF or I<sup>2</sup>C host and the M24SR02-Y.

Table 19. R-Block format

| PCB                                                                                                                                                                      | CRC         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| R(ACK) without the DID field: 0xA2 or 0xA3<br>R(ACK) with the DID field: 0xAA or 0xAB<br>R(NAK) without the DID field: 0xB2 0xB3<br>R(NAK) with the DID field: 0xBA 0xBB | 2 CRC bytes |

There are two kinds of R-Blocks:

- R(ACK): the acknowledgment block sent by the RF or I<sup>2</sup>C host or by the M24SR02-Y.
- R(NAK): the non-acknowledgment block sent by the RF or I<sup>2</sup>C host or by the M24SR02-Y.

Table 20. R-Block detailed format

| -                                                      | b7-b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|--------------------------------------------------------|-------|----|----|----|----|----|----|
|                                                        | 0b10  | 1  | X  | X  | 0  | 1  | X  |
| R-Block                                                |       |    |    |    |    |    |    |
| RFU                                                    |       |    |    |    |    |    |    |
| 1: NAK<br>0: ACK                                       |       |    |    |    |    |    |    |
| 0: DID field is not present<br>1: DID field is present |       |    |    |    |    |    |    |
| Must be set to 0                                       |       |    |    |    |    |    |    |
| Must be set to 1                                       |       |    |    |    |    |    |    |
| Block number                                           |       |    |    |    |    |    |    |

## 5.4 S-Block format

The S-Block is used to exchange control information between a reader and a contactless tag.

Table 21. S-Block format

| NFC frame                                                                                                                                                                                                    | SoD    |        |                | EoD     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|----------------|---------|
|                                                                                                                                                                                                              | PCB    | DID    | Payload        | CRC     |
| Length                                                                                                                                                                                                       | 1 byte | 1 byte | 1 to 255 bytes | 2 bytes |
| 0xC2: for S(DES) when the DID field is not present<br>0xCA: for S(DES) when the DID field is present<br>0xF2: for S(WTX) when the DID field is not present<br>0xFA: for S(WTX) when the DID field is present |        |        |                |         |
| DID field (optional)                                                                                                                                                                                         |        |        |                |         |
| WTX field <sup>(1)</sup>                                                                                                                                                                                     |        |        |                |         |
| 2 CRC bytes                                                                                                                                                                                                  |        |        |                |         |

1. This field is present when b5-b4 bits are set to 0b11 (S-Block is a WTX). see [Table 22](#).

There are two requests using the S-Block format:

- S(DES): the deselect command
- S(DES) is only applicable to RF
- S(WTX): the Waiting frame extension command or response.

A Waiting time extension request occurs, in RF or I<sup>2</sup>C, when the operating time needed by M24SRxx is greater than 9.6 ms.

The WTX field indicates the increase time factor to be used in this command execution (FDTtemp = WTX \* 9.6 ms). The max WTX value is equal to 0x0B.

Table 22. S-Block detailed format

|                                                        | b7-b6 | b5-b4 | b3 | b2 | b1 | b0 |
|--------------------------------------------------------|-------|-------|----|----|----|----|
|                                                        | 0b11  | X     | X  | 0  | 1  | 0  |
| S-Block                                                |       |       |    |    |    |    |
| 0b00: Deselect<br>0b11: WTX                            |       |       |    |    |    |    |
| 0: DID field is not present<br>1: DID field is present |       |       |    |    |    |    |
| -                                                      |       |       |    |    |    |    |
| RFU                                                    |       |       |    |    |    |    |
| RFU                                                    |       |       |    |    |    |    |

**Note:** After receiving the deselect command, the session is released and M24SR02-Y enters the Standby power mode. In I<sup>2</sup>C, the session is released after executing the I2C token release sequence.

In response to a RATS command, M24SR02-Y returns FWI parameter (default frame waiting time used); when M24SR02-Y needs more time for a command execution, it requests a frame waiting time extension by responding 0xF2 0xWTX (request waiting time = FWI \* WTX). If the reader accepts M24SR02-Y request, it acknowledges by sending the command 0xF2 0xWTX. The frame waiting time becomes FWI \* WTX for the current command only.

## 5.5 CRC of the I<sup>2</sup>C and RF frame

The two CRC bytes check the data transmission between the RF host or I<sup>2</sup>C host and the M24SR02-Y. For the RF frame, the CRC is computed on all the data bits in the frame, excluding parity bits, SOF and EOF, and the CRC itself.

For the I<sup>2</sup>C frames, the CRC is computed on all data bits of the frame excluding Device select and the CRC itself.

The CRC is as defined in ISO/IEC 13239. The initial register content must be 0x6363 and the register content must not be inverted after calculation.

## 5.6 NFC Forum Type 4 Tag protocol

### 5.6.1 Command set

With the NFC Forum Type 4 Tag protocol, the commands are common to RF and I<sup>2</sup>C.

**Table 23. Command set overview**

| Command name                | Brief description                                                  |
|-----------------------------|--------------------------------------------------------------------|
| NDEF Tag Application Select | Select the NDEF Tag Application                                    |
| Capability Container Select | Select the capability container (CC) file using the Select command |
| NDEF Select                 | Select the NDEF file                                               |
| System File Select          | Select the system file                                             |
| ReadBinary                  | Read data from a file                                              |
| UpdateBinary                | Write new data to a file                                           |

### 5.6.2 Status and error codes

This section lists the status and the error code of the M24SR02-Y.

**Table 24. Status code of the M24SR02-Y**

| -     | SW1  | SW2  | Comment                        |
|-------|------|------|--------------------------------|
| Value | 0x90 | 0x00 | Command completed successfully |

**Table 25. Error codes of the M24SR02-Y**

| -      | SW1    | SW2    | Comment                                                        |
|--------|--------|--------|----------------------------------------------------------------|
| Length | 1 byte | 1 byte | -                                                              |
| Value  | 0x62   | 0x80   | File overflow (Le error)                                       |
| Value  | 0x62   | 0x82   | End of file or record reached before reading Le bytes          |
| Value  | 0x63   | 0x00   | Password is required                                           |
| Value  | 0x63   | 0xCX   | Password is incorrect, X further retries allowed (X = 0, 1, 2) |
| Value  | 0x65   | 0x81   | Unsuccessful updating                                          |
| Value  | 0x67   | 0x00   | Wrong length                                                   |
| Value  | 0x69   | 0x81   | Command is incompatible with the file structure                |
| Value  | 0x69   | 0x82   | Security status not satisfied                                  |
| Value  | 0x69   | 0x84   | Reference data not usable                                      |
| Value  | 0x6A   | 0x80   | Incorrect parameters Le or Lc                                  |
| Value  | 0x6A   | 0x82   | File or application not found                                  |
| Value  | 0x6A   | 0x84   | File overflow (Lc error)                                       |
| Value  | 0x6A   | 0x86   | Incorrect P1 or P2 values                                      |

Table 25. Error codes of the M24SR02-Y (continued)

| -     | SW1  | SW2  | Comment                 |
|-------|------|------|-------------------------|
| Value | 0x6D | 0x00 | INS field not supported |
| Value | 0x6E | 0x00 | Class not supported     |

### 5.6.3 NDEF Tag Application Select command

The RF or the I<sup>2</sup>C host must send this command to activate the NDEF Tag Application.

To activate the NDEF Tag Application, the RF host sends the Select command (see [Table 26](#)) in addition to the sequence defined in the NFC Forum digital protocol.

To activate the NDEF Tag Application, the I<sup>2</sup>C host sends the Select command (see [Table 26](#)) in addition to the GetSession or the Kill RF session command.

[Table 26](#) defines the C-APDU of the Select command to select the NDEF Tag Application (called NDEF Tag Application Select).

Table 26. C-APDU of the NDEF Tag Application Select command

| Name                    | CLA  | INS  | P1   | P2   | Lc   | Data                 | Le   |
|-------------------------|------|------|------|------|------|----------------------|------|
| Value                   | 0x00 | 0xA4 | 0x04 | 0x00 | 0x07 | 0xD27600<br>00850101 | 0x00 |
| Class byte              |      |      |      |      |      |                      |      |
| Select instruction code |      |      |      |      |      |                      |      |
| P1 field                |      |      |      |      |      |                      |      |
| P2 field                |      |      |      |      |      |                      |      |
| Number of bytes of data |      |      |      |      |      |                      |      |
| Application ID          |      |      |      |      |      |                      |      |
| Le field                |      |      |      |      |      |                      |      |

[Table 27](#) defines the R-APDU of the NDEF Tag Application Select command.

Table 27. R-APDU of the NDEF Tag Application Select command

| -      | Data | SW1    | SW2    | Comment                        |
|--------|------|--------|--------|--------------------------------|
| Length | -    | 1 byte | 1 byte | -                              |
| Value  | -    | 0x90   | 0x00   | Command completed              |
| Value  | -    | 0x6A   | 0x82   | NDEF Tag Application not found |
| Value  | -    | 0x6D   | 0x00   | Class not supported            |

### 5.6.4 Capability Container Select command

The RF or I<sup>2</sup>C host uses the Capability Container Select procedure to select the capability container (CC) file.

The CC file is selected when this command returns “command completed” in the R-APDU. [Table 28](#) defines the C-APDU of the Select command to select the CC file (called Capability Container Select).

**Table 28. C-APDU of the Capability Container Select command**

| Name                    | CLA  | INS  | P1   | P2   | Lc   | Data   | Le |
|-------------------------|------|------|------|------|------|--------|----|
| Value                   | 0x00 | 0xA4 | 0x00 | 0x0C | 0x02 | 0xE103 | -  |
| Class byte              |      |      |      |      |      |        |    |
| Select instruction code |      |      |      |      |      |        |    |
| P1 field                |      |      |      |      |      |        |    |
| P2 field                |      |      |      |      |      |        |    |
| Number of bytes of data |      |      |      |      |      |        |    |
| CC file ID              |      |      |      |      |      |        |    |
| -                       |      |      |      |      |      |        |    |

[Table 29](#) defines the R-APDU of the CC Select command.

**Table 29. R-APDU of the Capability Container Select command**

| -      | Data | SW1    | SW2    | Comment                       |
|--------|------|--------|--------|-------------------------------|
| Length | -    | 1 byte | 1 byte | -                             |
| Value  | -    | 0x90   | 0x00   | Command completed             |
| Value  | -    | 0x6A   | 0x82   | File or application not found |
| Value  | -    | 0x6D   | 0x00   | Class not supported           |

### 5.6.5 NDEF Select command

The RF or I<sup>2</sup>C host uses the NDEF Select command to select the NDEF file.

The NDEF file is selected when this command returns “command completed” in the R-APDU. [Table 30](#) defines the C-APDU of the Select command to select the NDEF file (called NDEF Select).

In case of a password is required to access the NDEF file, the NDEF Select command will disable any previously granted access rights to this file. The Verify command might be required to access the file.

**Table 30. C-APDU of the NDEF Select command**

| Name                    | CLA  | INS  | P1   | P2   | Lc   | Data   | Le |
|-------------------------|------|------|------|------|------|--------|----|
| Value                   | 0x00 | 0xA4 | 0x00 | 0x0C | 0x02 | 0x000X | -  |
| Class byte              |      |      |      |      |      |        |    |
| Select instruction code |      |      |      |      |      |        |    |
| P1 field                |      |      |      |      |      |        |    |
| P2 field                |      |      |      |      |      |        |    |
| Number of bytes of data |      |      |      |      |      |        |    |
| 0x0001: first NDEF file |      |      |      |      |      |        |    |
| -                       |      |      |      |      |      |        |    |

[Table 31](#) defines the R-APDU of the NDEF Select command.

**Table 31. R-APDU of the NDEF Select command**

| -      | Data | SW1    | SW2    | Comment                       |
|--------|------|--------|--------|-------------------------------|
| Length | -    | 1 byte | 1 byte | -                             |
| Value  | -    | 0x90   | 0x00   | Command completed             |
| Value  | -    | 0x6A   | 0x82   | File or application not found |

## 5.6.6 System File Select command

The RF or I<sup>2</sup>C host uses this command to select the system file.

The System file is selected when this command returns "command completed" in the R-APDU.

[Table 32](#) defines the C-APDU of the command to select the System file (called System Select).

**Table 32. C-APDU of the System File Select command**

| Name                    | CLA  | INS  | P1   | P2   | Lc   | Data   | Le |
|-------------------------|------|------|------|------|------|--------|----|
|                         | 0x00 | 0xA4 | 0x00 | 0x0C | 0x02 | 0xE101 | -  |
| Class byte              |      |      |      |      |      |        |    |
| Select instruction code |      |      |      |      |      |        |    |
| P1 field                |      |      |      |      |      |        |    |
| P2 field                |      |      |      |      |      |        |    |
| Number of bytes of data |      |      |      |      |      |        |    |
| System file ID          |      |      |      |      |      |        |    |
| -                       |      |      |      |      |      |        |    |

[Table 33](#) defines the R-APDU of the System File Select command.

**Table 33. R-APDU of the System File Select command**

| -      | Data | SW1    | SW2    | Comment                                             |
|--------|------|--------|--------|-----------------------------------------------------|
| Length | -    | 1 byte | 1 byte | -                                                   |
| Value  | -    | 0x90   | 0x00   | Command completed                                   |
| Value  | -    | 0x6A   | 0x82   | Capability container not found, no data is returned |

### 5.6.7 ReadBinary command

On receiving the ReadBinary command, the M24SR02-Y reads the requested memory field and sends back its value in the R-APDU response.

Before sending a ReadBinary command, a file must be selected by using a Select command.

The Response of the ReadBinary command is successful when the data to be read is within the selected file <sup>(a)</sup>; in other words, when the sum of P1-P2 and Le fields is equal to or lower than the selected file length.

[Table 34](#) defines the ReadBinary command.

**Table 34. C-APDU of the ReadBinary command**

| Name                                                                           | CLA  | INS  | P1 and P2 | Lc | Data | Le     |
|--------------------------------------------------------------------------------|------|------|-----------|----|------|--------|
| -                                                                              | 0x00 | 0xB0 | 2 bytes   | -  | -    | 1 byte |
| Class byte                                                                     |      |      |           |    |      |        |
| Read instruction code                                                          |      |      |           |    |      |        |
| Offset in the file selected                                                    |      |      |           |    |      |        |
| -                                                                              |      |      |           |    |      |        |
| -                                                                              |      |      |           |    |      |        |
| Number of bytes to read between<br>0x01 ≤ Le ≤ max(Selected File length, 0xF6) |      |      |           |    |      |        |

[Table 35](#) defines the R-APDU of the ReadBinary command.

**Table 35. R-APDU of the ReadBinary command**

| -      | Data         | SW1    | SW2                       | Comment                       |
|--------|--------------|--------|---------------------------|-------------------------------|
| Length | -            | 1 byte | 1 byte                    | -                             |
| Value  | Content read | 0x90   | Don't care <sup>(1)</sup> | Command completed             |
| Value  | -            | 0x67   | 0x00                      | Wrong length                  |
| Value  | -            | 0x69   | 0x82                      | Security status not satisfied |

- a. For more details about CC file, refer to [Section 3.1.2: CC file layout](#).  
 For more details about NDEF file, refer to [Section 3.1.3: NDEF file layout](#).  
 For more details about System file, refer to [Section 3.1.4: System file layout](#).

**Table 35. R-APDU of the ReadBinary command (continued)**

| -     | Data | SW1  | SW2  | Comment                       |
|-------|------|------|------|-------------------------------|
| Value | -    | 0x6A | 0x82 | File or application not found |
| Value | -    | 0x6E | 0x00 | Class not supported           |

1. For more information, please contact your local ST support.

## 5.6.8 UpdateBinary command

On receiving the UpdateBinary command, the M24SR02-Y writes the data field into the selected file and sends back a status in the R-APDU response. If needed, the device will request a timing extension (see [Section 5.4](#)).

Before sending an UpdateBinary command, a file must be selected by issuing a Select command.

[Table 36](#) defines the UpdateBinary command.

**Table 36. C-APDU of the UpdateBinary command**

| Name                                                 | CLA  | INS  | P1 and P2 | Lc     | Data     | Le |
|------------------------------------------------------|------|------|-----------|--------|----------|----|
| -                                                    | 0x00 | 0xD6 | 2 bytes   | 1 byte | Lc bytes | -  |
| Class byte                                           |      |      |           |        |          |    |
| Write instruction code                               |      |      |           |        |          |    |
| Offset in the file selected                          |      |      |           |        |          |    |
| Number of bytes of data ( $0x01 \leq Lc \leq 0xF6$ ) |      |      |           |        |          |    |
| Data to write in the M24SR02-Y memory                |      |      |           |        |          |    |
| -                                                    |      |      |           |        |          |    |

[Table 37](#) defines the R-APDU of the UpdateBinary command.

**Table 37. R-APDU of the UpdateBinary command**

| -      | Data | SW1    | SW2    | Comment                       |
|--------|------|--------|--------|-------------------------------|
| Length | -    | 1 byte | 1 byte | -                             |
| Value  | -    | 0x90   | 0x00   | Command completed             |
| Value  | -    | 0x65   | 0x81   | Unsuccessful updating         |
| Value  | -    | 0x67   | 0x00   | Wrong length                  |
| Value  | -    | 0x69   | 0x82   | Security status not satisfied |
| Value  | -    | 0x6A   | 0x82   | File or application not found |
| Value  | -    | 0x6E   | 0x00   | Class not supported           |

**Note:** Chaining is not supported on “UpdateBinay” command. For further return codes and definitions, refer to [Status and error codes](#).

## 5.7 ISO/IEC 7816-4 commands

The ISO/IEC 7816-4 command set offers some extended features such as the protection of the NDEF file. This command set is used to manage the right access of the NDEF file.

### 5.7.1 Verify command

The Verify command has two functions:

1. check if a password is required to access to the NDEF file (the LC field = 0x00)
2. check that the password embedded in the Verify command enables the access to the memory (the Lc field = 0x10 and the password is present).

When the Lc field is equal to 0x00, the verify command returns a success code (0x90 00) provided that the access to the NDEF file does not require a password. When the access to the NDEF file is protected, the response to the Verify command returns an error code (0x63 00).

When the Lc field equals 0x10, on receiving the Verify command, the M24SR02-Y compares the requested password with the data contained in the request and reports whether the operation has been successful in the response.

Before sending this command, an NDEF file must be selected by issuing the NDEF Select command. Thus, this command checks the right access condition of the last NDEF file selected.

After a successful command, an access is granted for the whole NDEF file.

[Table 38](#) defines the Verify command.

**Table 38. Verify command format**

| Name                                                      | CLA  | INS  | P1 and P2 | Lc     | Data     | Le |
|-----------------------------------------------------------|------|------|-----------|--------|----------|----|
| -                                                         | 0x00 | 0x20 | 2 bytes   | 1 byte | Lc bytes | -  |
| Class byte                                                |      |      |           |        |          |    |
| Instruction code                                          |      |      |           |        |          |    |
| Password identification                                   |      |      |           |        |          |    |
| 0x0001: Read NDEF password transmit                       |      |      |           |        |          |    |
| 0x0002: Write NDEF password transmit                      |      |      |           |        |          |    |
| 0x0003: I <sup>2</sup> C password transmit <sup>(1)</sup> |      |      |           |        |          |    |
| Other: RFU                                                |      |      |           |        |          |    |
| 0x00: the password is not present                         |      |      |           |        |          |    |
| 0x10: the password is present in the data field           |      |      |           |        |          |    |
| Password                                                  |      |      |           |        |          |    |
| -                                                         |      |      |           |        |          |    |

1. This code can only be issued by the I<sup>2</sup>C host.

Table 39 defines the R-APDU of the Verify command.

**Table 39. R-APDU of the Verify command**

| -      | Data | SW1    | SW2                 | Comment                                                                                    |
|--------|------|--------|---------------------|--------------------------------------------------------------------------------------------|
| Length | -    | 1 byte | 1 byte              | -                                                                                          |
| Value  | -    | 0x90   | 0x00                | Command completed, the password is correct                                                 |
| Value  | -    | 0x69   | 0x85                | The conditions of use are not satisfied (e.g. no NDEF file was selected)                   |
| Value  | -    | 0x69   | 0x81                | Cmd incompatible with file structure                                                       |
| Value  | -    | 0x69   | 0x82                | Security status not satisfied                                                              |
| Value  | -    | 0x6A   | 0x80                | Incorrect parameter in cmd data field                                                      |
| Value  | -    | 0x63   | 0x00                | A password is required                                                                     |
| Value  | -    | 0x63   | 0xCX <sup>(1)</sup> | The password transmitted is incorrect and X encodes the number of further allowed retries. |
| Value  | -    | 0x6E   | 0x00                | Class not supported                                                                        |

1. At each session, the RF host can check a password 3 times.

## 5.7.2 Change Reference Data command

The Change Reference Data command replaces the read or write password related to the NDEF files previously selected. It can be performed only if the security status satisfies the security attributes for this command.

Before sending this command, the verify command with the correct NDEF write password must be issued. Thus, this command changes the reference data of the NDEF file.

Table 40 defines the Change Reference Data command.

**Table 40. Change reference data command format**

| Name                                                      | CLA  | INS  | P1 and P2 | Lc     | Data     | Le |
|-----------------------------------------------------------|------|------|-----------|--------|----------|----|
| -                                                         | 0x00 | 0x24 | 2 bytes   | 1 byte | Lc bytes | -  |
| Class byte                                                |      |      |           |        |          |    |
| Instruction code                                          |      |      |           |        |          |    |
| Password identification                                   |      |      |           |        |          |    |
| 0x0001: Read password transmit                            |      |      |           |        |          |    |
| 0x0002: Write password transmit                           |      |      |           |        |          |    |
| 0x0003: I <sup>2</sup> C password transmit <sup>(1)</sup> |      |      |           |        |          |    |
| Other: RFU                                                |      |      |           |        |          |    |
| 0x10: the password is present in the data field           |      |      |           |        |          |    |
| NDEF file or I <sup>2</sup> C Password                    |      |      |           |        |          |    |
| -                                                         |      |      |           |        |          |    |

1. This code can only be issued by the I<sup>2</sup>C host.

[Table 41](#) defines the R-APDU of the Change Reference Data command.

**Table 41. R-APDU of the Change Reference Data command**

| -      | Data | SW1    | SW2    | Comment                                              |
|--------|------|--------|--------|------------------------------------------------------|
| Length | 0    | 1 byte | 1 byte | -                                                    |
| Value  | -    | 0x90   | 0x00   | Command completed, the access right has been changed |
| Value  | -    | 0x69   | 0x81   | Command is incompatible with the file structure      |
| Value  | -    | 0x65   | 0x81   | Unsuccessful updating                                |
| Value  | -    | 0x69   | 0x82   | Security status not satisfied                        |
| Value  | -    | 0x6A   | 0x80   | CC file or System file selected                      |
| Value  | -    | 0x6A   | 0x82   | File or application not found                        |
| Value  | -    | 0x6A   | 0x86   | Incorrect P1 or P2 values                            |
| Value  | -    | 0x6E   | 0x00   | Class not supported                                  |

### 5.7.3 Enable Verification Requirement command

The Enable Verification Requirement command activates the protection by password of the NDEF file. When this command is successful, the read or write access to the NDEF file is protected by a 128-bit password. It can be performed only if the security status satisfies the security attributes for this command.

This command can update the right access of the NDEF file by writing into the EEPROM. In this case, the response timing will be around 5 ms.

Before sending this command, the verify command with the correct NDEF write password must be issued. Thus, this command changes the access right of the NDEF file.

[Table 42](#) defines the Enable Verification requirement command.

**Table 42. Enable Verification Requirement command format**

| Name                                                 | CLA  | INS  | P1 and P2 | Lc | Data | Le |
|------------------------------------------------------|------|------|-----------|----|------|----|
| -                                                    | 0x00 | 0x28 | 2 bytes   | -  | -    | -  |
| Class byte                                           |      |      |           |    |      |    |
| Instruction code                                     |      |      |           |    |      |    |
| New security attributes                              |      |      |           |    |      |    |
| 0x0001: Enable the read protection of the NDEF file  |      |      |           |    |      |    |
| 0x0002: Enable the write protection of the NDEF file |      |      |           |    |      |    |
| Other: RFU                                           |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |

The last five bits identify the password sent in the Verify command.

[Table 43](#) defines the R-APDU of the Enable Verification Requirement command.

**Table 43. R-APDU of the Enable Verification Requirement command**

| -      | Data | SW1    | SW2    | Comment                                         |
|--------|------|--------|--------|-------------------------------------------------|
| Length | 0    | 1 byte | 1 byte | -                                               |
| Value  | -    | 0x90   | 0x00   | Command completed, the password is correct      |
| Value  | -    | 0x69   | 0x81   | Command is incompatible with the file structure |
| Value  | -    | 0x69   | 0x82   | Security status not satisfied                   |
| Value  | -    | 0x6A   | 0x80   | CC file or System file selected                 |
| Value  | -    | 0x6A   | 0x82   | File or application not found                   |
| Value  | -    | 0x6A   | 0x86   | Incorrect P1 or P2 values                       |

#### 5.7.4 Disable Verification Requirement command

The Disable Requirement command deactivates the protection by password of the NDEF file. When this command is successful, the read or write access to the NDEF file is granted without security requirements. It can be performed only if the security status satisfies the security attributes for this command.

Before sending this command, the verify command with the correct NDEF write password must be issued. Thus, this command changes the access right of the NDEF file.

This command can update the right access of the NDEF file by writing into the EEPROM. In this case, the response timing will be around 6 ms.

[Table 44](#) defines the Disable Verification Requirement command.

**Table 44. Disable Verification Requirement command format**

| Name                                                  | CLA  | INS  | P1 and P2 | Lc | Data | Le |
|-------------------------------------------------------|------|------|-----------|----|------|----|
| -                                                     | 0x00 | 0x26 | 2 bytes   | -  | -    | -  |
| Class byte                                            |      |      |           |    |      |    |
| Instruction code                                      |      |      |           |    |      |    |
| New security attributes                               |      |      |           |    |      |    |
| 0x0001: Disable the read protection of the NDEF file  |      |      |           |    |      |    |
| 0x0002: Disable the write protection of the NDEF file |      |      |           |    |      |    |
| Other: RFU                                            |      |      |           |    |      |    |
| -                                                     |      |      |           |    |      |    |
| -                                                     |      |      |           |    |      |    |
| -                                                     |      |      |           |    |      |    |

[Table 45](#) defines the R-APDU of the Disable Verification Requirement command.

**Table 45. R-APDU of the Disable Verification Requirement command**

| -      | Data | SW1    | SW2    | Comment                                         |
|--------|------|--------|--------|-------------------------------------------------|
| Length | 0    | 1 byte | 1 byte | -                                               |
| Value  | -    | 0x90   | 0x00   | Command completed, the password is correct      |
| Value  | -    | 0x69   | 0x81   | Command is incompatible with the file structure |
| Value  | -    | 0x69   | 0x82   | Security status not satisfied                   |
| Value  | -    | 0x6A   | 0x80   | CC file or System file selected                 |
| Value  | -    | 0x6A   | 0x82   | File or application not found                   |
| Value  | -    | 0x6A   | 0x86   | Incorrect P1 or P2 values                       |
| Value  | -    | 0x6E   | 0x00   | Class not supported                             |
| Value  | -    | 0x65   | 0x81   | Update failed                                   |

## 5.8 ST proprietary command set

The RF or I<sup>2</sup>C host can be issued with the command set described in this section.

### 5.8.1 ExtendedReadBinary command

On receiving the ExtendedReadBinary command, the M24SR02-Y reads the requested memory field and sends back its value in the R-APDU response.

Before sending an ExtendedReadBinary command, a file must be selected by issuing an NDEF select command.

The response of the ExtendedReadBinary command will be successful even if the data to be read is beyond the NDEF message. The command returns an error code if the data to be read goes beyond the end of the file.

**Table 46. C-APDU of the ExtendedReadBinary command**

| Name                                                     | CLA  | INS  | P1 and P2 | Lc | Data | Le     |
|----------------------------------------------------------|------|------|-----------|----|------|--------|
| Length                                                   | 0xA2 | 0xB0 | 2 bytes   | -  | -    | 1 byte |
| ST Class byte                                            |      |      |           |    |      |        |
| Read instruction code                                    |      |      |           |    |      |        |
| Offset in the file selected                              |      |      |           |    |      |        |
| -                                                        |      |      |           |    |      |        |
| -                                                        |      |      |           |    |      |        |
| -                                                        |      |      |           |    |      |        |
| Number of bytes to read between $0x01 \leq Le \leq 0xF6$ |      |      |           |    |      |        |

[Table 47](#) defines the R-APDU of the read binary command.

**Table 47. R-APDU of the ExtendedReadBinary command**

| -      | Data         | SW1    | SW2                       | Comment                       |
|--------|--------------|--------|---------------------------|-------------------------------|
| Length | Le bytes     | 1 byte | 1 byte                    | -                             |
| Value  | Content read | 0x90   | Don't care <sup>(1)</sup> | Command completed             |
| Value  | -            | 0x67   | 0x00                      | Wrong length                  |
| Value  | -            | 0x69   | 0x82                      | Security status not satisfied |
| Value  | -            | 0x6A   | 0x82                      | File or application not found |
| Value  | -            | 0x6A   | 0x86                      | Incorrect P1 or P2 values     |
| Value  | -            | 0x6E   | 0x00                      | Class not supported           |

1. For more information, please contact your local ST support.

## 5.8.2 EnablePermanentState command

The command configures the NDEF file to the ReadOnly or to the WriteOnly State.

This command can update the right access to the NDEF file by writing into the EEPROM. In this case, the response timing will be around 6 ms.

[Table 48](#) defines the EnablePermanentState requirement command.

**Table 48. EnablePermanentState command format**

| Name                                                 | CLA  | INS  | P1 and P2 | Lc | Data | Le |
|------------------------------------------------------|------|------|-----------|----|------|----|
| Length                                               | 0xA2 | 0x28 | 2 bytes   | -  | -    | -  |
| Class byte                                           |      |      |           |    |      |    |
| Instruction code                                     |      |      |           |    |      |    |
| New security attributes                              |      |      |           |    |      |    |
| 0x0001: Enable the read protection of the NDEF file  |      |      |           |    |      |    |
| 0x0002: Enable the write protection of the NDEF file |      |      |           |    |      |    |
| Other: RFU                                           |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |
| -                                                    |      |      |           |    |      |    |

[Table 49](#) defines the R-APDU of the EnablePermanentState command.

**Table 49. R-APDU table of the EnablePermanentState command**

| -      | Data | SW1    | SW2    | Comment           |
|--------|------|--------|--------|-------------------|
| Length | -    | 1 byte | 1 byte | -                 |
| Value  | -    | 0x90   | 0x00   | Command completed |
| Value  | -    | 0x65   | 0x81   | Update failed     |
| Value  | -    | 0x67   | 0x00   | Wrong length      |

**Table 49. R-APDU table of the EnablePermanentState command (continued)**

| -     | Data | SW1  | SW2  | Comment                         |
|-------|------|------|------|---------------------------------|
| Value | -    | 0x69 | 0x82 | Security status not satisfied   |
| Value | -    | 0x6A | 0x80 | CC file or System file selected |
| Value | -    | 0x6A | 0x82 | File or application not found   |
| Value | -    | 0x6A | 0x86 | Incorrect P1 or P2 values       |
| Value | -    | 0x6E | 0x00 | Class not supported             |

### 5.8.3 DisablePermanentState command

The command configures the NDEF file to the Lock state.

This command can update the right access of the NDEF file by writing into the EEPROM. In this case, the response timing will be around 6 ms. This command is only valid in I<sup>2</sup>C. The SuperUser rights must have been granted to execute the command.

Before sending this command, an NDEF file must be selected by issuing the NDEF Select command.

[Table 50](#) defines the DisablePermanentState requirement command.

**Table 50. DisablePermanentState command format**

| Name                                                  | CLA  | INS  | P1 and P2 | Lc | Data | Le |
|-------------------------------------------------------|------|------|-----------|----|------|----|
| Length                                                | 0xA2 | 0x26 | 2 bytes   | -  | -    | -  |
| Class byte                                            |      |      |           |    |      |    |
| Instruction code                                      |      |      |           |    |      |    |
| New security attributes                               |      |      |           |    |      |    |
| 0x0001: Disable the read protection of the NDEF file  |      |      |           |    |      |    |
| 0x0002: Disable the write protection of the NDEF file |      |      |           |    |      |    |
| Other: RFU                                            |      |      |           |    |      |    |
| -                                                     |      |      |           |    |      |    |
| -                                                     |      |      |           |    |      |    |
| -                                                     |      |      |           |    |      |    |

[Table 51](#) defines the R-APDU of the DisablePermanentState command.

**Table 51. R-APDU of the DisablePermanentState command**

| -      | Data | SW1    | SW2    | Comment                       |
|--------|------|--------|--------|-------------------------------|
| Length | -    | 1 byte | 1 byte | -                             |
| Value  | -    | 0x90   | 0x00   | Command completed             |
| Value  | -    | 0x65   | 0x81   | Update failed                 |
| Value  | -    | 0x67   | 0x00   | Wrong length                  |
| Value  | -    | 0x69   | 0x82   | Security status not satisfied |

**Table 51. R-APDU of the DisablePermanentState command (continued)**

| -     | Data | SW1  | SW2  | Comment                         |
|-------|------|------|------|---------------------------------|
| Value | -    | 0x6A | 0x80 | CC file or System file selected |
| Value | -    | 0x6A | 0x82 | File or application not found   |
| Value | -    | 0x6A | 0x86 | Incorrect P1 or P2 values       |
| Value | -    | 0x6E | 0x00 | Class not supported             |

### 5.8.4 UpdateFileType command

This command allows to modify the file type of a selected file to Proprietary file (0x05) or NDEF file (0x04).

NFC Forum compatible tags must configure the file as NDEF file (0x04).

This command is granted only, when application and file are selected and if the file length and access right have previously been set to 0X00h (message invalid, all access rights granted).

This command will update the file type located in the CC file by writing into the EEPROM. In this case, the response timing will be around 6 ms.

[Table 52](#) defines the UpdateFileType command.

**Table 52. UpdateFileType command format**

| Name                    | CLA  | INS  | P1   | P2   | Lc   | Data         | Le |
|-------------------------|------|------|------|------|------|--------------|----|
| Value                   | 0xA2 | 0xD6 | 0x00 | 0x00 | 0x01 | 0x04 or 0x05 | -  |
| Class byte              |      |      |      |      |      |              |    |
| Select instruction code |      |      |      |      |      |              |    |
| P1 field                |      |      |      |      |      |              |    |
| P2 field                |      |      |      |      |      |              |    |
| Number of bytes of data |      |      |      |      |      |              |    |
| File type               |      |      |      |      |      |              |    |
| -                       |      |      |      |      |      |              |    |

[Table 53](#) describes the R-APDU of the UpdateFileType command.

**Table 53. R-APDU of the UpdateFileType command**

| -      | Data | SW1    | SW2    | Comment                         |
|--------|------|--------|--------|---------------------------------|
| Length | -    | 1 byte | 1 byte | -                               |
| Value  | -    | 0x90   | 0x00   | Command completed               |
| Value  | -    | 0x69   | 0x82   | Security status not satisfied   |
| Value  | -    | 0x6A   | 0x80   | CC file or System file selected |

**Table 53. R-APDU of the UpdateFileType command (continued)**

| -     | Data | SW1  | SW2  | Comment                       |
|-------|------|------|------|-------------------------------|
| Value | -    | 0x6A | 0x82 | File or application not found |
| Value | -    | 0x6A | 0x86 | Incorrect P1 or P2 values     |

### 5.8.5 SendInterrupt command

On receiving the SendInterrupt command, the M24SR02-Y generates a negative pulse on the GPO pin. It starts at the end of the command and ends at the end of the RF response.

Before sending this command, the system file must be selected by issuing the System Select command.

[Table 54](#) defines the SendInterrupt command.

**Table 54. SendInterrupt command format**

| -      | CLA    | INS    | P1&P2   | Lc     | Data | Le |
|--------|--------|--------|---------|--------|------|----|
| Length | 1 byte | 1 byte | 2 bytes | 1 byte | -    | -  |
| Value  | 0xA2   | 0xD6   | 0x001E  | 0x00   | -    | -  |

[Table 55](#) describes the R-APDU of the SendInterrupt command.

**Table 55. R-APDU of the SendInterrupt command**

|        | Data | SW1    | SW2    | Comment                                        |
|--------|------|--------|--------|------------------------------------------------|
| Length | -    | 1 byte | 1 byte | -                                              |
| Value  | -    | 0x90   | 0x00   | The interrupt has been sent                    |
| Value  | -    | 0x6A   | 0x80   | The GPO is not configured as an interrupt mode |
| Value  | -    | 0x6A   | 0x82   | File or application not found                  |
| Value  | -    | 0x6A   | 0x86   | Incorrect P1 or P2 values                      |
| Value  | -    | 0x6E   | 0x00   | Class not supported                            |

### 5.8.6 StateControl command

On receiving the StateControl command with reset value: data 0x00, the M24SR02-Y drives the GPO pin low. On receiving the StateControl command with set value: data 0x01, the M24SR02-Y releases the GPO pin, which returns to HZ.

Before sending this command, the system file must be selected by issuing the System Select command.

[Table 56](#) defines the StateControl command.

**Table 56. StateControl command format**

| -           | CLA    | INS    | P1&P2   | Lc     | Data | Le |
|-------------|--------|--------|---------|--------|------|----|
| Length      | 1 byte | 1 byte | 2 bytes | 1 byte | -    | -  |
| Reset value | 0xA2   | 0xD6   | 0x001F  | 0x01   | 0x00 | -  |
| Set value   | 0xA2   | 0xD6   | 0x001F  | 0x01   | 0x01 | -  |

**Table 57. R-APDU of the StateControl command**

| -      | Data | SW1    | SW2    | Comment                                        |
|--------|------|--------|--------|------------------------------------------------|
| Length | -    | 1 byte | 1 byte | -                                              |
| Value  | -    | 0x90   | 0x00   | The set or reset has been sent                 |
| Value  | -    | 0x6A   | 0x80   | The GPO is not configured in StateControl mode |
| Value  | -    | 0x6A   | 0x82   | File or application not found                  |
| Value  | -    | 0x6A   | 0x86   | Incorrect P1 or P2 values                      |
| Value  | -    | 0x6E   | 0x00   | Class not supported                            |

## 5.9 Specific RF command set

This section describes the command set that can be issued only by the RF host.

### 5.9.1 Anticollision command set

[Table 58](#) lists the commands that can be issued only by the RF host. The format of these commands is described in the NFC Forum Digital Protocol specification.

**Table 58. Commands issues by the RF host**

| Family command set | Command name | Instruction code     |
|--------------------|--------------|----------------------|
| NFC-A technology   | ALL_REQ      | 0x52 <sup>(1)</sup>  |
|                    | SENS_REQ     | 0x26 <sup>(1)</sup>  |
|                    | SDD_REQ      | 0x93 or 0x95 or 0x97 |
|                    | SEL_REQ      | 0x93 or 0x95 or 0x97 |
|                    | SLP_REQ      | 0x50                 |

1. Coded on 7 bits.

### 5.9.2 RATS command and ATS response

RATS command and ATS response are used for NFC Forum Type 4A Tag Platform Device Activation (as defined in NFC Forum Digital Protocol specification).

[Table 59](#) details the RATS command. This command must be sent after the anticollision process.

Table 59. RATS command

| Name               | INS  | Param  |       | CRC     |
|--------------------|------|--------|-------|---------|
| Byte field         | 0xE0 | 1 byte |       | 2 bytes |
| Bit field          | -    | b7-b4  | b3-b0 | -       |
| Instruction code   |      |        |       |         |
| FSDI               |      |        |       |         |
| DID (0 ≤ DID ≤ 14) |      |        |       |         |
| 2 CRC bytes        |      |        |       |         |

The FSDI field codes the FSD that defines the maximum size that an RF or I<sup>2</sup>C host is able to receive. [Table 60](#) gives the conversion from FSDI to FSD.

Table 60. Conversion from FSDI to FSD

| FSDI | 0x0 | 0x1 | 0x2 | 0x3 | 0x4 | 0x5 | 0x6 | 0x7 | 0x8 | 0x9h-0xE | 0xF |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|-----|
| FSD  | 16  | 24  | 32  | 40  | 48  | 64  | 96  | 128 | 256 | RFU      | 256 |

The DID field defines the value of the addressed M24SR02-Y.

Table 61. ATS response

| Name                                                                                        | TL   | T0   | TA(1)  | TB(1)  |       | TC(1) | CRC     |
|---------------------------------------------------------------------------------------------|------|------|--------|--------|-------|-------|---------|
| Byte field                                                                                  | 0x05 | 0x78 | 1 byte | 1 byte |       | 0x02  | 2 bytes |
| Bit field                                                                                   | -    | -    | -      | b8-b5  | b4-b1 | -     | -       |
| Length of the ATS response                                                                  |      |      |        |        |       |       |         |
| FSCI = 256 bytes                                                                            |      |      |        |        |       |       |         |
| The maximum ascending data rate is 106 kbps<br>The maximum descending data rate is 106 kbps |      |      |        |        |       |       |         |
| FWI field (9.6 ms when TB = 0x50)                                                           |      |      |        |        |       |       |         |
| SFGI field (302 μs when TB = 0x50)                                                          |      |      |        |        |       |       |         |
| The DID is supported                                                                        |      |      |        |        |       |       |         |
| 2 CRC bytes                                                                                 |      |      |        |        |       |       |         |

The FSCI codes the FSC, which stands for the maximum frame size that the M24SR02-Y is able to receive. The M24SR02-Y is able to receive up to 256 bytes of command. If the RF or I<sup>2</sup>C host sends a command with more than 256 bytes, the M24SR02-Y will not be able to treat the command and will not reply.

The FWI, which stands for the frame waiting time integer codes the FWT. This time corresponds to the maximum duration while an RF or I<sup>2</sup>C host must wait before sending the next command.

The SFGI, which stands for the start-up frame guard time is the minimum time that the reader must wait after receiving the response of the M24SR02-Y.

### 5.9.3 PPS command and response

PPS (protocol and parameter selection) command and response are defined in ISO/IEC 14443-4, in the protocol activation of PICC Type A.

The PPS command makes possible to change the data rates of the ascending (RF host to M24SR02-Y) and descending (M24SR02-Y to RF host) data rates.

**Table 62. PPS command**

|      | Name                 | INS   |       | PPS0 | PPS1   |       |       | CRC     |
|------|----------------------|-------|-------|------|--------|-------|-------|---------|
| -    | Byte field           | 0xDX  |       | 0x11 | 1 byte |       |       | 2 bytes |
|      | Bit field            | b7-b4 | b3-b0 | -    | 0b0000 | b3-b2 | b1-b0 | -       |
| INS  | Instruction code     |       |       |      |        |       |       |         |
|      | DID                  |       |       |      |        |       |       |         |
| -    | PPS1 is present      |       |       |      |        |       |       |         |
| PPS1 | RFU                  |       |       |      |        |       |       |         |
|      | Descending data rate |       |       |      |        |       |       |         |
|      | Ascending data rate  |       |       |      |        |       |       |         |
| -    | 2 CRC bytes          |       |       |      |        |       |       |         |

The ascending and descending data rates must be coded as described in [Table 63](#).

**Table 63. Ascending and descending data rate coding**

| Value     | 0b00     | 0b01 | 0b10 | 0b11 |
|-----------|----------|------|------|------|
| Data rate | 106 kbps | RFU  | RFU  | RFU  |

When the M24SR02-Y is able to change both data rates, it returns the following response. The data rate of this response is 106 kbps; then, the M24SR02-Y changes the ascending and descending data rates.

[Table 64](#) gives the details of the PPS response.

**Table 64. PPS response**

| Name          | INS   | -     | PPS0 |
|---------------|-------|-------|------|
| Byte field    | 0xDX  | -     | 0x11 |
| Bit field     | b8-b5 | b4-b1 |      |
| Response code |       |       |      |
| DID field     |       |       |      |
| 2 CRC bytes   |       |       |      |

## 5.10 Specific I<sup>2</sup>C command set

[Table 65](#) lists the commands that can only be issued by the I<sup>2</sup>C host.

**Table 65. Specific I<sup>2</sup>C commands**

| Command name  | Format | Class byte | Instruction code | Brief description                                                   |
|---------------|--------|------------|------------------|---------------------------------------------------------------------|
| GetI2Csession | -      | -          | 0x26             | Open an I <sup>2</sup> C session when the RF session is not ongoing |
| KillRFsession | -      | -          | 0x52             | Kill the RF session and open an I <sup>2</sup> C session            |

### 5.10.1 GetI2Csession command

The GetI2Csession command opens an I<sup>2</sup>C session if an RF session is not ongoing.

[Table 66](#) defines the GetI2Csession command.

**Table 66. GetI2Csession command format**

|        |        |
|--------|--------|
| -      | INS    |
| Length | 1 byte |
| Value  | 0x26   |

The GetI2Csession command does not create a reply.

When an RF session is ongoing, the M24SRxx will not acknowledge the command.

When no RF session is ongoing, the M24SRxx will acknowledge the command and open an I<sup>2</sup>C session.

### 5.10.2 KillRFsession command

The KillRF session command closes the RF session and opens an I<sup>2</sup>C session.

[Table 67](#) defines the KillRFsession command.

**Table 67. KillRFsession command format**

|        |        |
|--------|--------|
| -      | INS    |
| Length | 1 byte |
| Value  | 0x52   |

The KillRFsession command does not create a reply. The RF session is closed when the device acknowledges the command.

**Caution:** A successful completion of the RF command is not certain.

## **6 RF device operation**

### **6.1 Anticollision and Device activation command set for the RF interface**

The M24SR02-Y device supports the command set defined in the NFC-A Technology and the Type 4A Tag Platform chapters of the NFC Digital Protocol V1.0 specification.

### **6.2 Open an RF session**

Once the RF host has terminated the anticollision procedure and retrieve the ATS response, it must send the SelectApplication command. The M24SR02-Y will open an RF session. At this point, the RF host can send the applicative command set and the I<sup>2</sup>C cannot communicate with the M24SR02-Y without closing first the RF session using the I<sup>2</sup>C KillRFsession command.

### **6.3 Close an RF session**

The RF host can close the RF session through one of these methods:

- send an S(DES) command
- turn off the RF field.

### **6.4 Applicative command set**

The applicative command set is composed of the following command sets:

- the NFC Forum Type 4 Tag command set
- the ISO/IEC 7816-4 command set
- the proprietary command set.

## 7 I<sup>2</sup>C device operation

The M24SR02-Y device supports the I<sup>2</sup>C protocol. The device that controls the data transfer is known as the bus master, and the other one as the slave device. A data transfer can only be initiated by the bus master, which also provides the serial clock for synchronization. The M24SR02-Y device is a slave in all communications.

### 7.1 I<sup>2</sup>C communication protocol

The I<sup>2</sup>C communication is built on a system of command and reply exchange. The I<sup>2</sup>C host starts the communication by sending a request. Once a valid request is received by the M24SR02-Y device, it carries out an internal operation and creates its answer.

As defined in this document, and except for the GetI2C session and Kill RF session commands, the definition of a valid request is a command with a right CRC value.

Figure 12 shows an exchange of a command and a response between the I<sup>2</sup>C host and the M24SR02-Y. Once the I<sup>2</sup>C session is open, the I<sup>2</sup>C host can send a command. The command is composed of:

- a Device Select field with the R/W bit set to 0
- the command field.

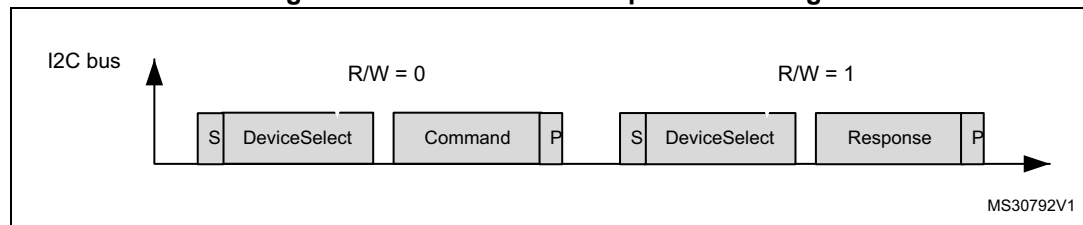
The M24SR02-Y acknowledges on the reception of each byte.

Once the M24SR02-Y is ready to send the answer, the I<sup>2</sup>C host must:

- send a Device Select field with the R/W bit set to 1
- release the SDA line and send an SCL clock.

The I<sup>2</sup>C host must acknowledge on the reception of each byte.

**Figure 12. Command and response exchange**



Legend:

- S is the I<sup>2</sup>C Start bit sequence
- P is the I<sup>2</sup>C Stop bit sequence
- R/W is the 8<sup>th</sup> bit of Device Select.

**Note:** A restart during a command and response exchange is not supported by the M24SR02-Y. After a command, the I<sup>2</sup>C host can execute a Polling sequence to determine when the response is available.

*Polling sequence: Loop on < START (S) + DeviceSelect with RW=0 + read NACK/ACK + STOP (P) >*

*The response is available as soon as the M24SR02-Y sends an ACK ( host read will a '0').*

## 7.2 Start condition

A Start condition is identified by a falling edge of serial data (SDA) while the serial clock (SCL) is stable in the high state. A Start condition must precede any data transfer command. The device continuously monitors (except during an instruction processing) the SDA and the SCL for a Start condition, and does not respond unless one is given.

## 7.3 Stop condition

A Stop condition is identified by a rising edge of serial data (SDA) while the serial clock (SCL) is stable and driven high. A Stop condition terminates a command between the device and the bus master.

## 7.4 I<sup>2</sup>C token release sequence

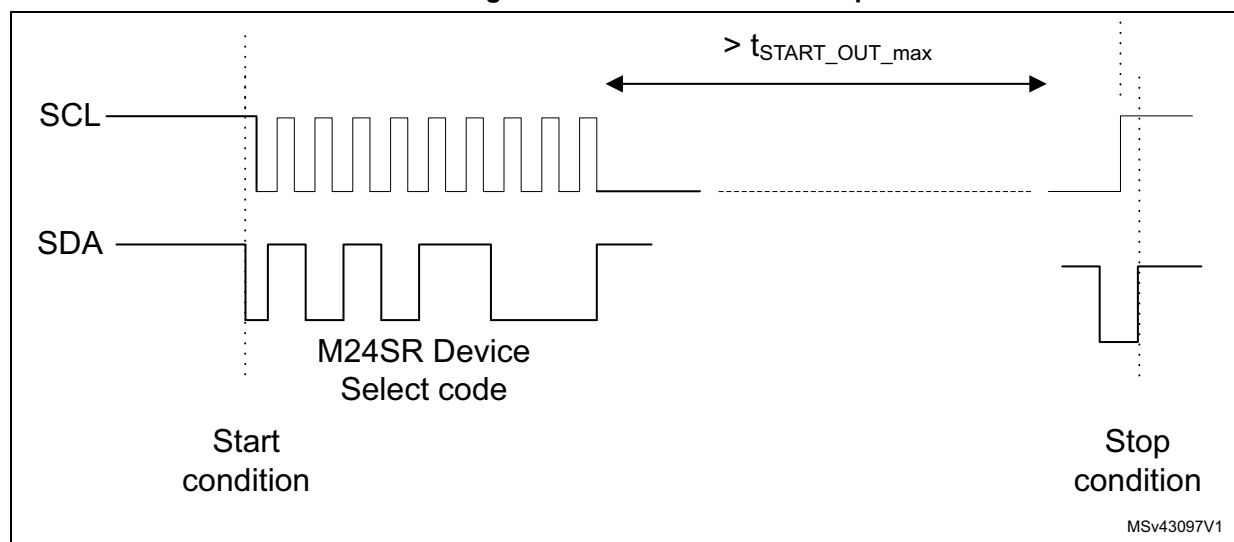
As explained in the M24SR02-Y session mechanism, the I<sup>2</sup>C communication is reserved to the I<sup>2</sup>C host when the session token has the I<sup>2</sup>C value.

The following sequence explains how to release the I<sup>2</sup>C value of the session token.

I<sup>2</sup>C communication with the M24SR02-Y starts with a valid Start condition, followed by a device select code.

If the delay between the Start condition and the following rising edge of the Serial Clock (SCL) that samples the most significant of the Device Select exceeds the  $t_{\text{START\_OUT\_MAX}}$  time (see [Table 78](#)), the I<sup>2</sup>C logic block is reset and further incoming data transfer is ignored until the next valid Start condition.

Figure 13. I<sup>2</sup>C token release sequence



**Note:** If the above delay is below  $t_{\text{START\_OUT\_min}}$  (see [Table 78](#)), I<sup>2</sup>C session token stays unmodified.  
 If the delay is between  $t_{\text{START\_OUT\_min}}$  and  $t_{\text{START\_OUT\_max}}$ , I<sup>2</sup>C session token might or not be released. This range of delay is not authorized for safe operation.

## 7.5 I<sup>2</sup>C timeout on clock period

During a data transfer on the I<sup>2</sup>C bus, if the serial clock high pulse or serial clock low pulse exceeds  $t_{CL\_RESET}$  value that is the maximum value specified in [Table 78](#), the I<sup>2</sup>C logic block is reset and any further incoming data transfer is ignored until the next valid Start condition.

If the serial clock high pulse is under the maximum value of  $t_{CHCL}$  and the serial clock low pulse is under the maximum value of  $t_{CLCH}$  in [Table 78](#), the I<sup>2</sup>C logic block is not reset.

For proper operation, the serial clock high pulse must not be higher than  $t_{CHCL}$  and lower than  $t_{CL\_RESET}$ , and the serial clock low pulse must not be higher than  $t_{CHCH}$  and lower than  $t_{CL\_RESET}$ .

## 7.6 Acknowledge bit (ACK)

The acknowledge bit is used to indicate a successful byte transfer. The bus transmitter, whether a bus master or a slave device, releases the serial data (SDA) after sending eight bits of data. During the 9th clock pulse period, the receiver pulls the SDA low to acknowledge the receipt of the eight data bits.

## 7.7 Data input

During data input, the device samples serial data (SDA) on the rising edge of the serial clock (SCL). For a correct device operation, the SDA must be stable during the rising edge of the SCL, and the SDA signal must change only when the SCL is driven low.

## 7.8 I<sup>2</sup>C device address

The device address is the concatenation of the group number coded on 4 bits and the I<sup>2</sup>C address coded on 3 bits, as shown in [Table 68](#).

**Table 68. I<sup>2</sup>C device address format**

| -            | b7-b4  | b3 | b2 | b1 | b0  |
|--------------|--------|----|----|----|-----|
|              | 0b1010 | 1  | 1  | 0  | 0bx |
| Group number |        |    |    |    |     |
| E2 bit       |        |    |    |    |     |
| E1 bit       |        |    |    |    |     |
| E0 bit       |        |    |    |    |     |
| 0 = Request  |        |    |    |    |     |
| 1 = Answer   |        |    |    |    |     |

## 7.9 I<sup>2</sup>C frame format

The I<sup>2</sup>C frame is composed of three fields:

1. SOD field: contains the device select and the PCB. The PCB field is detailed in [Section 5.2](#).
2. Payload field: contains the command and its parameter, as defined in the I<sup>2</sup>C command set.
3. EOD field: contains the two CRC bytes computed on the SOD but excluding the device select byte field.

[Table 69](#) shows the format of an I<sup>2</sup>C frame.

**Table 69. I<sup>2</sup>C frame format**

| I <sup>2</sup> C frame                                                                                 | SOD          |        | Payload        | EOD     |
|--------------------------------------------------------------------------------------------------------|--------------|--------|----------------|---------|
|                                                                                                        | 0xAC or 0xAD | 1 byte | 1 to 251 bytes | 2 bytes |
| Device select<br>0xAC: to send a request to the M24SR02-Y<br>0xAD: to read a response of the M24SR02-Y |              |        |                |         |
| PCB field                                                                                              |              |        |                |         |
| I <sup>2</sup> C command or I <sup>2</sup> C answer                                                    |              |        |                |         |
| 2 CRC bytes                                                                                            |              |        |                |         |

### 7.9.1 Example of I<sup>2</sup>C frame commands

#### NDEF Tag Application command

This example presents the I<sup>2</sup>C frame of an NDEF Tag Application Select command. The I<sup>2</sup>C frame is detailed in [Table 70](#).

**Table 70. I<sup>2</sup>C host to M24SR02-Y**

| Field                                    | SOD  |              | Payload       | EOD            |
|------------------------------------------|------|--------------|---------------|----------------|
| Value                                    | 0xAC | 0x02 or 0x03 | Command field | 35 C0 or DF BE |
| Device select                            |      |              |               |                |
| PCB field                                |      |              |               |                |
| 0x00 A4 04 00 07 D2 76 00 00 85 01 01 00 |      |              |               |                |
| 2 CRC bytes                              |      |              |               |                |

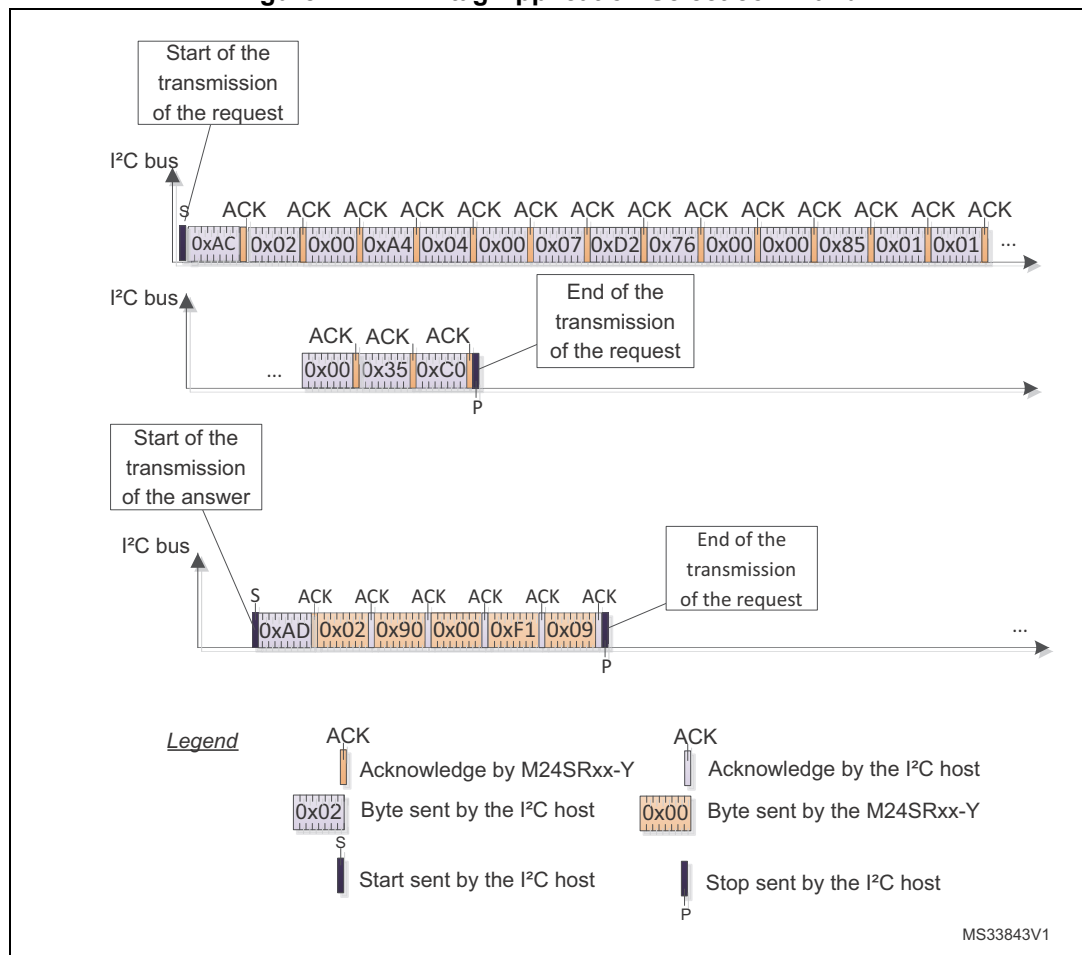
Before sending a new command, the I<sup>2</sup>C host can send an I<sup>2</sup>C frame to read the M24SR02-Y answer to the NDEF tag Application Select command.

Table 71. M24SR02-Y to I<sup>2</sup>C host

| Field                    | SOD                                |                                    | Payload | EOD            |
|--------------------------|------------------------------------|------------------------------------|---------|----------------|
|                          | I <sup>2</sup> C host to M24SR02-Y | M24SR02-Y to I <sup>2</sup> C host |         |                |
| Value                    | 0xAD                               | 0x02 or 0x03                       | 0x90 00 | F1 09 or 2D 53 |
| Device select            |                                    |                                    |         |                |
| PCB field                |                                    |                                    |         |                |
| I <sup>2</sup> C command |                                    |                                    |         |                |
| 2 CRC bytes              |                                    |                                    |         |                |

Figure 14 shows the I<sup>2</sup>C frame of the NDEF tag Application Select command.

Figure 14. NDEF tag Application Select command



## 7.10 Open an I<sup>2</sup>C session

To open an I<sup>2</sup>C session, the I<sup>2</sup>C host must send either the GetSession command or the KillRFsession command. The GetSession Command opens an I<sup>2</sup>C session if an RF session is not currently opened.

A KillRFsession command closes the current RF session if it exists, and opens an I<sup>2</sup>C session.

When an I<sup>2</sup>C session is opened, the RF host cannot communicate with the M24SR02-Y and cannot close the I<sup>2</sup>C session.

## 7.11 Close the I<sup>2</sup>C session

There are four ways to close an I<sup>2</sup>C session:

- turn off the Vcc power supply
- send the I<sup>2</sup>C token release sequence
- wait for the I<sup>2</sup>C watchdog when it is enabled
- wait for the I<sup>2</sup>C timeout on clock period.

## 8 Functional procedures

This section describes some procedure to access the memory or manage its protection.

### 8.1 Selection of an NDEF message

The RF or I<sup>2</sup>C host must use this procedure to detect the NDEF message inside an M24SR02-Y.

The NDEF detection procedure is as follows:

1. Open an RF or an I<sup>2</sup>C session
2. Send the SelectNDEFTagApplication command
3. Select the CC file
4. Read the CC file
5. Select the NDEF file

### 8.2 Reading of an NDEF message

The RF or I<sup>2</sup>C host executes the NDEF read procedure to read the NDEF file.

1. Detect successfully the NDEF file using the NDEF detection procedure
2. Check that the read access without any security is granted for the NDEF file from the information provided by the CC file
3. Select the NDEF file
4. Read the NDEF file

*Note:* Reading the NDEF file must not go beyond the NDEF Length field (NLEN), which indicates the size of the NDEF message stored in the NDEF file.

### 8.3 Reading a locked NDEF file

The RF or I<sup>2</sup>C host executes this procedure to read an NDEF file that has been previously locked.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Verify the Read password by using the Verify command
4. Read the data in the NDEF file

## 8.4 Locking an NDEF file

The RF or I<sup>2</sup>C host executes this procedure to protect an NDEF file.

1. Select the NDEF Tag Application
2. Check the right access provided by the CC file
3. Select the NDEF file
4. Transmit the NDEF file Write password by using the Verify command
5. Lock the NDEF file by sending the Enable verification command.

## 8.5 Unlocking an NDEF file

The RF or I<sup>2</sup>C host executes this procedure to unlock an NDEF file that has been previously locked.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Verify the NDEF file Write password or the I<sup>2</sup>C password by using the Verify command
4. Unlock the NDEF file by sending the Disable verification command.

## 8.6 Reaching the read-only state for an NDEF file

The RF or I<sup>2</sup>C host executes this procedure to reach the read-only state for an NDEF file.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Transmit the NDEF file Write password or the I<sup>2</sup>C password by using the Verify command
4. Send an EnablePermanentState command as the Write access right of the previous Select NDEF file.

## 8.7 Changing an NDEF password procedure

The RF or I<sup>2</sup>C host could use this procedure to change one NDEF password. it can be a Read or Write password.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Transmit the NDEF file Write password or the I<sup>2</sup>C password by using the Verify command
4. Change the password by sending a ChangeReferenceData command.

## 8.8 Changing a File type Procedure

The RF or I<sup>2</sup>C host executes this procedure to change the File Type of a file for which all access rights were previously granted.

1. Select the NDEF Tag Application
2. Select the File to be modified
3. Set the File Length to 0x00 using the UpdateBinary command
4. Send an UpdateFileType command with the New file Type as data.

## 8.9 Updating an NDEF file

When there's enough space in the file to update it with new content, the following steps must be followed to update the NDEF message:

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Unlock the NDEF file if necessary
4. Write the NDEF length to 0x0000 with the Update Binary command.
5. Write the NDEF message in the NDEF message field using one or more Update Binary commands.
6. Write the NDEF length of the NDEF message using the Update Update command.

It is recommended the NDEF length is read back and checked against the desired value to ensure the Update sequence has been correctly performed.

# 9      UID: unique identifier

The M24SR02-Y is uniquely identified by a 7-byte unique identifier (UID). The UID is a read-only code and comprises:

- the IC manufacturer code on 1 byte (0x02 for STMicroelectronics)
- the product code on 1 byte
- a device number on 5 bytes.

*Table 72* describes the UID format.

**Table 72. UID format**

| -                      | 0x02 | 0x82 | 5 bytes |
|------------------------|------|------|---------|
| IC manufacturer code   |      |      |         |
| M24SR02-Y product code |      |      |         |
| Device number          |      |      |         |

## 10 Maximum ratings

Stressing the device above the ratings listed in [Table 73](#) may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect the device reliability.

**Table 73. Absolute maximum ratings**

| Symbol                            | Parameter                                                             |                                                | Min.                    | Max.             | Unit   |
|-----------------------------------|-----------------------------------------------------------------------|------------------------------------------------|-------------------------|------------------|--------|
| $T_A$                             | Ambient operating temperature                                         |                                                | -40                     | 85               | °C     |
| $T_{STG}$ , $h_{STG}$ , $t_{STG}$ | Storage conditions                                                    | Sawn wafer on UV tape                          | 15                      | 25               | °C     |
|                                   |                                                                       |                                                |                         | 9 <sup>(1)</sup> | months |
|                                   |                                                                       | Kept in its original packing form              |                         |                  |        |
| $T_{STG}$                         | Storage temperature                                                   | UFDFPN8, SO8, TSSOP8                           | -65                     | 150              | °C     |
| $T_{STG}$                         | Storage temperature                                                   | Sawn bumped wafer (kept in its antistatic bag) | 15                      | 25               | °C     |
|                                   | Storage time                                                          |                                                |                         | 9                | months |
| $T_{LEAD}$                        | Lead temperature during soldering                                     | UFDFPN8, SO8, TSSOP8                           | See note <sup>(2)</sup> |                  | °C     |
| $V_{IO}$                          | I <sup>2</sup> C input or output range and GPO                        |                                                | -0.50                   | 6.5              | V      |
| $I_{CC}^{(3)}$                    | RF supply current AC0 - AC1                                           |                                                | -                       | 100              | mA     |
| $V_{MAX\_1}^{(3)}$                | RF input voltage amplitude between AC0 and AC1, GND pad left floating | VAC0-VAC1                                      | -                       | 10               | V      |
| $V_{MAX\_2}^{(3)}$                | AC voltage between AC0 and GND, or AC1 and GND                        | VAC0-GND or VAC1-GND                           | -0.5                    | 4.5              | V      |
| $V_{ESD}$                         | Electrostatic discharge voltage (human body model) <sup>(4)</sup>     | AC0-AC1                                        | -                       | 1000             | V      |
| $V_{ESD}$                         | Electrostatic discharge voltage (human body model) <sup>(4)</sup>     | Other pads                                     | -                       | 3500             | V      |

1. Counted from ST shipment date.
2. Compliant with JEDEC Std J-STD-020D (for small body, Sn-Pb or Pb assembly), the ST ECOPACK 7191395 specification, and the European directive on Restrictions on Hazardous Substances (ROHS directive 2011/65/EU, July 2011).
3. Based on characterization, not tested in production. Maximum adsorbed power = 100 mW @ 7.5 A/m
4. AEC-Q100-002 (compliant with JEDEC Std JESD22-A114A, C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω)

## 11 I<sup>2</sup>C DC and AC parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device in I<sup>2</sup>C mode. The parameters in the DC and AC characteristic tables that follow are derived from tests performed under the measurement conditions summarized in the relevant tables. Designers must check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

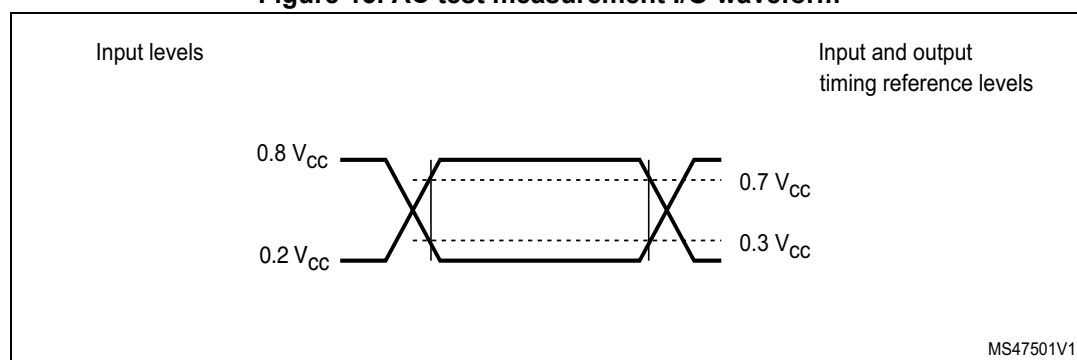
**Table 74. I<sup>2</sup>C operating conditions**

| Symbol          | Parameter                     | Min. | Max. | Unit |
|-----------------|-------------------------------|------|------|------|
| V <sub>CC</sub> | Supply voltage                | 2.7  | 5.5  | V    |
| T <sub>A</sub>  | Ambient operating temperature | – 40 | 85   | °C   |

**Table 75. AC test measurement conditions**

| Symbol                          | Parameter                                | Min.                                       | Max. | Unit |
|---------------------------------|------------------------------------------|--------------------------------------------|------|------|
| C <sub>L</sub>                  | Load capacitance                         | 100                                        |      | pF   |
| t <sub>r</sub> , t <sub>f</sub> | Input rise and fall times                | -                                          | 50   | ns   |
| V <sub>hi-lo</sub>              | Input levels                             | 0.2 V <sub>CC</sub> to 0.8 V <sub>CC</sub> |      | V    |
| V <sub>ref(t)</sub>             | Input and output timing reference levels | 0.3 V <sub>CC</sub> to 0.7 V <sub>CC</sub> |      | V    |

**Figure 15. AC test measurement I/O waveform**



**Table 76. Input parameters**

| Symbol          | Parameter                                         | Min. | Max. | Unit |
|-----------------|---------------------------------------------------|------|------|------|
| C <sub>IN</sub> | Input capacitance (SDA)                           | -    | 8    | pF   |
| C <sub>IN</sub> | Input capacitance (other pins)                    | -    | 6    | pF   |
| t <sub>NS</sub> | Pulse width ignored (Input filter on SCL and SDA) | -    | 80   | ns   |

Table 77. I<sup>2</sup>C DC characteristics

| Symbol           | Parameter                                        | Test condition                                                                   | Min.                | Max.                | Unit |
|------------------|--------------------------------------------------|----------------------------------------------------------------------------------|---------------------|---------------------|------|
| I <sub>LI</sub>  | Input leakage current (SCL, SDA)                 | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub><br>device in Standby mode   | -                   | ± 2                 | μA   |
| I <sub>LO</sub>  | Output leakage current                           | SDA in Hi-Z, external voltage applied on SDA: V <sub>SS</sub> or V <sub>CC</sub> | -                   | ± 2                 | μA   |
| I <sub>CC0</sub> | Standby power mode supply current                | V <sub>CC</sub> = 3.3 V, with RF ON                                              | -                   | 30                  | μA   |
|                  |                                                  | V <sub>CC</sub> = 3.3 V, with RF OFF                                             | -                   | 5                   |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V, with RF ON <sup>(1)</sup>                               | -                   | 30                  |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V, with RF OFF                                             | -                   | 5                   |      |
| I <sub>CC1</sub> | Supply current (I <sup>2</sup> C Session open)   | V <sub>CC</sub> = 3.3 V, with RF ON                                              | -                   | 150                 | μA   |
|                  |                                                  | V <sub>CC</sub> = 3.3 V, with RF OFF                                             | -                   | 150                 |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V, with RF ON                                              | -                   | 150                 |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V, with RF OFF                                             | -                   | 150                 |      |
| I <sub>CC2</sub> | Supply current <sup>(2)</sup><br>(Read binary)   | V <sub>CC</sub> = 3.3 V (f <sub>C</sub> = 1 MHz), with RF ON <sup>(3)</sup>      | -                   | 250                 | μA   |
|                  |                                                  | V <sub>CC</sub> = 3.3 V (f <sub>C</sub> = 1 MHz), with RF OFF <sup>(3)</sup>     | -                   | 200                 |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V (f <sub>C</sub> = 1 MHz), with RF ON <sup>(3)</sup>      | -                   | 250                 |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V (f <sub>C</sub> = 1 MHz), with RF OFF <sup>(3)</sup>     | -                   | 200                 |      |
| I <sub>CC3</sub> | Supply current <sup>(2)</sup><br>(Update binary) | V <sub>CC</sub> = 3.3 V (f <sub>C</sub> = 1 MHz), with RF ON <sup>(3)</sup>      | -                   | 550                 | μA   |
|                  |                                                  | V <sub>CC</sub> = 3.3 V (f <sub>C</sub> = 1 MHz), with RF OFF <sup>(3)</sup>     | -                   | 500                 |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V (f <sub>C</sub> = 1 MHz), with RF ON <sup>(3)</sup>      | -                   | 550                 |      |
|                  |                                                  | V <sub>CC</sub> = 5.5 V (f <sub>C</sub> = 1 MHz), with RF OFF <sup>(3)</sup>     | -                   | 500                 |      |
| V <sub>IL</sub>  | Input low voltage (SDA, SCL)                     | V <sub>CC</sub> = 2.7 V<br>V <sub>CC</sub> = 5.5 V                               | -0.45               | 0.3 V <sub>CC</sub> | V    |
| V <sub>IH</sub>  | Input high voltage (SDA, SCL)                    | V <sub>CC</sub> = 2.7 V<br>V <sub>CC</sub> = 5.5 V                               | 0.7 V <sub>CC</sub> | 6.5                 | V    |
| V <sub>IL</sub>  | Input low voltage (RF disable)                   | V <sub>CC</sub> = 2.7 V<br>V <sub>CC</sub> = 5.5 V                               | -                   | 0.45                | V    |
| V <sub>IH</sub>  | Input high voltage (RF disable)                  | V <sub>CC</sub> = 2.7 V<br>V <sub>CC</sub> = 5.5 V                               | 1.4                 | -                   | V    |
| V <sub>OL</sub>  | Output low voltage (SDA)                         | I <sub>OL</sub> = 3 mA, V <sub>CC</sub> = 5.5 V                                  | -                   | 0.4                 | V    |
|                  | Output low voltage (GPO)                         | I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 2.7 to 5.5 V                           | -                   | 0.4                 | V    |

1. When an RF session is Opened, I<sub>CC</sub> corresponds to the standby power mode.

2. Characterized only.

3. Input levels as defined in [Figure 15](#).

Table 78. I<sup>2</sup>C AC characteristics (400 kHz)

| Test conditions specified in <a href="#">Table 74</a><br>(preliminary data based on design simulations) |              |                                                      |       |       |         |
|---------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------|-------|-------|---------|
| Symbol                                                                                                  | Alt.         | Parameter                                            | Min.  | Max.  | Unit    |
| $f_C$                                                                                                   | $f_{SCL}$    | Clock frequency                                      | 0.05  | 400   | kHz     |
| $t_{CHCL}^{(1)}$                                                                                        | $t_{HIGH}$   | Clock pulse width high                               | 0.6   | 20000 | $\mu s$ |
| $t_{CLCH}^{(2)}$                                                                                        | $t_{LOW}$    | Clock pulse width low                                | 1.3   | 20000 | $\mu s$ |
| $t_{CL\_reset}$                                                                                         | -            | Clock reset                                          | 40000 | -     | $\mu s$ |
| $t_{XH1XH2}$                                                                                            | $t_R$        | Input signal rise time                               | (3)   | (3)   | ns      |
| $t_{XL1XL2}$                                                                                            | $t_F$        | Input signal fall time                               | (3)   | (3)   | ns      |
| $t_{DL1DL2}$                                                                                            | $t_F$        | SDA (out) fall time                                  | 20    | 300   | ns      |
| $t_{DXCX}$                                                                                              | $t_{SU:DAT}$ | Data in set up time                                  | 100   | -     | ns      |
| $t_{CLDX}$                                                                                              | $t_{HD:DAT}$ | Data in hold time                                    | 0     | -     | ns      |
| $t_{CLQX}^{(4)}$                                                                                        | $t_{DH}$     | Data out hold time                                   | 100   | -     | ns      |
| $t_{CLQV}^{(5)}$                                                                                        | $t_{AA}$     | Clock low to next data valid (access time)           | -     | 900   | ns      |
| $t_{CHDX}^{(6)}$                                                                                        | $t_{SU:STA}$ | Start condition set up time                          | 600   | -     | ns      |
| $t_{DLCL}$                                                                                              | $t_{HD:STA}$ | Start condition hold time                            | 600   | -     | ns      |
| $t_{CHDH}$                                                                                              | $t_{SU:STO}$ | Stop condition set up time                           | 600   | -     | ns      |
| $t_{DHDL}$                                                                                              | $t_{BUF}$    | Time between Stop condition and next Start condition | 1300  | -     | ns      |
| $t_W$                                                                                                   | $t_{WR}$     | I <sup>2</sup> C write time in one page              | -     | 5     | ms      |
|                                                                                                         |              | I <sup>2</sup> C write time up to 246 bytes          | -     | 90    | ms      |
| $t_{NS}^{(7)}$                                                                                          | -            | Pulse width ignored (input filter on SCL and SDA)    | -     | 80    | ns      |
| $t_{START\_OUT}$                                                                                        | -            | Delay for I <sup>2</sup> C token release             | 20    | 40    | ms      |

1.  $t_{CHCL}$  timeout.2.  $t_{CLCH}$  timeout.3. There is no min. or max. value for the input signal rise and fall times. It is however recommended by the I<sup>2</sup>C specification that the input signal rise and fall times be more than 20 ns and less than 300 ns when  $f_C < 400$  kHz.

4. To avoid spurious Start and Stop conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.

5.  $t_{CLQV}$  is the time (from the falling edge of SCL) required by the SDA bus line to reach  $0.8V_{CC}$  in a compatible way with the I<sup>2</sup>C specification (which specifies  $t_{SU:DAT}$  (min) = 100 ns), assuming that the  $R_{bus} \times C_{bus}$  time constant is less than 500 ns (as specified in [Figure 16](#)).

6. For a restart condition, or following a write cycle.

7. Characterized only, not tested in production.

Table 79. I<sup>2</sup>C AC characteristics (1 MHz)

| Test conditions specified in <a href="#">Table 74</a><br>(preliminary data based on design simulations) |              |                                                      |      |      |      |
|---------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------|------|------|------|
| Symbol                                                                                                  | Alt.         | Parameter                                            | Min. | Max. | Unit |
| $f_C$                                                                                                   | $f_{SCL}$    | Clock frequency                                      | 0.05 | 1000 | kHz  |
| $t_{CHCL}^{(1)}$                                                                                        | $t_{HIGH}$   | Clock pulse width high                               | 260  | -    | ns   |
| $t_{CLCH}^{(2)}$                                                                                        | $t_{LOW}$    | Clock pulse width low                                | 500  | -    | ns   |
| $t_{XH1XH2}$                                                                                            | $t_R$        | Input signal rise time                               | (3)  | (3)  | ns   |
| $t_{XL1XL2}$                                                                                            | $t_F$        | Input signal fall time                               | (3)  | (3)  | ns   |
| $t_{DL1DL2}$                                                                                            | $t_F$        | SDA (out) fall time                                  | 20   | 120  | ns   |
| $t_{DXCX}$                                                                                              | $t_{SU:DAT}$ | Data in set up time                                  | 50   | -    | ns   |
| $t_{CLDX}$                                                                                              | $t_{HD:DAT}$ | Data in hold time                                    | 0    | -    | ns   |
| $t_{CLQX}$                                                                                              | $t_{DH}$     | Data out hold time                                   | 100  | -    | ns   |
| $t_{CLQV}^{(4)(5)}$                                                                                     | $t_{AA}$     | Clock low to next data valid (access time)           | -    | 450  | ns   |
| $t_{CHDX}^{(6)}$                                                                                        | $t_{SU:STA}$ | Start condition set up time                          | 250  | -    | ns   |
| $t_{DLCL}$                                                                                              | $t_{HD:STA}$ | Start condition hold time                            | 250  | -    | ns   |
| $t_{CHDH}$                                                                                              | $t_{SU:STO}$ | Stop condition set up time                           | 250  | -    | ns   |
| $t_{DHDL}$                                                                                              | $t_{BUF}$    | Time between Stop condition and next Start condition | 500  | -    | ns   |
| $t_W$                                                                                                   | $t_{WR}$     | I <sup>2</sup> C write time in one page              | -    | 5    | ms   |
|                                                                                                         |              | I <sup>2</sup> C write time up to 246 bytes          | -    | 90   | ms   |
| $t_{NS}^{(7)}$                                                                                          | -            | Pulse width ignored (input filter on SCL and SDA)    | -    | 80   | ns   |

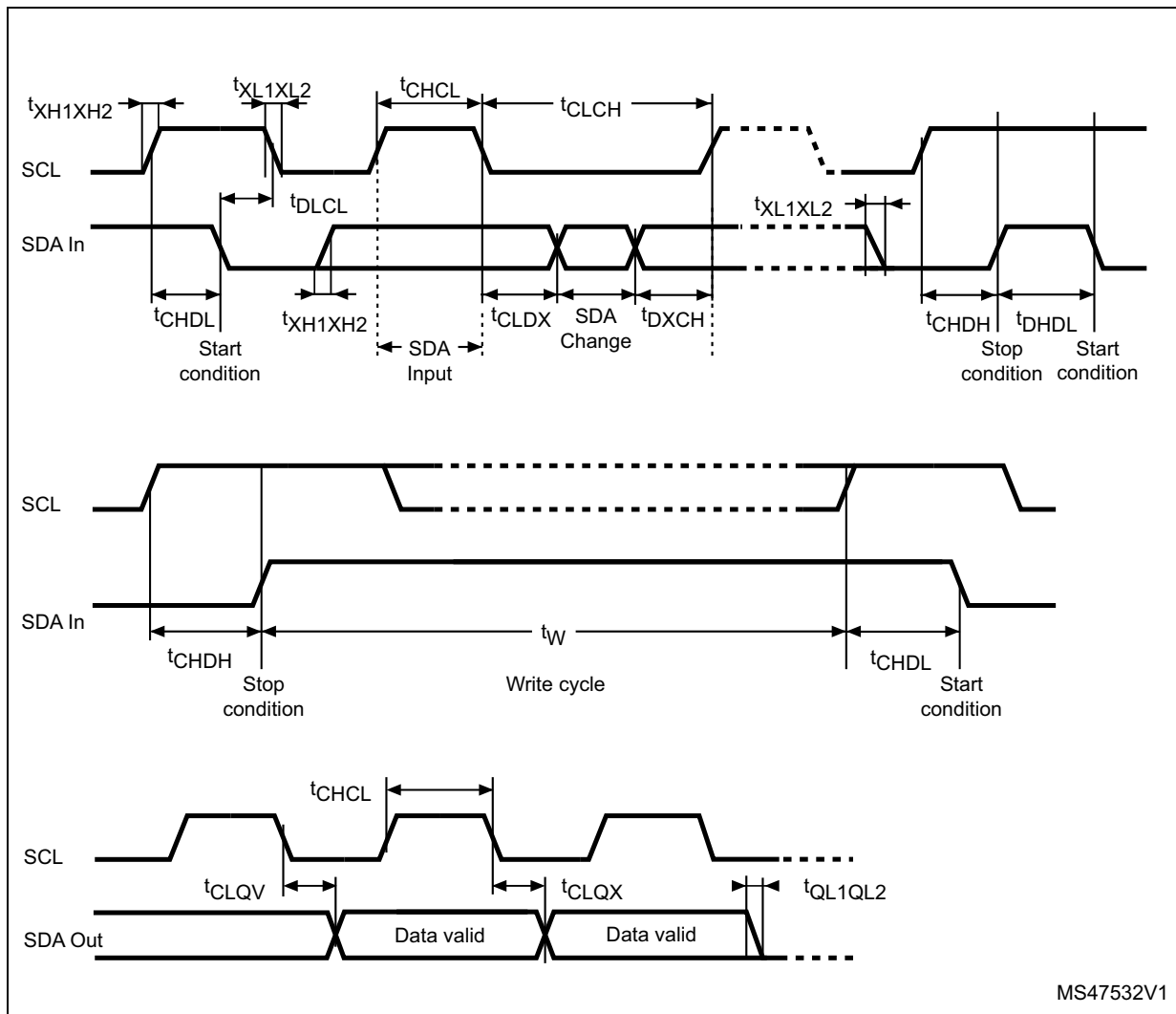
1.  $t_{CHCL}$  timeout.2.  $t_{CLCH}$  timeout.3. There is no min. or max. value for the input signal rise and fall times. It is however recommended by the I<sup>2</sup>C specification that the input signal rise and fall times be less than 120 ns when  $f_C < 1$  MHz.

4. To avoid spurious Start and Stop conditions, a minimum delay is placed between SCL = 1 and the falling or rising edge of SDA.

5.  $t_{CLQV}$  is the time (from the falling edge of SCL) required by the SDA bus line to reach  $0.8V_{CC}$  in a compatible way with the I<sup>2</sup>C specification (which specifies  $t_{SU:DAT}(\min) = 100$  ns), assuming that the  $R_{bus} \times C_{bus}$  time constant is less than 500 ns (as specified in [Figure 16](#)).

6. For a reStart condition, or following a write cycle.

7. Characterized only, not tested in production.

Figure 16. I<sup>2</sup>C AC waveforms

## 11.1 I<sup>2</sup>C timing measurement condition

Figure 17 represents the maximum  $R_{bus}$  value versus bus parasitic capacitance ( $C_{bus}$ ) for an I<sup>2</sup>C bus at maximum frequency  $f_C = 400$  kHz.

Figure 17. Maximum  $R_{bus}$  value with  $f_C = 400$  kHz

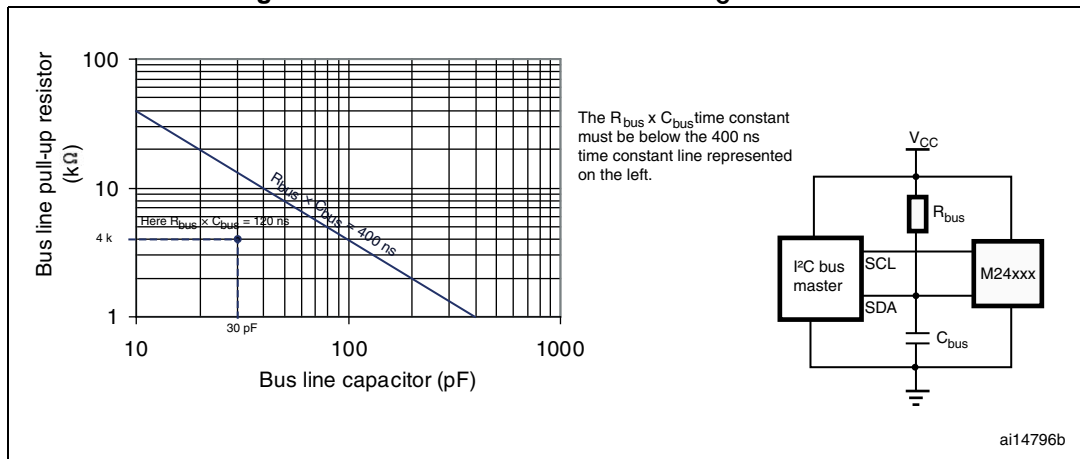


Figure 18 represents the Maximum  $R_{bus}$  value versus bus parasitic capacitance ( $C_{bus}$ ) for an I<sup>2</sup>C bus at maximum frequency  $f_C = 1$  MHz.

Figure 18. Maximum  $R_{bus}$  value with  $f_C = 1$  MHz

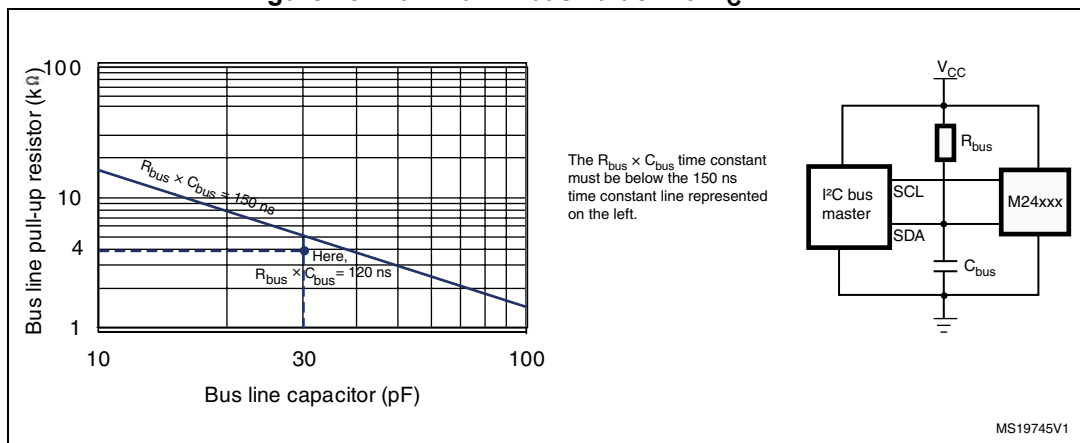


Figure 19. I<sup>2</sup>C bus protocol

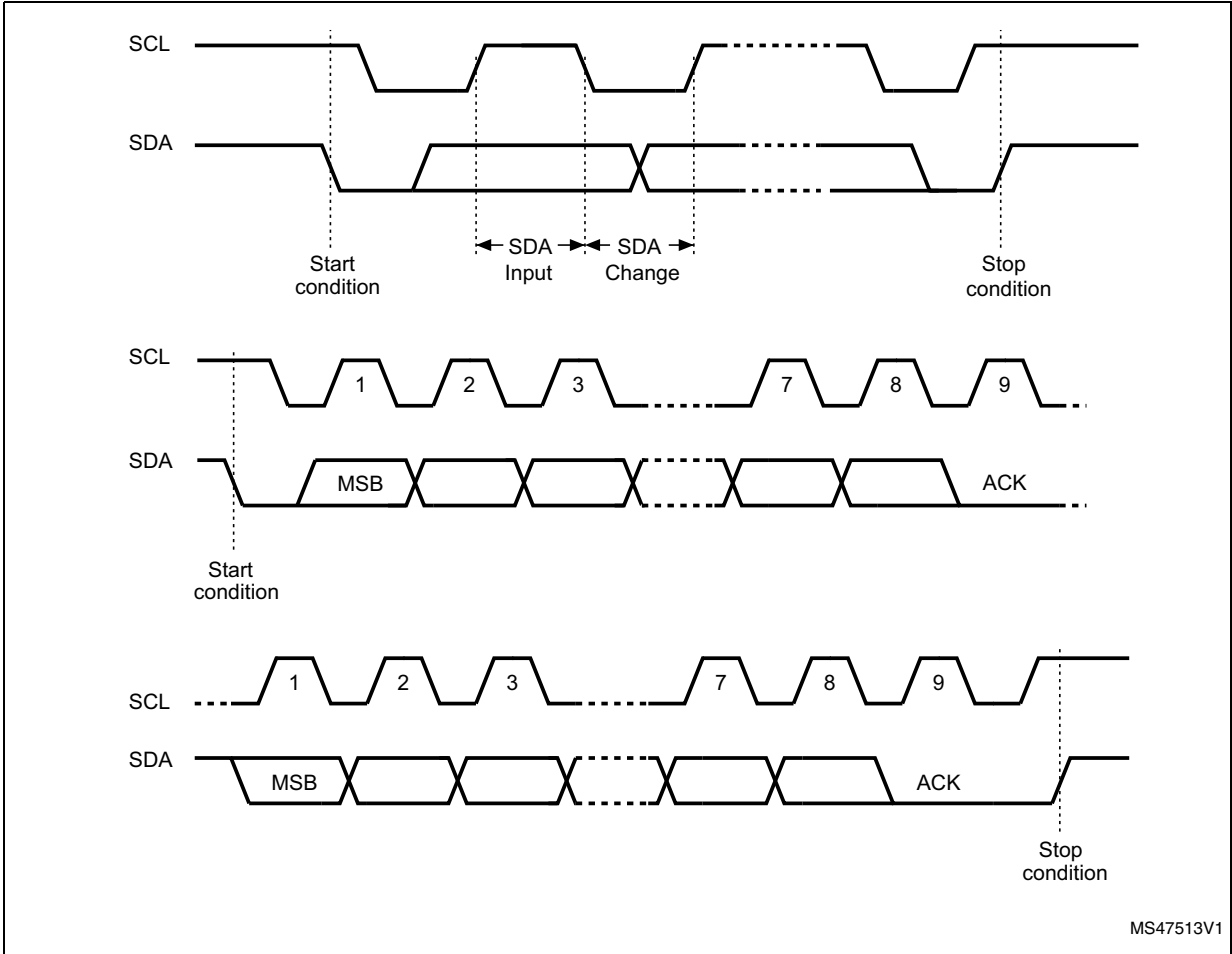


Table 80. Device select code

| Device type identifier <sup>(1)</sup> |    |    |    | Chip Enable address |    |    | RW |
|---------------------------------------|----|----|----|---------------------|----|----|----|
| b7                                    | b6 | b5 | b4 | b3                  | b2 | b1 | b0 |
| 1                                     | 0  | 1  | 0  | 1                   | 1  | 0  | RW |

1. The most significant bit, b7, is sent first.

## 12 GPO parameters

This section lists the timing of the GPO according to its configuration.

**Table 81. GPO timings measurement <sup>(1)</sup>**

| GPO field           |      | I/F              | Condition                                    | Command                                 | Symbol                                    | Typ.              | Unit     |
|---------------------|------|------------------|----------------------------------------------|-----------------------------------------|-------------------------------------------|-------------------|----------|
| Session open        | 0xX1 | I <sup>2</sup> C | GPO low when session active                  | Kill session                            | CmdSTPtoGPlow                             | 15 <sup>(2)</sup> | µs       |
|                     |      |                  |                                              | Get session                             |                                           | 15 <sup>(2)</sup> |          |
|                     |      | I <sup>2</sup> C | GPO return HZ                                | I <sup>2</sup> C token release sequence | AnswerlbLBtoGPHZ                          | 105               | ns       |
|                     | 0x1X | RF               | GPO low when session active                  | NDEF select                             | CmdEOFtoGPlow                             | 170               | µs       |
|                     |      | RF               | GPO return HZ                                | Deselect                                | CmdEOFtoGPHZ                              | 370               |          |
| WIP                 | 0xX2 | I <sup>2</sup> C | GPO low when programming                     | Update Binary                           | CmdSTPtoGPlow                             | 45                | µs       |
|                     |      | I <sup>2</sup> C |                                              |                                         | Writing time duration (No time extension) | 5                 | ms       |
|                     |      | RF               | GPO low when programming                     | Update Binary                           | CmdEOFtoGPlow                             | 75                | µs       |
|                     | 0x2X | RF               |                                              |                                         | Writing time duration (No time extension) | 5                 | ms       |
| Answer ready        | 0xX3 | I <sup>2</sup> C | GPO low when a command is computed           | ReadBinary or UpdateBinary              | CmdSTPtoGPlow                             | 55 or 5           | µs<br>ms |
|                     |      | I <sup>2</sup> C | GPO return HZ on new command                 | All commands                            | After NewCmdlbFB or AnswerlbFB            | 105               | ns       |
| Message in progress | 0x3X | RF               | GPO low when modifying NDEF                  | UpdateBinary (Msg Length #0)            | CmdEOFtoGPlow                             | 75                | µs       |
|                     |      | RF               | GPO low when modifying NDEF                  | UpdateBinary                            | Writing time duration (No time extension) | 5                 | ms       |
| Interrupt           | 0xX4 | I <sup>2</sup> C | GPO low after receiving an Interrupt command | SendInterrupt                           | CmdSTPtoGPlow                             | 50                | µs       |
|                     |      | I <sup>2</sup> C | GPO return HZ                                | All commands                            | After NewCmdlbFB or AnswerlbFB            | 105               | ns       |
|                     | 0x4X | RF               | GPO low after receiving an Interrupt command | SendInterrupt                           | CmdEOFtoGPlow                             | 75                | µs       |
|                     |      | RF               |                                              |                                         | Pulse duration                            | 540               |          |

Table 81. GPO timings measurement <sup>(1)</sup> (continued)

| GPO field     |      | I/F              | Condition                                                         | Command                                                                          | Symbol        | Typ. | Unit |
|---------------|------|------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------|------|------|
| State control | 0xX5 | I <sup>2</sup> C | GPO low when reset                                                | Reset GPO                                                                        | CmdSTPtoGPlow | 40   | μs   |
|               |      | I <sup>2</sup> C | GPO return HZ when set                                            | Set GPO                                                                          | CmdSTPtoGPHZ  | 40   |      |
|               | 0x5X | RF               | GPO low when reset                                                | Reset GPO                                                                        | CmdEOFtoGPlow | 60   |      |
|               |      | RF               | GPO return HZ when set                                            | Set GPO                                                                          | CmdEOFtoGPHZ  | 60   |      |
| RF busy       | 0x6X | RF               | GPO low after receiving an RF command                             | Anticollision command or start of RF disturb (command using another RF protocol) | CmdSOFtoGPlow | 6    |      |
|               |      | RF               | GPO return HZ after deselection or RF command in another protocol | Deselect or end of RF disturb (command using another RF protocol)                | CmdEOFtoGPHZ  | 460  |      |

1. Characterized only.

2. Add 100 μs for boot after POR.

## 13 Write cycle definition

**Table 82. Write cycle definition<sup>(1)</sup>**

| Symbol | Parameter                            | Test Conditions                                                             | Min | Max       | Units       |
|--------|--------------------------------------|-----------------------------------------------------------------------------|-----|-----------|-------------|
| Ncycle | Write cycle endurance <sup>(2)</sup> | $T_A \leq 25\text{ }^{\circ}\text{C}, V_{CC(\min)} < V_{CC} < V_{CC(\max)}$ | -   | 1,000,000 | Write cycle |
|        |                                      | $T_A \leq 85\text{ }^{\circ}\text{C}, V_{CC(\min)} < V_{CC} < V_{CC(\max)}$ | -   | 600,000   |             |

1. A write cycle is calculated per byte, and corresponds to a write to this byte.
2. Write cycle endurance is defined by characterization and qualification.

## 14 RF electrical parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device in RF mode.

The parameters in the following tables are derived from tests performed under the measurement conditions summarized in the relevant tables. Designers have to check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

**Table 83. Default operating conditions**

| Symbol | Parameter                     | Min. | Max. | Unit |
|--------|-------------------------------|------|------|------|
| $T_A$  | Ambient operating temperature | -40  | 85   | °C   |

**Table 84. RF characteristics <sup>(1)</sup>**

| Symbol         | Parameter                                              | Condition                             | Min              | Typ    | Max          | Unit    |
|----------------|--------------------------------------------------------|---------------------------------------|------------------|--------|--------------|---------|
| $f_C$          | External RF signal frequency                           |                                       | 13.553           | 13.560 | 13.567       | MHz     |
| $H_{ISO}$      | Operating field according to ISO                       | $T_A = 0\text{ °C to }50\text{ °C}$   | 1500             | -      | 7500         | mA/m    |
| $H_{Extended}$ | Operating field in extended temperature range          | $T_A = -40\text{ °C to }85\text{ °C}$ | 500              | -      | 7500         | mA/m    |
| $MI_{CARRIER}$ | 100% carrier modulation index                          | $MI=(A-B)/(A+B)$                      | 90               | -      | 100          | %       |
| $t_1$          | Pause A length                                         | -                                     | $28 / f_C$       | -      | $40.5 / f_C$ | $\mu s$ |
| $t_2$          | Pause A low time                                       | -                                     | $7 / f_C$        | -      | $t_1$        |         |
| $t_3$          | Pause A rise time                                      | -                                     | $1.5 \times t_4$ | -      | $16 / f_C$   |         |
| $t_4$          | Pause A rise time section                              | -                                     | 0                | -      | $6 / f_C$    |         |
| $t_{MIN CD}$   | Minimum time from carrier generation to first data     | From H-field min                      | -                | -      | 5            | ms      |
| $W_t$          | RF write time (including internal verify) for one page | -                                     | -                | 6      | -            |         |
| $C_{TUN}$      | Internal tuning capacitor in SO8 <sup>(2)</sup>        | $f_C = 13.56\text{ MHz}$              | 22.5             | 25     | 27.5         | pF      |
| $t_{RF\_OFF}$  | RF OFF time                                            | Chip reset                            | -                | -      | 5            | ms      |

- All timing characterizations are performed on a reference antenna with the following characteristics:  
 External size: 75 mm x 48 mm  
 Number of turns: 6  
 Width of conductor: 0.6 mm  
 Space between two conductors: 0.6 mm  
 Value of the tuning capacitor in SO8: 25 pF (M24SR02-Y)  
 Value of the coil: 5  $\mu H$   
 Tuning frequency: 14.2 MHz.
- Characterized only, at room temperature only, measured at VAC0-VAC1 = 2 V peak to peak at 13.56 MHz.

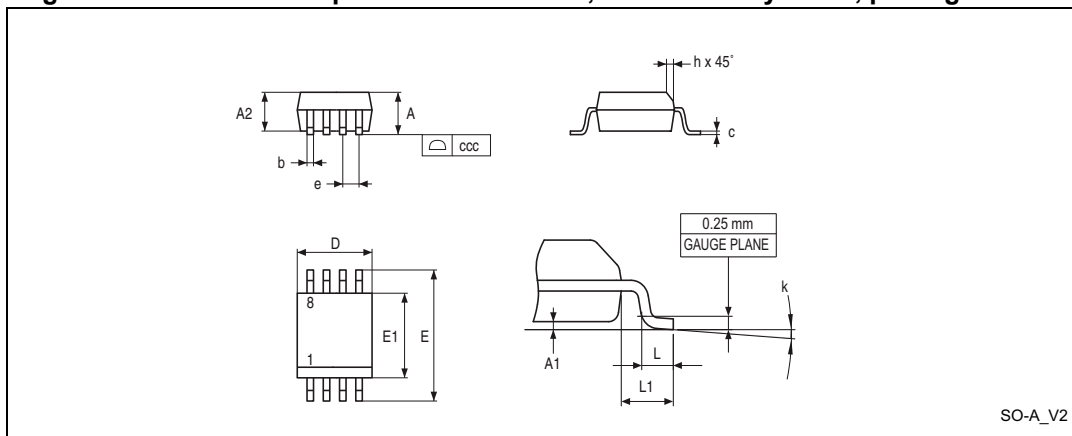
## 15 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

ECOPACK is an ST trademark.

### 15.1 SO8N package information

Figure 20. SO8N - 8-lead plastic small outline, 150 mils body width, package outline



1. Drawing is not to scale.

Table 85. SO8N - 8-lead plastic small outline, 150 mils body width, package data

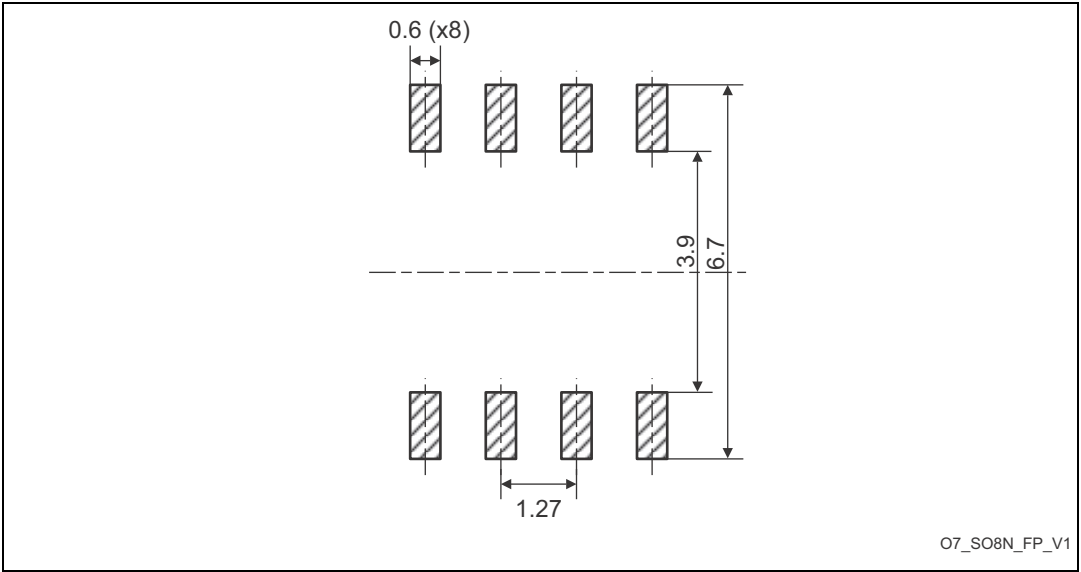
| Symbol | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|--------|-------------|-------|-------|-----------------------|--------|--------|
|        | Min         | Typ   | Max   | Min                   | Typ    | Max    |
| A      | -           | -     | 1.750 | -                     | -      | 0.0689 |
| A1     | 0.100       | -     | 0.250 | 0.0039                | -      | 0.0098 |
| A2     | 1.250       | -     |       | 0.0492                | -      | -      |
| b      | 0.280       | -     | 0.480 | 0.0110                | -      | 0.0189 |
| c      | 0.170       | -     | 0.230 | 0.0067                | -      | 0.0091 |
| D      | 4.800       | 4.900 | 5.000 | 0.1890                | 0.1929 | 0.1969 |
| E      | 5.800       | 6.000 | 6.200 | 0.2283                | 0.2362 | 0.2441 |
| E1     | 3.800       | 3.900 | 4.000 | 0.1496                | 0.1535 | 0.1575 |
| e      | -           | 1.270 | -     | -                     | 0.0500 | -      |
| h      | 0.250       | -     | 0.500 | 0.0098                | -      | 0.0197 |
| k      | 0°          | -     | 8°    | 0°                    | -      | 8°     |
| L      | 0.400       | -     | 1.270 | 0.0157                | -      | 0.0500 |

Table 85. SO8N - 8-lead plastic small outline, 150 mils body width, package data (continued)

| Symbol | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|--------|-------------|-------|-------|-----------------------|--------|--------|
|        | Min         | Typ   | Max   | Min                   | Typ    | Max    |
| L1     | -           | 1.040 | -     | -                     | 0.0409 | -      |
| ccc    | -           | -     | 0.100 | -                     | -      | 0.0039 |

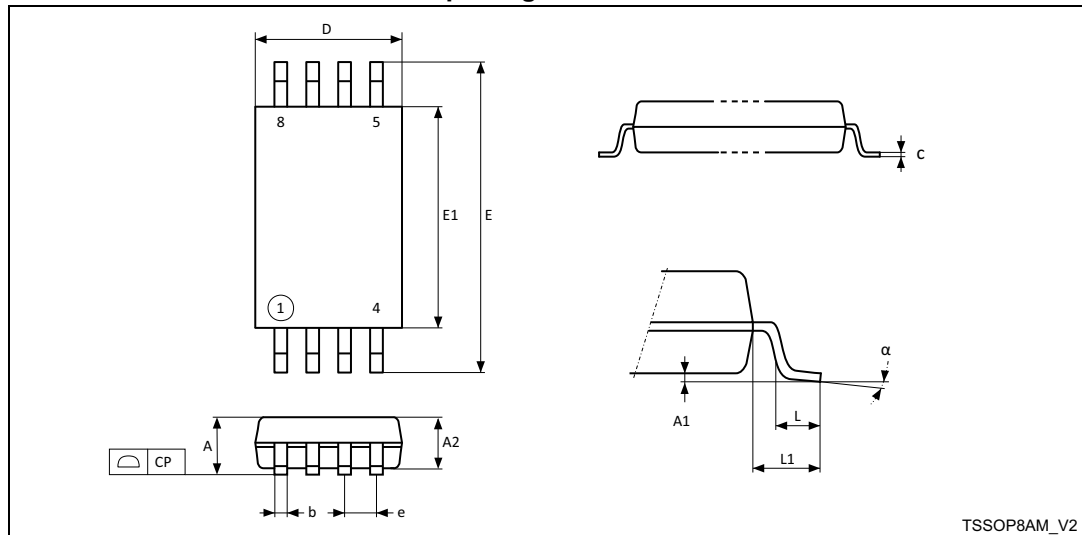
1. Values in inches are converted from mm and rounded to four decimal digits.

Figure 21. SO8N - 8-lead plastic small outline, 150 mils body width, package recommended footprint



## 15.2 TSSOP8 package information

**Figure 22. TSSOP8 – 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch, package outline**



1. Drawing is not to scale.

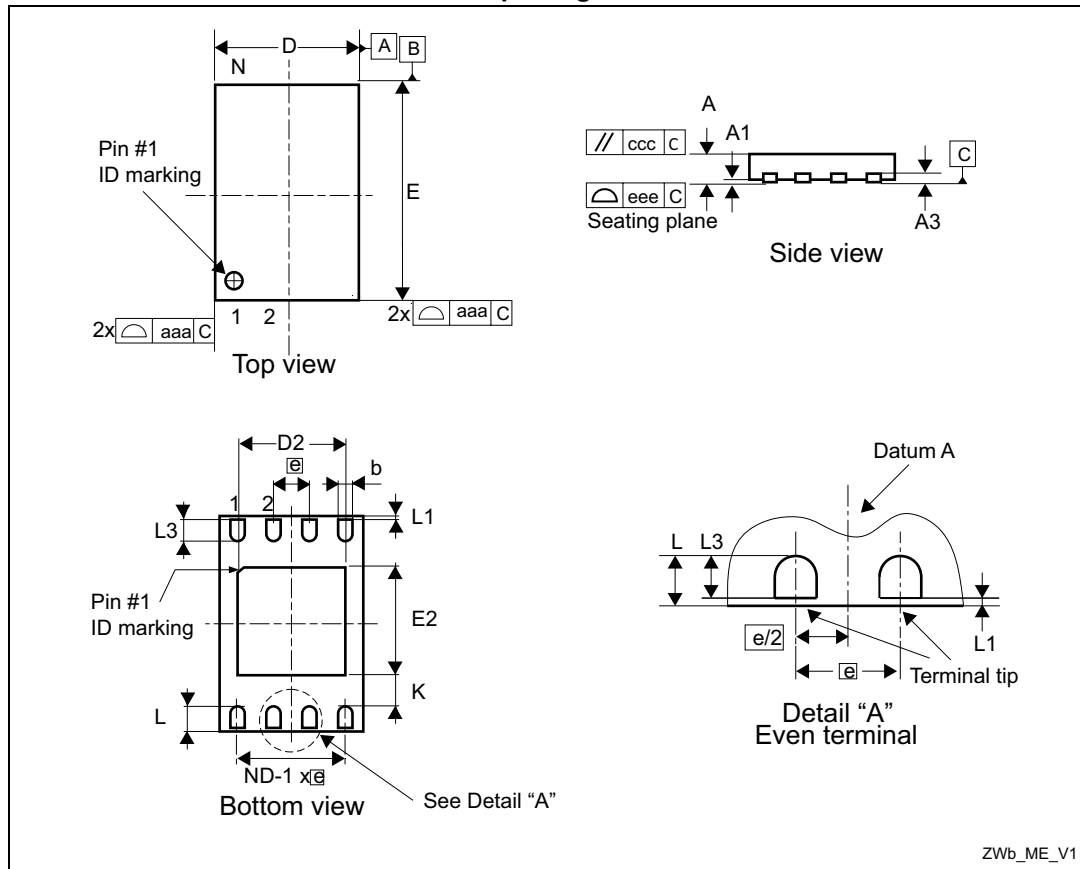
**Table 86. TSSOP8 – 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch, package mechanical data**

| Symbol   | millimeters |       |       | inches <sup>(1)</sup> |         |        |
|----------|-------------|-------|-------|-----------------------|---------|--------|
|          | Typ         | Min   | Max   | Typ                   | Min     | Max    |
| A        | -           | -     | 1.200 | -                     | -       | 0.0472 |
| A1       | 0.050       | -     | 0.150 | 0.0020                | -       | 0.0059 |
| A2       | 0.800       | 1.000 | 1.050 | 0.0315                | 0.0394  | 0.0413 |
| b        | 0.190       | -     | 0.300 | 0.0075                | -       | 0.0118 |
| c        | 0.090       | -     | 0.200 | 0.0035                | -       | 0.0079 |
| CP       | -           | -     | 0.100 | -                     | -       | 0.0039 |
| D        | 2.900       | 3.000 | 3.100 | 0.1142                | 0.1181  | 0.1220 |
| e        | -           | 0.650 | -     | -                     | 0.0256  | -      |
| E        | 6.200       | 6.400 | 6.600 | 0.2441                | 0.2520  | 0.2598 |
| E1       | 4.300       | 4.400 | 4.500 | 0.1693                | 0.1732  | 0.1772 |
| L        | 0.450       | 0.600 | 0.750 | 0.0177                | 0.02636 | 0.0295 |
| L1       | -           | 1.000 | -     | -                     | 0.0394  | -      |
| $\alpha$ | 0°          |       | 8°    | 0°                    | -       | 8°     |

1. Values in inches are converted from mm and rounded to four decimal digits.

### 15.3 UDFPN8 package information

Figure 23. UDFPN8 - 8-lead, 2 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package outline



1. Max package warpage is 0.05 mm.
2. Exposed copper is not systematic and can appear partially or totally according to the cross section.
3. Drawing is not to scale.
4. The central pad (the area E2 by D2 in the above illustration) must be either connected to  $V_{SS}$  or left floating (not connected) in the end application.

**Table 87. UFDFPN8 - 8- lead, 2 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package mechanical data**

| Symbol             | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|--------------------|-------------|-------|-------|-----------------------|--------|--------|
|                    | Min         | Typ   | Max   | Min                   | Typ    | Max    |
| A                  | 0.450       | 0.550 | 0.600 | 0.0177                | 0.0217 | 0.0236 |
| A1                 | 0.000       | 0.020 | 0.050 | 0.0000                | 0.0008 | 0.0020 |
| b <sup>(2)</sup>   | 0.200       | 0.250 | 0.300 | 0.0079                | 0.0098 | 0.0118 |
| D                  | 1.900       | 2.000 | 2.100 | 0.0748                | 0.0787 | 0.0827 |
| D2 (rev MC)        | 1.200       | -     | 1.600 | 0.0472                | -      | 0.0630 |
| E                  | 2.900       | 3.000 | 3.100 | 0.1142                | 0.1181 | 0.1220 |
| E2 (rev MC)        | 1.200       | -     | 1.600 | 0.0472                | -      | 0.0630 |
| e                  | -           | 0.500 | -     | -                     | 0.0197 | -      |
| K (rev MC)         | 0.300       | -     | -     | 0.0118                | -      | -      |
| L                  | 0.300       | -     | 0.500 | 0.0118                | -      | 0.0197 |
| L1                 | -           | -     | 0.150 | -                     | -      | 0.0059 |
| L3                 | 0.300       | -     | -     | 0.0118                | -      | -      |
| aaa                | -           | -     | 0.150 | -                     | -      | 0.0059 |
| bbb                | -           | -     | 0.100 | -                     | -      | 0.0039 |
| ccc                | -           | -     | 0.100 | -                     | -      | 0.0039 |
| ddd                | -           | -     | 0.050 | -                     | -      | 0.0020 |
| eee <sup>(3)</sup> | -           | -     | 0.080 | -                     | -      | 0.0031 |

1. Values in inches are converted from mm and rounded to four decimal digits.
2. Dimension b applies to plated terminal and is measured between 0.15 and 0.30 mm from the terminal tip.
3. Applied for exposed die paddle and terminals. Exclude embedded part of exposed die paddle from measuring.

## 16 Ordering information

|                                                                                                                                                     |     |    |       |    |   |   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|-------|----|---|---|----|
| Example:                                                                                                                                            | M24 | SR | 02- Y | MN | 6 | T | /2 |
| <b>Device type</b>                                                                                                                                  |     |    |       |    |   |   |    |
| M24 = I <sup>2</sup> C interface device                                                                                                             |     |    |       |    |   |   |    |
| <b>Device feature</b>                                                                                                                               |     |    |       |    |   |   |    |
| SR = Short range                                                                                                                                    |     |    |       |    |   |   |    |
| <b>Memory size</b>                                                                                                                                  |     |    |       |    |   |   |    |
| 02 = memory size in Kbits                                                                                                                           |     |    |       |    |   |   |    |
| <b>Voltage range</b>                                                                                                                                |     |    |       |    |   |   |    |
| Y = 2.7 to 5.5 V                                                                                                                                    |     |    |       |    |   |   |    |
| <b>Package</b>                                                                                                                                      |     |    |       |    |   |   |    |
| MN = SO8N<br>DW = TSSOP8<br>MC = UFDFPN8<br>SG12I = 120 µm ± 15 µm bumped and sawn inkless wafer on 8-inch frame<br>U = unsawn wafer 725 µm ± 20 µm |     |    |       |    |   |   |    |
| <b>Device grade</b>                                                                                                                                 |     |    |       |    |   |   |    |
| 6 = industrial: device tested with standard test flow over –40 to 85 °C<br>(no parameter for SG12I)                                                 |     |    |       |    |   |   |    |
| <b>Option</b>                                                                                                                                       |     |    |       |    |   |   |    |
| T = Tape and reel packing<br>(no parameter for SG12I)                                                                                               |     |    |       |    |   |   |    |
| <b>Capacitance</b>                                                                                                                                  |     |    |       |    |   |   |    |
| /2 = 25 pF                                                                                                                                          |     |    |       |    |   |   |    |

**Note:** Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST Quality has to be contacted prior to any decision to use these Engineering samples to run qualification activity.

## 17 Revision history

**Table 88. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29-Oct-2013 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 09-Nov-2013 | 2        | Added a note to <a href="#">Section 7.1: I2C communication protocol</a> below <a href="#">Figure 12: Command and response exchange</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 20-Dec-2013 | 3        | <p>Changed the datasheet status from "Preliminary data" to "Production data".</p> <p>Restored the whole content of <a href="#">Table 77: I2C DC characteristics</a>.</p> <p>Updated the capacitor values in <a href="#">Section 2.5.1: Operating supply voltage VCC</a>.</p> <p>Removed bullet (4) from <a href="#">Section 8.6: Reaching the read-only state for an NDEF file</a>.</p> <p>Updated <math>V_{ESD}</math> value in <a href="#">Table 73: Absolute maximum ratings</a>, <math>I_{CC}</math> values in <a href="#">Table 77: I2C DC characteristics</a>, and <math>H_{Extended}</math> value in <a href="#">Table 84: RF characteristics</a>.</p> <p>Added details to "S(WTX)" bullet in <a href="#">Section 5.4: S-Block format</a>.</p> <p>Added sentences to <a href="#">Section 5.6.8: UpdateBinary command</a> and to <a href="#">Section 5.8.3: DisablePermanentState command</a>.</p> <p>Changed '0x001E' value into '0x001F' in <a href="#">Table 56: StateControl command format</a>.</p> <p>Updated values in <a href="#">Table 61: ATS response</a>.</p> <p>Added Note (4) to <a href="#">Figure 10: Changing the read access right to an NDEF file</a> and <a href="#">Figure 11: Changing the write access right to an NDEF file</a>.</p>                                                                |
| 28-Feb-2014 | 4        | <p>Updated <a href="#">Figure 5: GPO configured as I2C answer ready (GPO field = 0xX3)</a> and <a href="#">Figure 8: GPO configured as State control (GPO field = 0xX5 or 0x5X)</a>.</p> <p>Added I2C text to the Note below <a href="#">Table 22: S-Block detailed format</a>.</p> <p>Edited the third paragraph of <a href="#">Section 5.8.1: ExtendedReadBinary command</a>.</p> <p>Added <a href="#">Section 5.8.4: UpdateFileType command</a> and <a href="#">Section 8.8: Changing a File type Procedure</a>.</p> <p>Updated bullet 3 in <a href="#">Section 7.9: I2C frame format</a>, and the Payload row of <a href="#">Table 70: I2C host to M24SR02-Y</a>. Updated bullet 2 in <a href="#">Section 7.11: Close the I2C session</a>.</p> <p>Edited <math>V_{IO}</math> row and removed <math>V_{ESD}</math> (machine model) row from <a href="#">Table 73: Absolute maximum ratings</a>.</p> <p>Updated <math>I_{CC}</math> rows and added a Note to <a href="#">Table 77: I2C DC characteristics</a>.</p> <p>Updated <a href="#">Figure 20: SO8N - 8-lead plastic small outline, 150 mils body width, package outline</a>.</p> <p>Fixed a typo in <a href="#">Figure 23: UFDPFN8 - 8-lead, 2 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package outline</a> title: UFDPFN8 changed into UFDPFN8.</p> |

Table 88. Document revision history (continued)

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 04-Jun-2014 | 5        | <p>Added data for automotive grade in <a href="#">Table 6: Field list</a> and <a href="#">Table 72: UID format</a></p> <p>Added WFDFPN8 package for automotive grade under qualification</p> <p>Added <a href="#">Figure 24: WFDFPN8 (MLP8) 8-lead, 2 x 3 mm, 0.5 mm pitch very thin fine pitch dual flat package outline</a></p> <p>Added <a href="#">Table 88: WFDFPN8 8-lead thin fine pitch dual flat package no lead mechanical data</a></p> <p>Added MF = WFDFPN8 inside <a href="#">Table 88: Ordering information scheme for packaged devices</a></p> <p>Inserted byte &lt;04&gt; between A4 and 00 inside <a href="#">Table 26: C-APDU of the NDEF Tag Application Select command</a></p>                         |
| 04-May-2016 | 6        | <p>Added</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 7: Details about I2C watchdog</a></li> <li>– <a href="#">Table 82: Write cycle definition</a></li> <li>– <a href="#">Section 13: Write cycle definition</a></li> </ul> <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Features</a></li> <li>– <a href="#">Section 2.7.6: State control configuration (GPO field = 0xX5 or 0x5X)</a></li> <li>– <a href="#">Table 73: Absolute maximum ratings</a></li> <li>– <a href="#">Table 74: I2C operating conditions</a></li> </ul>                                                                                                                                                   |
| 08-Aug-2016 | 7        | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 2.7.1: Session Open configuration (GPO field = 0xX1 or 0x1X)</a></li> <li>– <a href="#">Section 4.2.2: I2C token</a></li> <li>– <a href="#">Section 7.4: I<sup>2</sup>C token release sequence</a></li> <li>– <a href="#">Figure 13: I<sup>2</sup>C token release sequence</a></li> <li>– <a href="#">Section 7.5: I<sup>2</sup>C timeout on clock period</a></li> <li>– <a href="#">Section 7.11: Close the I<sup>2</sup>C session</a></li> <li>– <a href="#">Table 78: I2C AC characteristics (400 kHz)</a></li> <li>– <a href="#">Table 81: GPO timings measurement</a></li> </ul>                                                         |
| 04-Oct-2016 | 8        | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 3.2.2: Changing the read access right to NDEF files</a></li> <li>– <a href="#">Section 3.2.3: Changing the write access right to NDEF files</a></li> <li>– <a href="#">Section 5.6.5: NDEF Select command</a></li> <li>– <a href="#">Section 5.8.4: UpdateFileType command</a></li> <li>– <a href="#">Section 5.8.5: SendInterrupt command</a></li> <li>– <a href="#">Section 8.2: Reading of an NDEF message</a></li> <li>– <a href="#">Section 8.5: Unlocking an NDEF file</a></li> <li>– <a href="#">Section 8.6: Reaching the read-only state for an NDEF file</a></li> <li>– <a href="#">Section 16: Ordering information</a></li> </ul> |
| 23-Nov-2016 | 9        | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 35: R-APDU of the ReadBinary command</a></li> <li>– <a href="#">Table 47: R-APDU of the ExtendedReadBinary command</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 88. Document revision history (continued)

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 07-Feb-2017 | 10       | <p>Added:</p> <ul style="list-style-type: none"> <li>– Note 4, on <a href="#">Figure 23.: UDFPN8 - 8-lead, 2 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package outline</a></li> </ul> <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 88: Ordering information scheme for packaged devices</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 02-Oct-2017 | 11       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 6: Field list</a></li> <li>– <a href="#">Table 20: R-Block detailed format</a></li> <li>– <a href="#">Table 72: UID format</a></li> <li>– <a href="#">Table 74: I2C operating conditions</a></li> <li>– <a href="#">Table 78: I2C AC characteristics (400 kHz)</a></li> <li>– <a href="#">Table 86: TSSOP8 – 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch, package mechanical data</a></li> <li>– <a href="#">Table 88: Ordering information scheme for packaged devices</a></li> <li>– <a href="#">Figure 10: Changing the read access right to an NDEF file</a></li> <li>– <a href="#">Figure 11: Changing the write access right to an NDEF file</a></li> <li>– <a href="#">Figure 15: AC test measurement I/O waveform</a></li> <li>– <a href="#">Figure 16: I2C AC waveforms</a></li> <li>– <a href="#">Figure 19: I2C bus protocol</a></li> <li>– <a href="#">Figure 22: TSSOP8 – 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch, package outline</a></li> <li>– <a href="#">Section 16: Ordering information</a></li> </ul> |
| 04-Apr-2019 | 12       | <p>Updated <a href="#">Features, Section 7.11: Close the I<sup>2</sup>C session</a> and note in <a href="#">Section 16: Ordering information</a>.</p> <p>Updated <a href="#">Table 7: Details about I2C watchdog</a> and <a href="#">Table 81: GPO timings measurement</a>.</p> <p>Updated footnote 5 of <a href="#">Table 78</a> and footnote 5 of <a href="#">Table 79</a>.</p> <p>Minor text edits across the whole document.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to [www.st.com/trademarks](http://www.st.com/trademarks). All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2019 STMicroelectronics – All rights reserved