AN13539

OM-SE05xARD hardware overview

Rev. 1.2 — 8 November 2022 Application note

Document information

Information	Content
Keywords	OM-SE050ARD-E, OM-SE050ARD-F, OM-SE051ARD, OM-SE051ARD-W, OM-SE051ARD-H, OM-SE05xARD, EdgeLock SE05x
Abstract	This document describes the OM-SE05xARD development kits and details how to use its jumpers to configure the different communication options with the EdgeLock SE05x security IC.

Revision history

Revision history

Revision number	Date	Description
1.0	2022-03-23	First release
1.1	2022-05-19	Correct J22 pin assignment in Figure 2
1.2	2022-11-08	Add board OM-SE051ARD-H

1 Overview

The EdgeLock SE05x product family offers enhanced Common Criteria EAL 6+ based security, for unprecedented protection against the latest attack scenarios. This ready-to-use family of secure elements for IoT devices provides a root of trust at the IC level and supports the increasing demand for easy-to-design and scalable IoT security.

The EdgeLock SE05x uses I^2C as communication interface and its commands are wrapped using the Smartcard T=1 over I²C (T=1oI2C) protocol. In addition, the EdgeLock SE05x supports the following interfaces, as shown in Figure 1:

- I^2C interface in target mode with date rates up to 3.4 Mbps on some product variants.
- I^2C interface in controller mode with date rates up to 400 kHz.
- ISO/IEC 14443 T=CL (passive) protocol on some product variants.

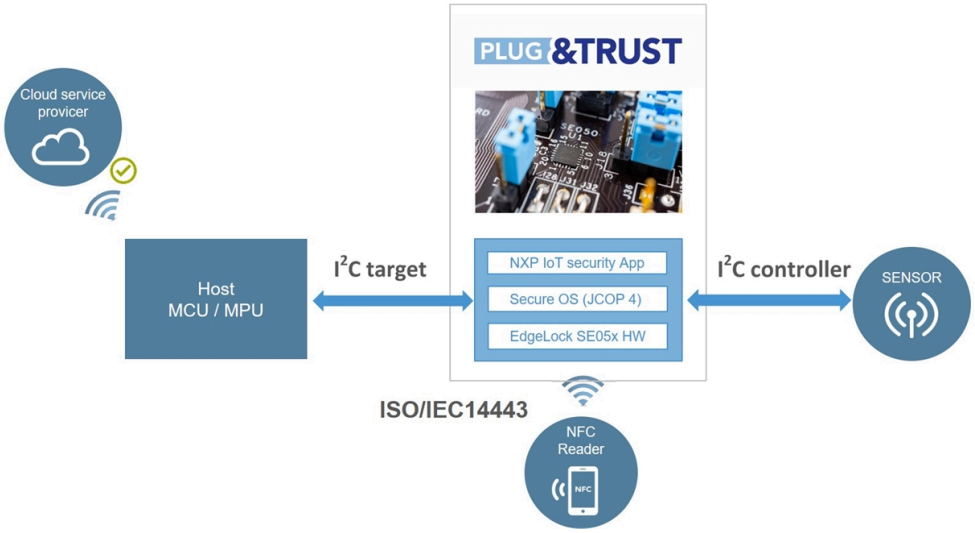


Figure 1. EdgeLock SE05x interface overview

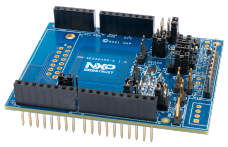
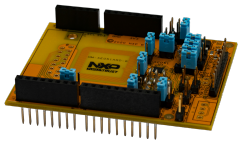
Note: *Only the I^2C target interface is mandatory. The I^2C controller and ISO/IEC 14443 interfaces are optional.*

The OM-SE05xARD are the development kits for the EdgeLock SE05x security IC's. This development kit allows you to evaluate the EdgeLock SE05x product features and simplifies the development of your custom applications. Table 1 list the ordering details of OM-SE05xARD development kits.

Table 1. OM-SE05xARD development kit ordering details

Part number	12NC	SE05x chip type	Picture
OM-SE050ARD-F	9354 357 63598	SE050F2HQ1/Z018H	

Table 1. OM-SE05xARD development kit ordering details...*continued*

Part number	12NC	SE05x chip type	Picture
OM-SE050ARD-E	9354 332 66598	SE050E2HQ1/Z01Z3	
OM-SE051ARD	935399187598	SE051C2HQ1/Z01XD	
OM-SE051ARD-W	9354 210 01598	SE051W2HQ1/Z013Y	
OM-SE051ARD-H	9354 449 78598	SE051H2HQ1/Z0112	

Note: *All listed boards OM-SE050ARD-F, OM-SE050ARD-E, OM-SE051ARD, OM-SE051ARD-W, OM-SE051ARD-H do have the same schematic and layout. In the following we use the OM-SE051ARD board as reference.*

Table 2. Supported interfaces

Part number	ISO/IEC14443-4-A (passive)	I^2C Target	I^2C Controller
OM-SE051ARD	✔	✔ (up to 3.4 Mbit/s)	✔
OM-SE051ARD-W	✔	✔ (up to 3.4 Mbit/s)	✔
OM-SE051ARD-H	✔	✔ (up to 3.4 Mbit/s)	✔
OM-SE050ARD-F	✔	✔ (up to 3.4 Mbit/s)	✔
OM-SE050ARD-E		✔ (up to1 Mbit/s)	✔

1.1 RED information

Table 3. RED information

P/N	RF Technology	Frequency Range (MHz)	Maximum Reader TX Power (dBm)
OM-SE050ARD-F	ISO/IEC14443-4-A (passive)	10 to 15	+23dBm
OM-SE051ARD	ISO/IEC14443-4-A (passive)	10 to 15	+23dBm
OM-SE051ARD-W	ISO/IEC14443-4-A (passive)	10 to 15	+23dBm
OM-SE051ARD-H	ISO/IEC14443-4-A (passive)	10 to 15	+23dBm

Note: *OM-SE050ARD-E kit is not listed here as the IC does not support ISO/IEC 14443-4-A.*

According to the Radio Equipment Directive (RED) 2014/53/EU, this user manual states that:

- frequency bands in which the equipment operates ranges from 10MHz to 15MHz; carrier signal is 13.56MHz, according to ISO/IEC14443-4-A.
- maximum RF power transmitted: +23dBm, response signal is modulated on subcarrier, and transmitted over 13.56MHz signal coming from external NFC active device.

EUROPEAN DECLARATION OF CONFORMITY (Simplified DoC per Article 10.9 of the Radio Equipment Directive 2014/53/EU)

- This apparatus, namely OM-SE050ARD-F board for contactless operation, conforms to Radio Equipment directive 2014/53/EU.
- This apparatus, namely OM-SE051ARD board for contactless operation, conforms to Radio Equipment directive 2014/53/EU.
- This apparatus, namely OM-SE051ARD-W board for contactless operation, conforms to Radio Equipment directive 2014/53/EU.
- This apparatus, namely OM-SE051ARD-H board for contactless operation, conforms to Radio Equipment directive 2014/53/EU.

The full EU Declaration of conformity for all apparatus can (will) be found at this location: www.nxp.com/SE051

2 Headers and connectors

The OM-SE05xARD is designed with several headers and connectors that allow you to interface with EdgeLock SE05x. The OM-SE05xARD is equipped with:

- **Arduino-R3 header:** It allows you to easily attach it to any NXP MCU/MPU development board with Arduino compatible headers such as many Kinetis, LPC and i.MX MCU boards. The Arduino-R3 female connectors come soldered in the OM-SE05xARD.
- **External I²C connector:** It allows you to connect any non-Arduino compatible MCU boards via I²C target interface. The OM-SE05xARD includes the mounting holes for the External I²C connector.
- **10-pin header:** It allows you to access several pins of the EdgeLock SE05x, including the I²C controller interface to attach sensors or peripherals to the board. The 10-pin header male connectors come soldered in the OM-SE05xARD.
- **DB15 header:** It allows you to access several pins of the EdgeLock SE05x, including the ISO/IEC 14443 or the I²C controller interface to attach sensors or peripherals to the board. The OM-SE05xARD includes the mounting holes for the DB15 connector.

Figure 2 shows an overview to OM-SE05xARD headers and connectors together with its corresponding pin description.

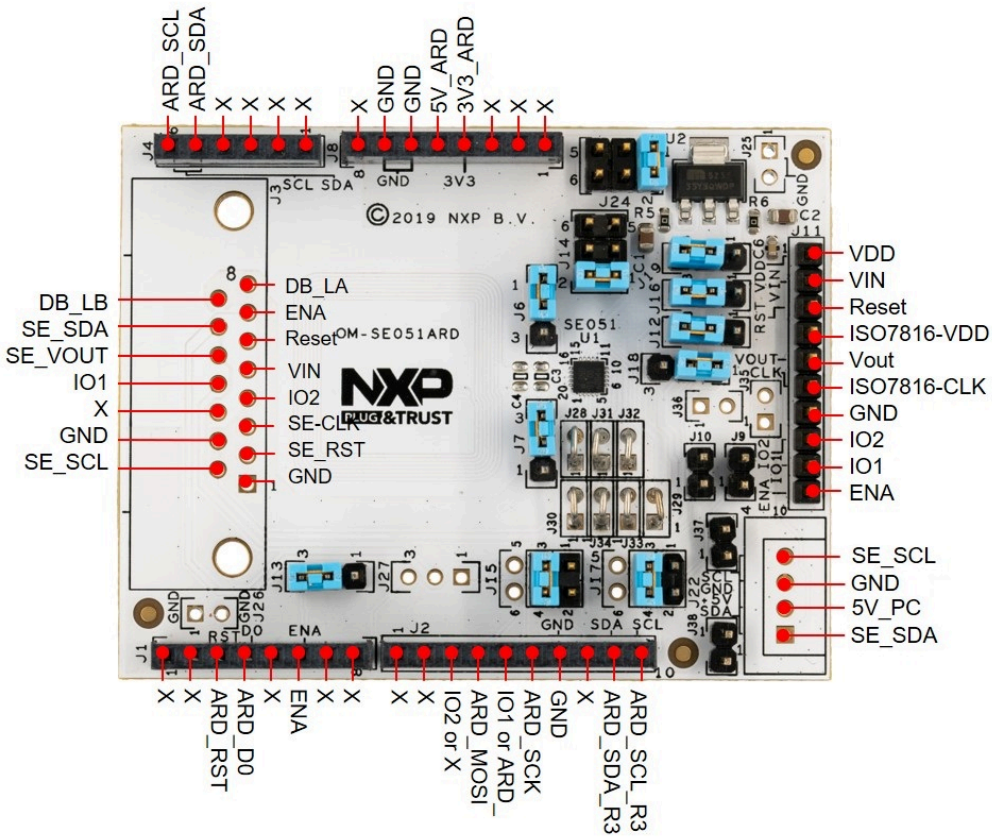


Figure 2. OM-SE05xARD headers and connectors overview

Note: *The OM-SE05xARD schematic is available in* SE05xARD-SCH.

3 OM-SE05xARD board schematics

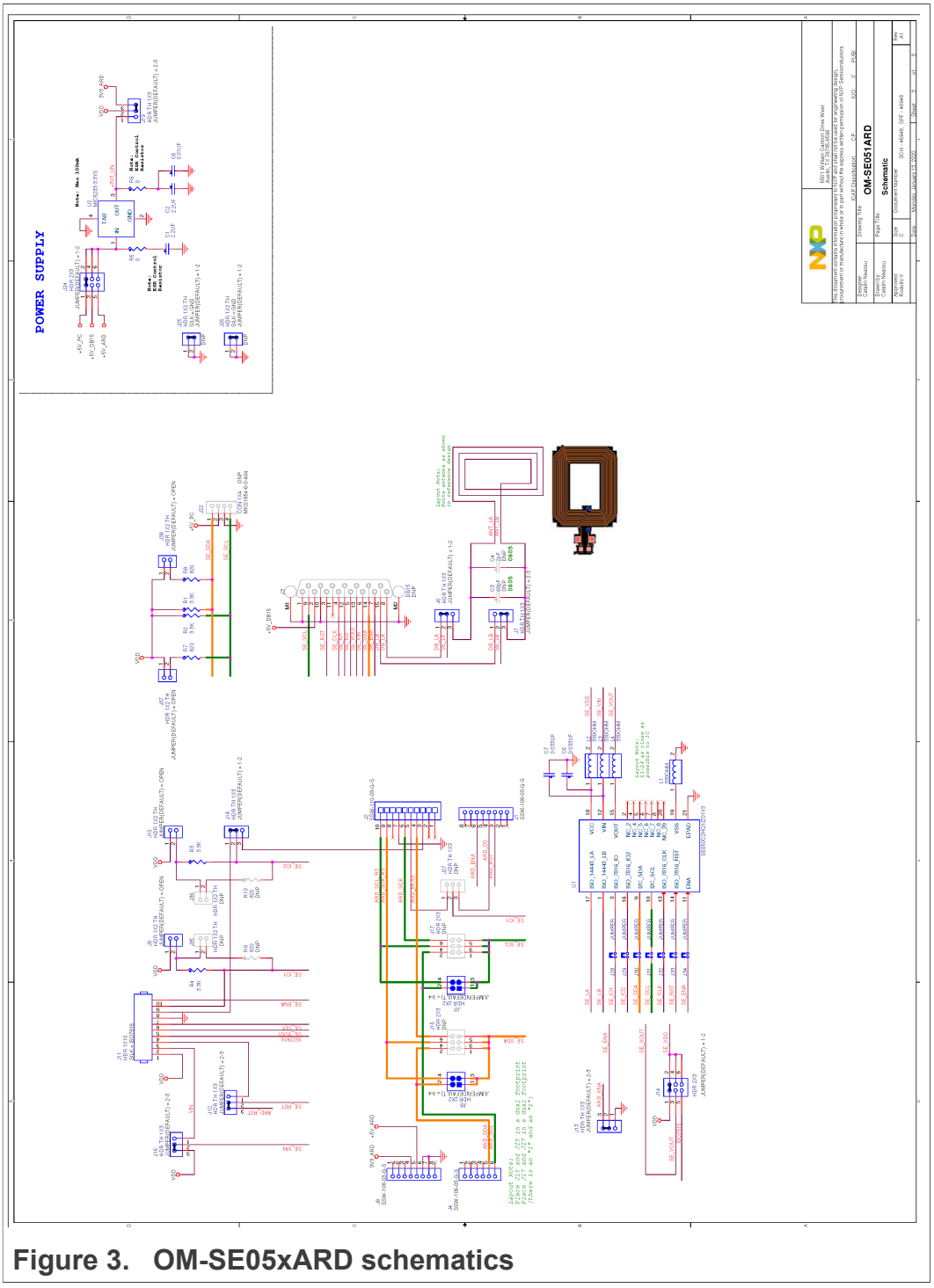


Figure 3. OM-SE05xARD schematics

Note: The OM-SE05xARD schematic is available in SE05xARD-SCH.

4 Jumpers overview

The OM-SE05xARD board uses individual jumpers to configure settings related with the EdgeLock SE05x interfaces, power supply and power modes. This section provides an overview to the OM-SE05xARD jumpers and its configuration options.

4.1 I^2C configuration

The OM-SE05xARD has jumpers that allow you to control the configuration of the I^2C target and controller interfaces available in EdgeLock SE05x. These jumpers are:

- J9, J10: Configures the I^2C controller pull up connection.
- J15, J17: Configures the I^2C target connection.
- J37, J38: Configures the I^2C target interface pull up resistor.

Table 4 describes the OM-SE05xARDjumper settings for each I^2C setting configuration.

Table 4. Jumpers for I^2C configuration

Jumper	Description	Open	1-2	3-4
J9	I^2C controller pull up connection	not connected (Default)	3k3 Ohm	n.a.
J10	I^2C controller pull up connection	not connected (Default)	3k3 Ohm	n.a.
J15	I^2C target SDA connection	not connected	Arduino R3 J4:5	Arduino R3 J2:9 (Default)
J17	I^2C target SCL connection	not connected	Arduino R3 J4:6	Arduino R3 J2:10 (Default)
J18	SE05x_IO2 routing	n.a	Routed to J11:9 (Default)	Routed to J2:3
J37	I^2C target SCL pull up	3k3 Ohm (Default, FastMode)	660 Ohm (HS-Mode)	n.a.
J38	I^2C target SDA pull up	3k3 Ohm (Default, FastMode)	660 Ohm (HS-Mode)	n.a.

Figure 4 highlights in blue the location of the OM-SE05xARD for I^2C settings configuration.

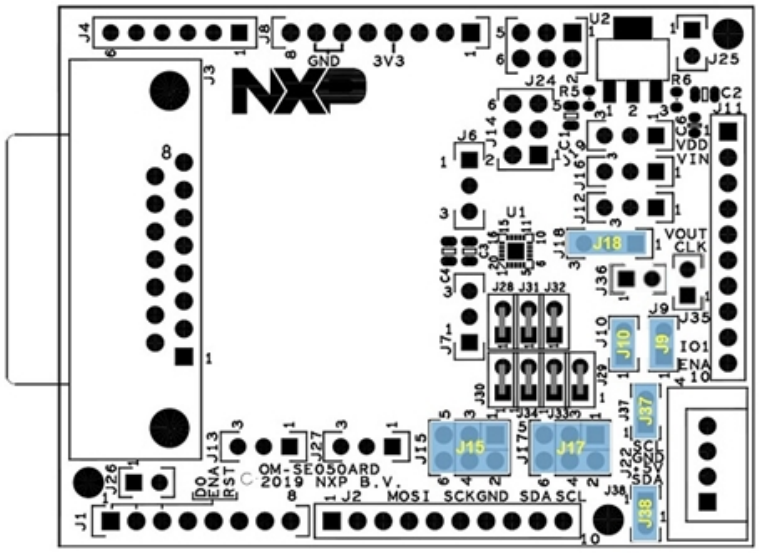


Figure 4. OM-SE05xARD jumpers for I²C settings configuration

4.2 Power supply options

The jumpers that allow you to change the OM-SE05xARD power supply settings are:

- J19: Configures V_{DD} supply voltage options.
- J16: Configures SE05x_V_{IN} supply options.
- J24: Configures V_{DD} supply voltage options in case the LDO is used.

Table 5 describes the OM-SE05xARDjumper settings for each power supply settings configuration.

Table 5. Jumpers for power supply settings configuration

Jumper	Description	1-2	2-3	3-4	5-6
J16	EdgeLock SE05x_V_{in} supply	Supplied by J11:2 pin	Supplied by the V_{DD} (see J19) (Default)	n.a.	n.a.
J19	V_{DD} supply voltage	From LDO	From 3V3_ ARD pin (Default)	n.a.	n.a.
J24	V_{DD} supply voltage (if LDO is used)	From 5V_PC (External I²C connector - Default)	n.a.	From 5V_ DB15 pin	From 5V_ARD pin

Figure 5 shows the power supply unit schematics.

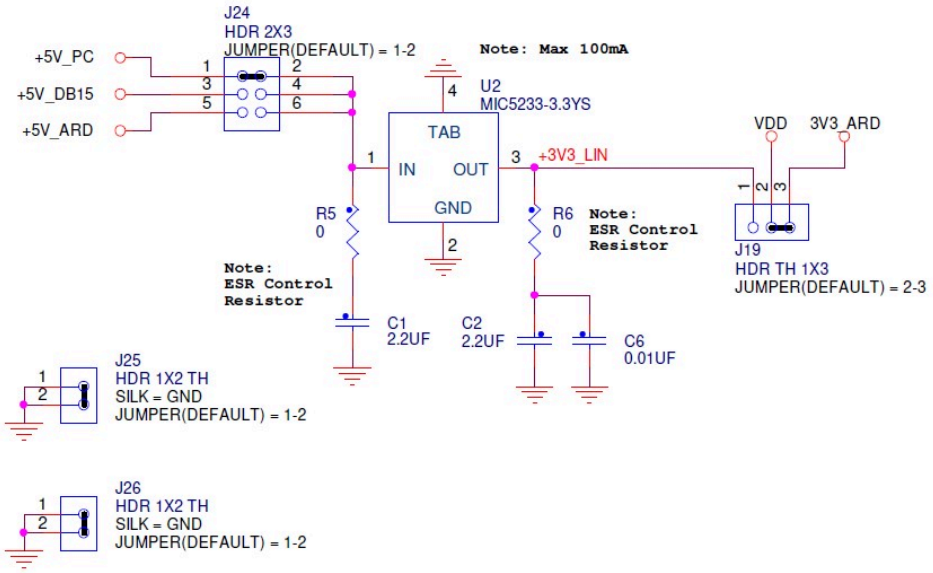


Figure 5. OM-SE05xARD power supply settings

Figure 6 highlights in blue the location of theOM-SE05xARD for power supply settings configuration.

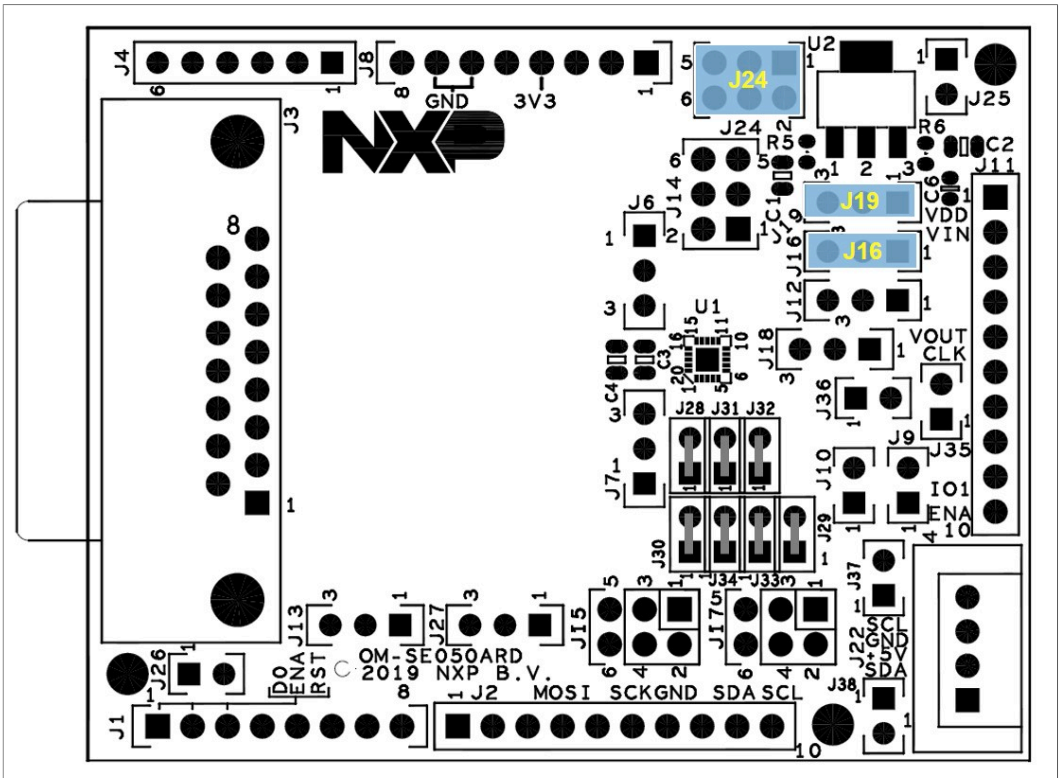


Figure 6. OM-SE05xARD jumpers for power settings configuration

4.3 Deep power-down mode

The deep power-down mode reduces the EdgeLock SE05x power consumption to the minimum. In this mode, only I^2C pads stay supplied via V_{in}. The deep power-down mode is enabled by setting the ENA pin to a logic zero. In addition, it is required to supply V_{in} pin and connect V_{out} and V_{cc} pins at the PCB level.

The ENA pin controls an internal switch between V_{out} and V_{in} as shown in Figure 7. Therefore, if V_{out} is connected to V_{cc}, the ENA pin can effectively switch the power on and off to V_{cc}.

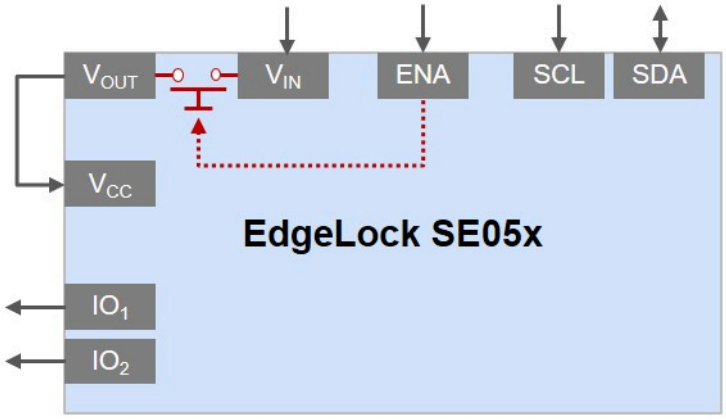


Figure 7. Deep power-down mode diagram

The jumpers J13 and J14 of the OM-SE05xARD allow you to control the EdgeLock SE05x deep power-down mode. To enable the deep power-down mode using the OM-SE05xARD:

- J13: Must be set to position 2-3.
- J14: Must be set to position 3-4.

Table 6 describes the OM-SE05xARD jumper settings for the deep power-down mode configuration

Table 6. Jumpers for deep power-down mode configuration

Jumper	Description	1-2	2-3	3-4	5-6
J13	EdgeLock SE05x_ENA pin routing	ENA low. Switch disabled	ENA controlled by Arduino R3 (Default)	n.a.	n.a.
J14	EdgeLock SE05x_V_{CC} pin routing	Routed to V_{DD} supply voltage	n.a.	Routed to SE05x_V_{out} pin (Default)	Routed to J11:4 pin

Figure 8 highlights in blue the location of jumper J13 and J14.

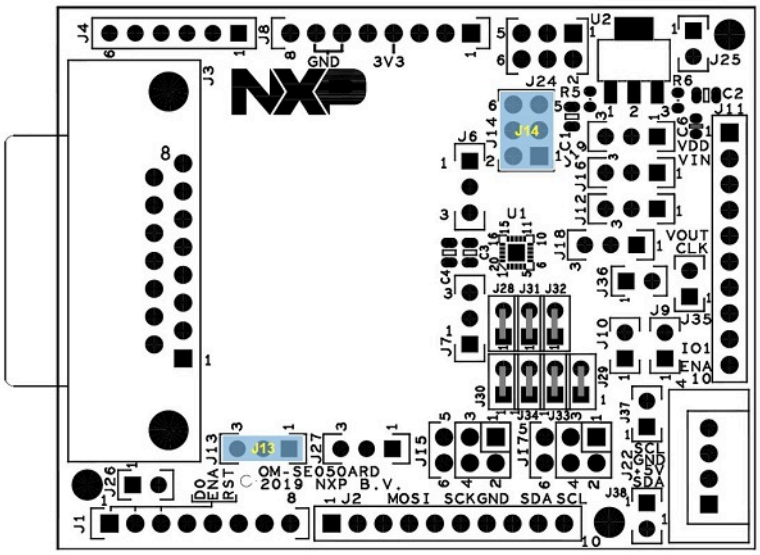


Figure 8. OM-SE05xARD jumper J13 and J14 location

4.4 Reset pin routing

Jumper J12 allows you to control the I^2C reset pin routing of the EdgeLock SE05x. Table 7 indicates the J12 configuration.

Note: *The EdgeLock SE05x reset pin does not apply for the I^2C interface.*

Table 7. Jumpers for reset pin routing configuration

Jumper	Description	Open	1-2	2-3
J12	EdgeLock SE05x_RST pin	Not connected	Routed to J11:3 strip pin connector	Routed to Arduino R3 (Default)

Figure 9 highlights in blue the location of Jumper J12.

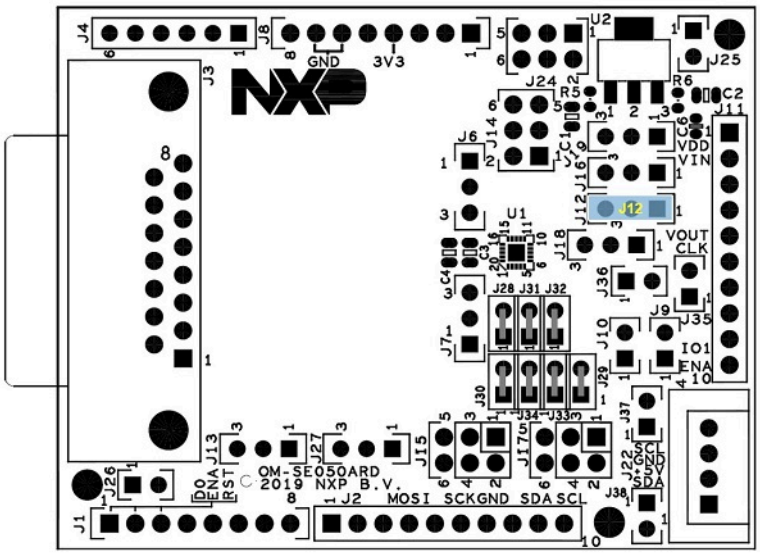


Figure 9. OM-SE05xARD Jumper J12 location

4.5 ISO/IEC14443 contactless interface

Jumper J6 and J7 allow you to control the EdgeLock SE05x contactless interface and allows you to select which antenna shall be used for contactless communication. Table 8 indicates J6 and J7 jumper settings.

Table 8. Jumpers for ISO/IEC14443 contactless interface settings

Jumper position	Description
J6: 2-3 and J7: 1-2	Contactless operation disabled
J6: 1-2 and J7: 2-3	Contactless operation disabled (Default)
J6: 2-3 and J7: 2-3	Contactless operation enabled with OM-SE05xARD internal antenna
J6: 1-2 and J7: 1-2	Contactless operation enabled with external ID1 antenna through DB15 connector

Note: *OM-SE050ARD-E kit does not support ISO/IEC 14443-4-A.*

Figure 10 highlights in blue the location of jumpers J6 and J7.

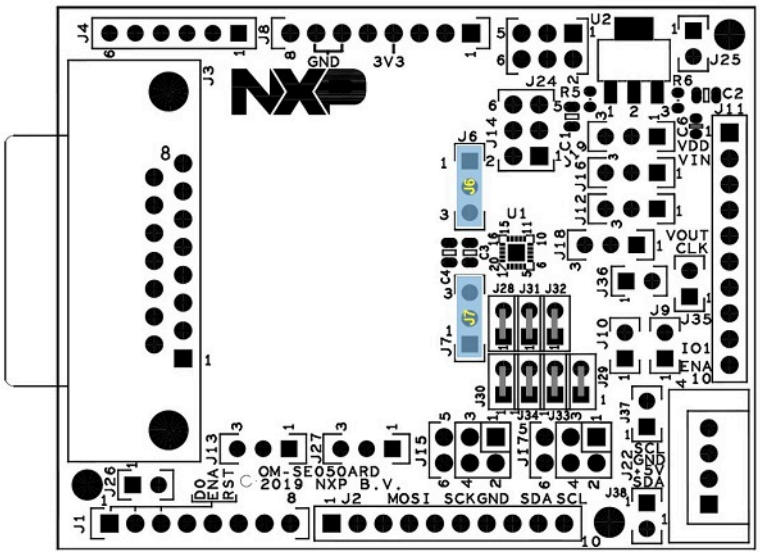


Figure 10. OM-SE05xARD jumper J6 and J7 location

5 OM-SE05xARD board use cases

This section details the jumper settings to configure the differnet interfaces and to enable specific use cases with the OM-SE05xARD board.

5.1 EdgeLock SE05x via Arduino header

This section details the jumper configuration to enable the I^2C target interface in the Arduino header. The related jumpers of the OM-SE050ARD-E for I^2C target interface configuration are:

- J37 and J38: Configure the pull up resistors of the I^2C interface.
- J19: Configures V_{DD} supply voltage options.
- J24: Configures V_{DD} supply voltage options in case the LDO is used.

Table 9. Jumper settings for I^2C target interface configuration

Jumper	Configuration	Comment
J6	**Set to 1-2 (Default)**	Contactless operation disabled
J7	**Set to 2-3 (Default)**	Contactless operation disabled
J9, J10	**Set to "Open" (Default)**	I^2C controller pull ups disabled
J12	**Set to 2-3 (Default)**	SE_RST routed to ARD_RST on J1:3
J13	**Set to 2-3 (Default)**	SE_ENA set to ARD_ENA on J1:6
J14	**Set to 3-4 (Default)**	SE_V_{OUT} as SE_V_{DD}
J15	**Set to 3-4 (Default)**	I^2C_SDA routed to ARD_SDA_R3 (J2:9)
	Set to 1-2	I^2C_SDA routed to ARD_SDA (J4:5)
J16	Set to 2-3	V_{DD} as SE_V_{IN}
J17	**Set to 3-4 (Default)**	I^2C_SCL routed to ARD_SCL_R3 (J2:10)
	Set to 1-2	I^2C_SCL routed to ARD_SCL (J4:6)
J19	**Set to 2-3 (Default)**	SE_V_{DD}=3.3V from Arduino-R3 voltages
	Set to 1-2	SE_V_{DD}=3.3V from LDO.
J24	**Set to 1-2 (Default)**	No input LDO
	Set to 5-6	5V_ARD to LDO
J25, J26	Do not care	Dummy jumpers
J37, J38	**Set to "Open" (Default)**	3k3 pull-up resistor for I^2C standard mode

Table 9. Jumper settings for I²C target interface configuration...*continued*

Jumper	Configuration	Comment
	Set to "Closed"	Additional 820 Ohm parallel pull-up resistor for I²C high speed mode

Figure 11 shows the jumper settings to configure the I²C target in standard mode and 3.3V_ARD supply voltage (no LDO).

In this example, the jumper configuration used in Figure 11 correspond to the values highlighted in bold in Table 9 (J15, J17, J19, J24, J37 and J38).

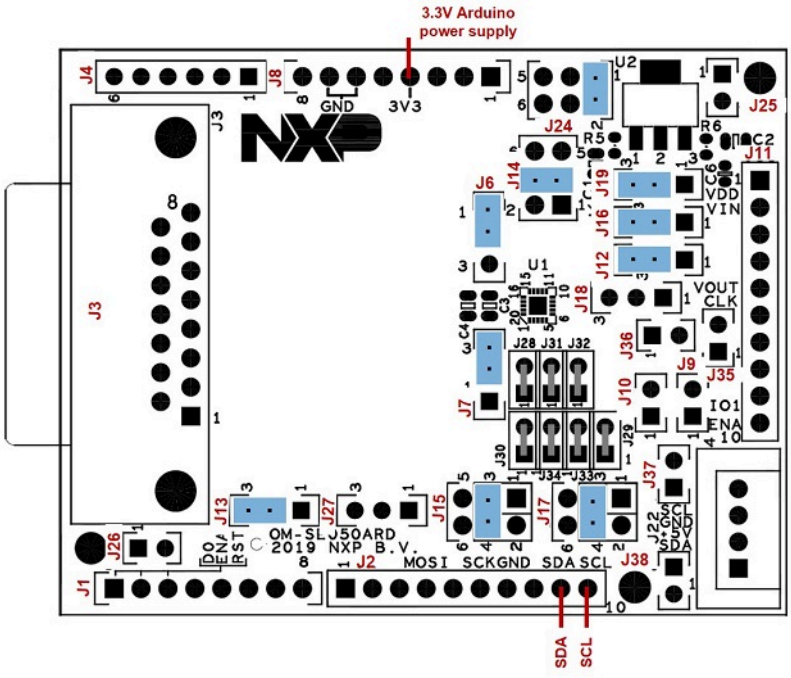


Figure 11. I²C standard mode and 3.3V Arduino power supply

You may modify the I²C mode or power supply settings just changing the jumper settings accordingly as indicated in Table 9.

5.2 SE05x via external I²C connector

Figure 12 shows the jumper settings to configure EdgeLock SE05x communication via external I²C connector:

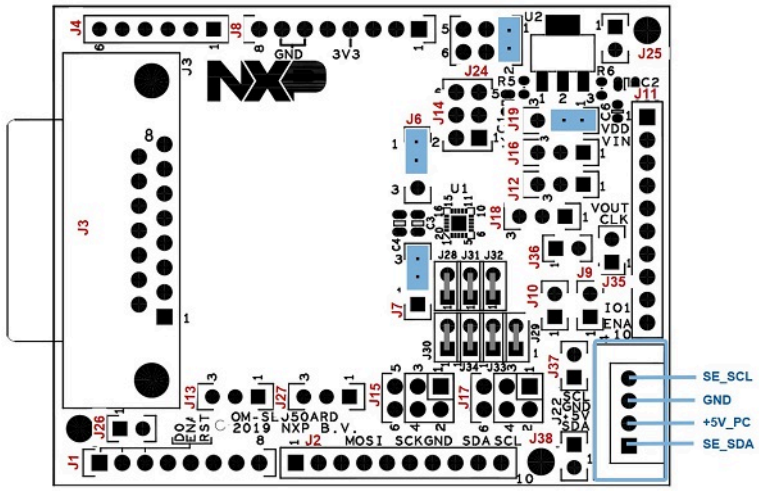


Figure 12. OM-SE050ARD-E external I²C connector

Table 10 details the jumper settings for this configuration (External I²C connector).

Table 10. OM-SE050ARD-E external I²C connector

Jumper	Configuration	Comment
J6	Set to 1-2 (Default)	Contactless operation disabled
J7	Set to 2-3 (Default)	Contactless operation disabled
J9, J10	Do not care	
J12	Do not care	
J13	Do not care	
J14	Do not care	
J15	Do not care	
J16	Do not care	
J17	Do not care	
J19	Set to 1-2	3.3V from LDO as SE_V_{DD}
J24	Set to 1-2 (Default)	5V_PC from external MCU board to LDO
J25, J26	Do not care	Dummy jumpers
J37, J38	Set to “Open” (Default)	3k3 pull-up resistor for I²C standard mode

5.3 SE05x in I²C controller mode

This section details the jumper configuration to enable the I²C controller of the SE05x. The I2C controller interface can be used to connect a sensor securely. The SE05x guarantees the privacy and the authenticity of the data extracted by sensor. The data collected in the application over the SE05x private sensor can be transferred to the cloud for further treatment and analysis. The Figure 13 shows the SE05x solution block diagram for this use case:

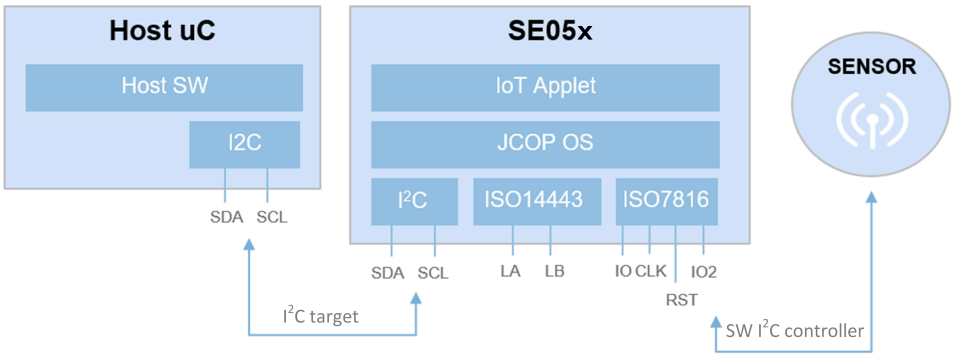


Figure 13. SE05x smart sensor use case block diagram

Figure 14 shows the jumper settings to enable the SE05x I²C controller interface.

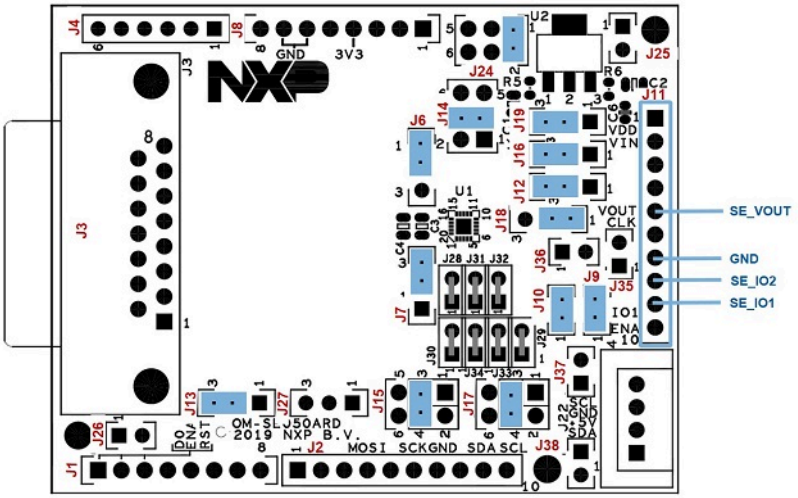


Figure 14. EdgeLock SE05x in I²C controller mode

Table 11 details the jumper settings for the configuration of the SE05x I²C controller interface.

Table 11. Jumper settings for EdgeLock SE05x in I²C controller mode

Jumper	Configuration	Comment
J6	Set to 1-2 (Default)	Contactless operation disabled
J7	Set to 2-3 (Default)	Contactless operation disabled
J9, J10	Set to "Closed"	Set to “Closed” to enable pull-up resistors for I²C controller signals SE_IO1 and SE_IO2 *(if IOT sensor board not already provides pull-up resistors)*.
J12	Set to 2-3 (Default)	SE_RST routed to ARD_RST on J1:3

Table 11. Jumper settings for EdgeLock SE05x in I^2C controller mode...*continued*

Jumper	Configuration	Comment
J13	Set to 2-3 (Default)	SE_ENA set to ARD_ENA on J1:6
J14	Set to 3-4 (Default)	SE_V_{OUT} as SE_V_{DD}
J15	Set to 3-4 (Default)	I^2C_SDA routed to ARD_SDA_R3 (J2:9)
J16	Set to 2-3	V_{DD} as SE_V_{IN}
J17	Set to 3-4 (Default)	I^2C_SCL routed to ARD_SCL_R3 (J2:10)
J18	Set 1-2 (Default)	SE_IO2 to pin 9 of header J11
J19	Set to 2-3 (Default)	SE_V_{DD}=3.3V from Arduino-R3 voltages
J24	Set to 1-2 (Default)	No input LDO
J25, J26	Do not care	Dummy jumpers
J37, J38	Set to “Open” (Default)	3k3 pull-up resistor for I^2C standard mode

5.4 EdgeLock SE05x via ISO14443 mode

This section details the jumper settings to operate the OM-SE05xARD via the ISO/IEC14443 interface.

Note: *Only the I^2C target interface is mandatory. The I^2C controller and ISO/IEC 14443 interfaces are optional.*

Note: *OM-SE050ARD-E kit does not support ISO/IEC 14443-4-A.*

5.4.1 ISO/IECC 144443-A via onboarded antenna

Figure 15 shows the jumper settings to configure the contactless interface via the onboarded antenna in the OM-SE05xARD board.

Note: *The IC selects the active interface on boot up, only one interface will be active. Take care for the interface precedence on IC boot up as described in the datasheet section "startup behavior" as I2C takes precedence over the contactless interface.*

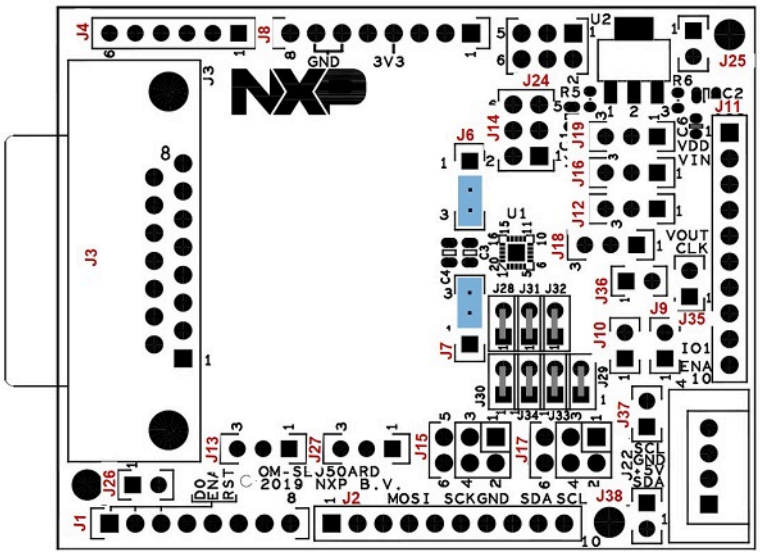


Figure 15. ISO/IEC14443 via onboarded antenna

Table 12 details the jumper settings for this configuration (ISO/IEC14443 via onboarded antenna).

Table 12. ISO/IEC14443 via onboarded antenna

Jumper	Configuration	Comment
J6	Set to 2-3	Contactless operation enabled with onboarded antenna
J7	Set to 2-3	Contactless operation enabled with onboarded antenna

5.4.2 ISO/IECC 144443-A via external antenna

Figure 16 shows the jumper settings to configure the contactless interface via an IN-CLA7816 probe connected through DB15 connector.

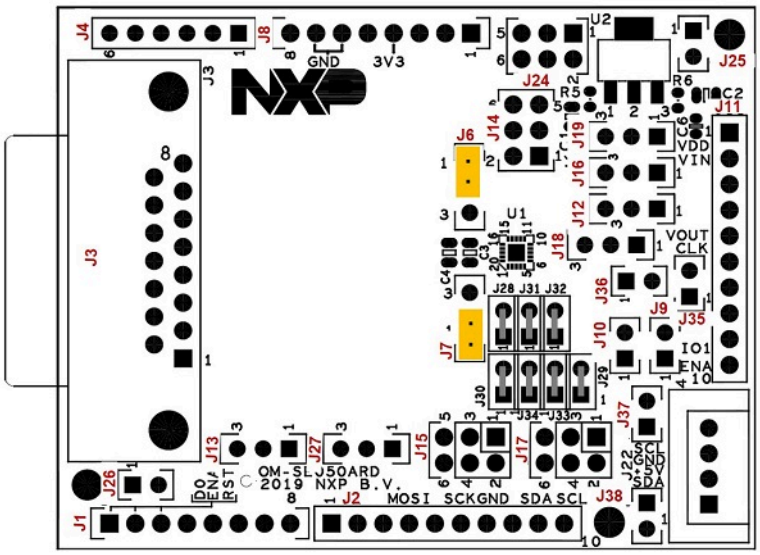


Figure 16. ISO/IEC14443 via DB15 connector

Table 13 details the jumper settings for this configuration (ISO/IECC 144443-A via external antenna).

Table 13. ISO/IEC14443 via DB15 connector

Jumper	Configuration	Comment
J6	**Set to 1-2**	**Contactless operation enabled with external ID1 antenna through DB15 connector**
J7	**Set to 1-2**	**Contactless operation enabled with external ID1 antenna through DB15 connector**

5.4.3 ISO/IEC 14443 via DB15 connector

Figure 17 shows an external contactless interface connected to an IN-CLA7816 probe through DB15 connector.

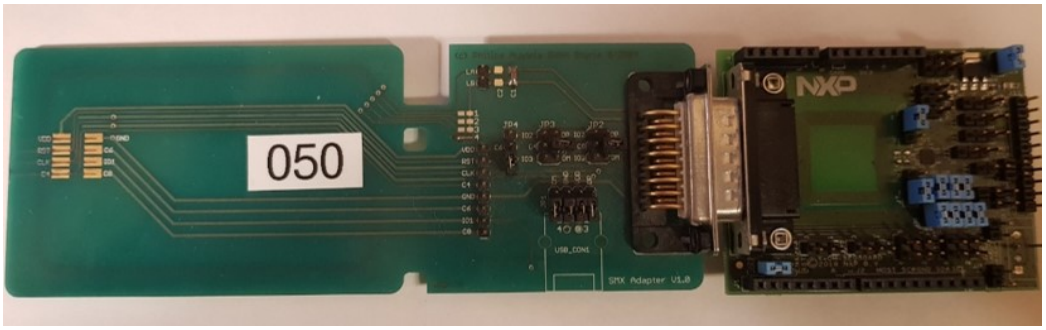


Figure 17. External contactless interface connected to an IN-CLA7816 probe through DB15 connector

6 OM-SE05xARD technical operation description

Please refer to application note 'AN13013 - Get started with EdgeLock SE05x support package' how to get started with the OM-SE05xARD board and for getting familiar with EdgeLock SE050 and SE051 support package. The document is available at this location: http://www.nxp.com/SE050 respectively www.nxp.com/SE051.

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Tables

Figures

Contents

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