MIFARE® DESFire® EV3

Application Note

PLT-05618, A.0
April 2021

Powering
Trusted Identities

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What's new

Date	Description	Revision
April 2021	Initial release.	A.0

A complete list of revisions is available in **Revision history**.

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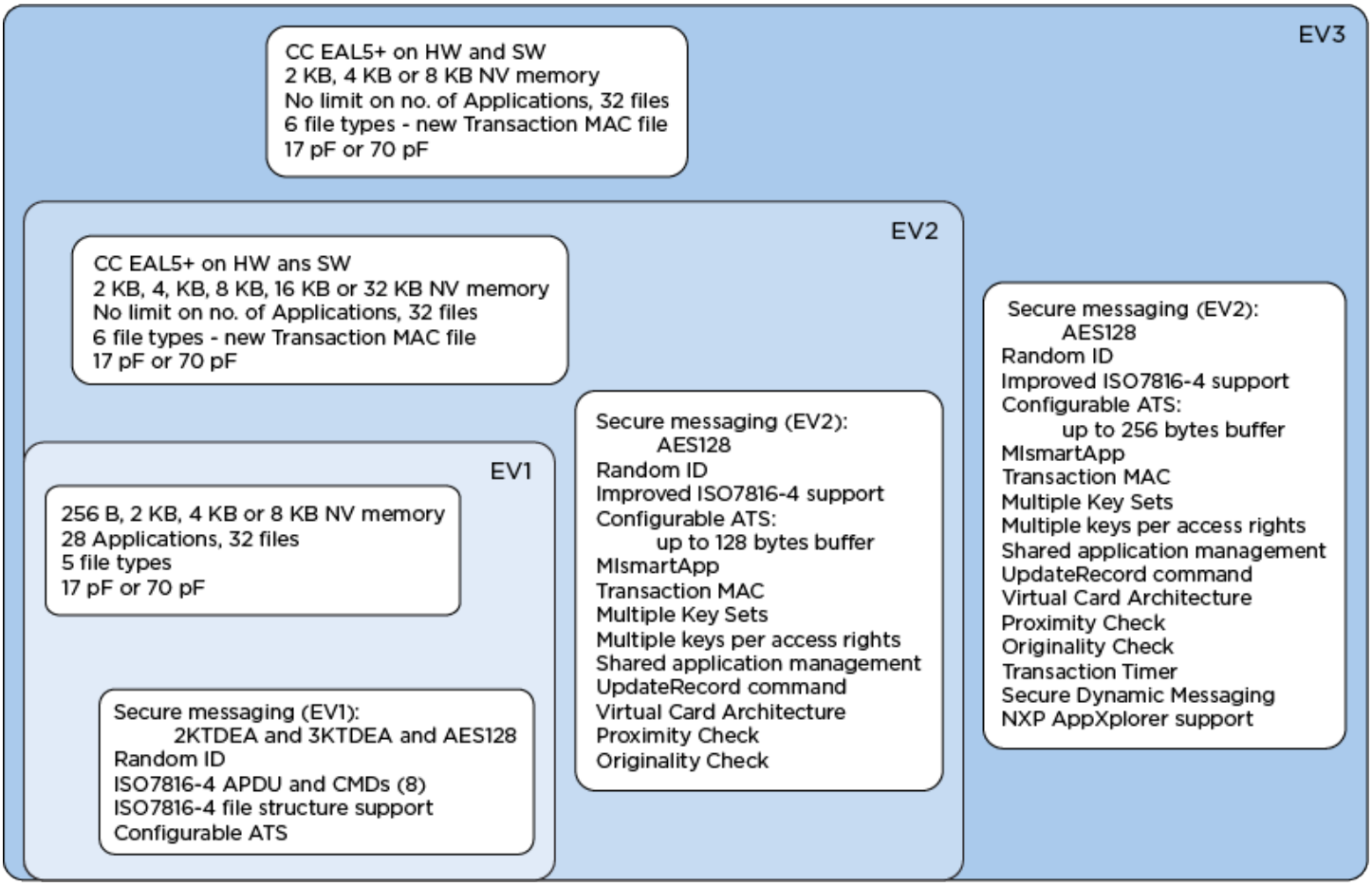
1.1 What is DESFire EV3?

EV3 is NXP's latest DESFire family member that combines enhanced performance with greater operating distance and improved transaction speed compared to its predecessors. DESFire EV3 is fully backward compatible with DESFire EV1 and EV2 deployments. The use of new features requires activation and/or the use of new commands. For further information on HID Global's DESFire compliant Physical Access Control solutions, please visit **www.hidglobal.com**.

Summary of EV1, EV2, and EV3 features



1.2 HID Secure Identity Object™ (SIO®) Implementation

1.2.1 DESFire EV1 and EV2

The current implementation of Secure Identity Object (SIO) on DESFire EV1/EV2 is based on a DESFire Application and file management using 2TDEA and MAC communication.

1.2.2 DESFire EV3

HID's new EV3 implementation of Secure Identity Object (SIO) leverages AES128 and the very latest DESFire security features supported by our new highly flexible HID Signo Reader platform.

1.2.3 Maintaining Backward Compatibility

A Compatibility Profile option for EV3 has been introduced to offer backward compatibility with iCLASS SE® and multiCLASS® Rev E readers reading DESFire EV1 or EV2 Secure Identity Object (SIO) cards. This is achieved through the provision of both applications onto the DESFire EV3 credential. iCLASS SE and multiCLASS SE Rev E readers can continue to read the EV1 compatible Secure Identity Object (SIO) application while the latest Signo reader firmware selects the new higher security Secure Identity Object (SIO) application, leveraging the latest security features.

DESFire EV1 Card with Secure Identity Object Application

DESFire EV3 Card with Secure Identity Object, High Security Application (High Security Profile)

DESFire EV3 Card with Dual Secure Identity Object Application (Compatibility Profile)

1.2.4 Secure Identity Object (SIO) Security

HID's Secure Identity Object (SIO) is independent of the DESFire file security, utilizing AES128 encryption, a message authentication code (MAC) for data integrity and incorporates binding elements to card HW.

1.3 DESFire EV3 Programming Profiles

To simplify order management, three core DESFire EV3 programming profiles are available. Each profile has its own base part number with optional support for HID or Indala Prox technology to provide interoperability with legacy 125kHz systems and ease migration to higher security solutions.

1.3.1 High Security Profile

Base Part Numbers: 802 (DESFire EV3) and 812 (DESFire EV3 + 125kHz) Based on Secure Identity Object (SIO) with enhanced EV3 application security designed for HID Signo Reader (Firmware 10.0.2.2 or higher).

1.3.2 Compatibility Profile

Base Part Numbers: 801 (DESFire EV3) and 811(DESFire EV3 + 125kHz) Compatible with iCLASS SE, multiCLASS, and all HID Signo readers capable of reading DESFire EV1 or EV2 SIO. This profile is compatible with the CP1000 for the purpose of EV1 Secure Identity Object (SIO) and custom EV1 data field programming.

1.3.3 Custom Profile

Base Parts Numbers: 800 (DESFire EV3) and 810 (DESFire EV3 + 125kHz) Custom application support or unprogrammed options that are compatible with third party EV1, EV2 or EV3 compliant tools and solutions.

1.4 High Security Profile

HID's new DESFire EV3 Secure Identity Object (SIO) application leverages the best possible security settings and features of EV3 combined with NIST based open standards for key diversification. This profile is compatible with HID Signo readers operating with firmware version 10.0.2.2 or higher.

1.4.1 Base Part Numbers:

- 802 (DESFire EV3 8K, SIO High Security EV3 Application, Random UID)
- 812 (DESFire EV3 8K, SIO High Security EV3 Application, Random UID , 125kHz) - supports HID Prox and Indala formats

1.4.2 Feature Summary

The High Security Profile offers the following features:

- Random 4 Byte UID
- PICC, application and file management based on HID AES128 keys
- Contains Secure Identity Object (SIO) High Security EV3 Application
  - Enhanced secure messaging based on AES128 to protect over the air-transmission of data
  - Key diversification based on NIST SP 800-108 (AES/CMAC in counter mode)
  - Proximity check function to minimize the risk of relay attacks
  - Random UID for privacy protection
  - Independently AES128 encrypted Secure Identity Object (SIO)
- Supports HID Elite keys
- Supports standard HID formats such as Corporate 1000™, OEM and open formats (e.g. H10301, H10302)

1.4.3 Reader Compatibility

The High Security Profile is Compatible with HID Signo readers operating with firmware version 10.0.2.2 or higher. Optionally, upgrade Signo readers to the latest firmware using HID's Reader Manager tool to support the High Security Profile. After upgrading, support for existing deployed Secure Identity Object (SIO) based EV1 or EV2 credentials is maintained.

High Security Profile Base Part 802/812

Firmware 10.0.2.2 or Higher

Reader Manager Firmware Upgrade

HID does not recommend enabling ISO14443A UID when using High Security Profile cards, the presence of random UID may result in random UID output disrupting the SIO application.

1.4.4 Multi-Application Compatibility

For maximum multi-application flexibility the card is configured to accept additional DESFire applications without the need to authenticate with the HID managed PICC Master key. See **1.4.5 Random UID** below.

Should the end-user wish to take full control of application management, a custom part number may be requested with end-user defined PICC master keys. This provides full control over third party application management through release of the custom PICC master key to 3rd party vendors.

1.4.5 Random UID

The High Security Profile utilizes a random UID for privacy protection, this feature ensures that no information that could be associated with the cardholder is ever shared openly. When writing additional applications to the card with diversified keys, a suitable method to store key diversification material is required (for example, via a static keyed file allowing access to true UID following authentication). It is important to verify random UID support with application vendors prior to deployment to ensure their systems and devices can support the High Security Profile.

1.5 Compatibility Profile

The Compatibility Profile maintains full compatibility with existing deployments of iCLASS SE Rev E and multiCLASS SE readers. These readers continue to utilize the DESFire EV1 compliant Secure Identity Object (SIO) application loaded onto the DESFire EV3 credential. Upgrade seamlessly to the DESFire EV3 Secure Identity Object (SIO) high security application via Signo readers operating with firmware version 10.0.2.2 or higher.

1.5.1 Base Part Numbers:

- 801 (DESFire EV3 8K, SIO High Security EV3 Application + DESFire EV1 SIO Application)
- 811 (DESFire EV3 8K, SIO High Security EV3 Application + DESFire EV1 SIO Application + 125kHz) - supports HID Prox and Indala formats

1.5.2 Feature Summary

The Compatibility Profile offers the following features

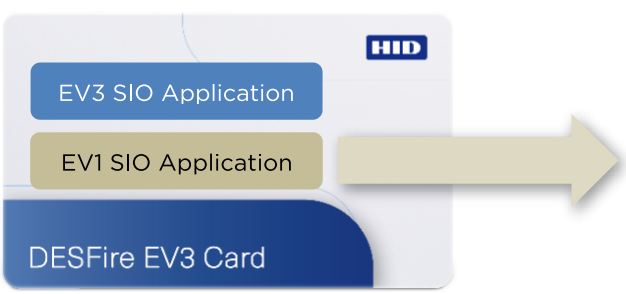
- Static 7 Byte UID
- PICC, application and file management based on 2TDEA keys for iCLASS SE, multiCLASS SE and CP1000 compatibility
- Contains SIO High Security EV3 Application
  - Application and file management based on HID AES128 keys
  - Enhanced secure messaging based on AES128 to protect over the air-transmission of data
  - Key diversification based on NIST SP 800-108 (AES/CMAC in counter mode)
  - Proximity check function to minimize the risk of relay attacks
  - Independently AES128 encrypted Secure Identity Object (SIO)
  - Supported by Signo reader with firmware 10.0.2.2 or higher
- Contains backward compatible SIO EV1 Application
  - Application and file management based on 2TDEA keys
  - MAC based communication
  - Key diversification based on NIST SP 800-108 (HMAC,SHA-1)
  - Independently AES128 encrypted Secure Identity Object (SIO)
  - Supported by iCLASS SE and multiCLASS SE readers
- Supports HID Elite keys
- Supports standard HID formats such as Corporate 1000, OEM and open formats (e.g. H10301, H10302)
- "V" Programming Option
  - Ready for EV1 SIO Application encoding via CP1000

1.5.3 Reader Compatibility

Due to the presence of the DESFire EV1 compatible Secure Identity Object (SIO) application and the new DESFire EV3 Secure Identity Object (SIO) high security application, this profile maintains full compatibility with iCLASS® Rev E and multiCLASS SE readers. This profile offers a seamless upgrade to the new DESFire EV3 Secure Identity Object (SIO) high security application via deployment of Signo readers operating with firmware 10.0.2.2 or higher.

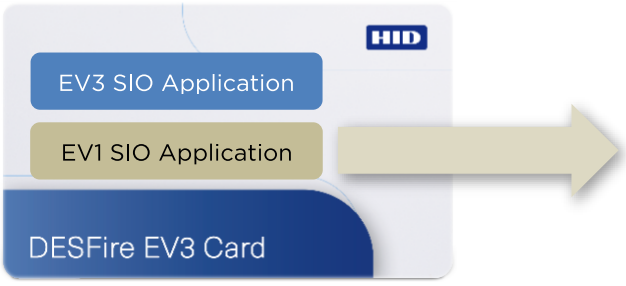
Signo readers operating with older versions of firmware that support DESFire EV1 Secure Identity Object (SIO) application may be upgraded to the latest version of firmware using HID's Reader Manager tool.

Once upgraded, the Signo reader will automatically prioritize the DESFire EV3 Secure Identity Object (SIO) High Security application. Existing DESFire EV1 Secure Identity Object (SIO) credentials that remain in the population will continue to be supported by Signo readers after firmware upgrade.



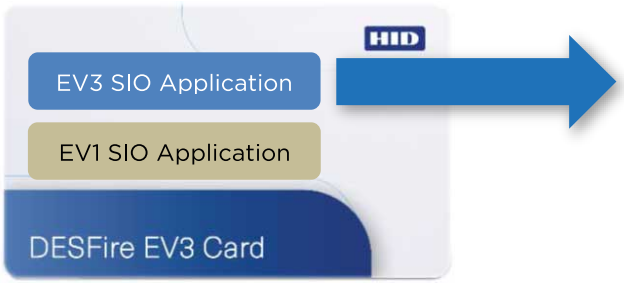
Compatibility Profile
Base Part 801/811

iCLASS/multiCLASS
Rev E



Compatibility Profile
Base Part 801/811

Signo Reader
(Previous Firmware)



Compatibility Profile
Base Part 801/811

Firmware
10.0.2.2 or Higher

Reader Manager
Firmware Upgrade

1.5.4 Multi-Application Compatibility

For maximum multi-application flexibility the card is configured to accept additional DESFire applications without the need to authenticate with the HID managed PICC Master key.

Should the end-user wish to take full control of application management, a custom part may be requested with end-user defined PICC master keys. This provides full control over third party application management through release of the custom PICC master key to 3rd party vendors.

1.5.5 Static UID

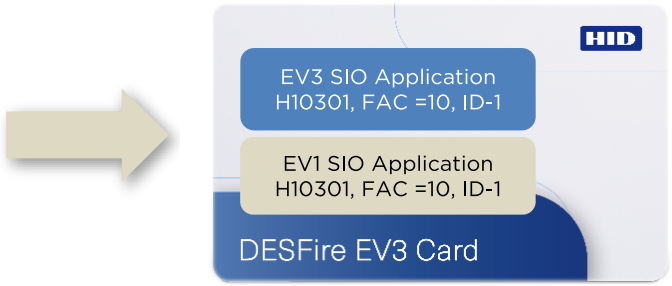
The Compatibility Profile utilizes static ISO14443A 7 byte UID. If iCLASS SE, multiCLASS SE, or Signo readers are enabled to read ISO14443A it may result in occasional UID output. HID recommends disabling ISO14443A to enhance user experience, or if using Signo readers use the Smart Profile.

1.5.6 Secure Identity Object (SIO) Programming

When ordering Compatibility Profile part numbers quote the desired PACS format and (optional) Elite key programming. The requested PACS format is automatically packaged into the Secure Identity Object (SIO) and is replicated between both DESFire applications. This ensures reader output is consistent between iCLASS SE, multiCLASS SE and Signo reader regardless of whether the Signo reader is reading the DESFire EV1 Secure Identity Object (SIO) application or the DESFire EV3 Secure Identity Object (SIO) high security application.

Selected DESFire Programming (example):

- **Format: H10301**
- **Facility Code: 10**
- **ID Range: 1-100**



Resulting Compatibility Profile
DESFire Application Programming

1.5.7 CP1000 Field Encoding Compatibility

The Compatibility Profile supports CP1000 DESFire EV1 Secure Identity Object (SIO) programming, EV1 Secure Identity Object (SIO) application management and DESFire EV1 custom data programming.

It should be noted that where the DESFire EV1 Secure Identity Object (SIO) application is reprogrammed or application keys are rolled, the PACS data stored within the DESFire EV3 Secure Identity Object (SIO) High Security Application will not be updated.

Select option "V" for DESFire EV1 Secure Identity Object (SIO) application field encoding. This option allows field programmed DESFire EV3 cards to support existing DESFire EV1 Secure Identity Object (SIO) based deployments with iCLASS SE or multiCLASS SE readers.

1.5.8 CP1000 Field Encoding Summary

- "V" part programming option for field encoding of DESFire EV1 compatible Secure Identity Object (SIO) application (in standard, Elite or custom keys)
- Reprogram DESFire EV1 compatible Secure Identity Object (SIO) PACS data
- Roll DESFire EV1 compatible Secure Identity Object (SIO) PACS data keys to custom or Elite

- Roll HID PICC master keys to custom or Elite
- Write custom data with DESFire EV1 features (e.g. 2TDEA, AES128)
- Supports all CP1000 EV1 NXP diversification algorithms

1.6 Custom Profile

The Custom Profile option provides an option for custom programming via 3rd party DESFire EV1, EV2 or EV3 compliant solutions (using unprogrammed DESFire EV3 credentials issued with NXP default settings and key), or HID factory encoded custom programmed part numbers. Existing custom EV1 application profiles may be replicated on DESFire EV3 to maintain full backward compatibility with existing EV1 compliant infrastructure and/or upgraded to make use of the latest DESFire EV2/EV3 features.

1.6.1 Base Part Numbers:

- 800 (Custom or Unprogrammed DESFire EV3 8K)
- 810 (Custom or Unprogrammed DESFire EV3 8K + 125kHz) – supports HID Prox and Indala formats

1.6.2 Feature Summary

The Custom Profile offers the following options:

- Custom factory encoding services (via custom part number)
  - Custom key management services (upload of private keys to HID's HSM infrastructure)
  - Custom application programming (PICC/ Application/File/Data)
  - Fully backward compatible with DESFire EV1 and EV2 solutions using compliant features
  - Latest DESFire features such as proximity check and multiple access conditions
- Unprogrammed
  - Delivered with NXP default PICC master key and settings ready for full field customization

1.6.3 Custom Profile Engagement

Contact your local HID sales, pre-sales or sales engineering representative to discuss setup and qualification of custom DESFire EV3 programming profiles and part numbers. Setup time and sample lead times apply.

1.7 DESFire EV1 and EV2 Part Number Conversion Table

If you are currently purchasing HID DESFire EV1 or EV2 credentials, refer to the table below to determine the required compatible DESFire EV3 credential part number. In order to reduce PVC content, HID DESFire EV3 credentials are offered with composite construction only.

DESFire EV1 SIO Enabled Part Numbers	Compatibility Profile DESFire EV3 Part Number
3700CP (DESFire EV1, PVC)	801FP (DESFire EV3, Composite)
3700CV (DESFire EV1, PVC)	801FV (DESFire EV3, Composite)
3750CP (DESFire EV1, Composite)	801FP (DESFire EV3, Composite)
3750CV (DESFire EV1, Composite)	801FV (DESFire EV3, Composite)
3800CP (DESFire EV1 +125kHz, PVC)	811FPN (DESFire EV3 + 125kHz Composite)
3800CR (DESFire EV1 +125kHz, PVC)	811FPP (DESFire EV3 + 125kHz Composite)
3800CV (DESFire EV1 +125kHz, PVC)	811FVN (DESFire EV3 + 125kHz Composite)
3850CP (DESFire EV1 +125kHz, Composite)	811FPN (DESFire EV3 + 125kHz Composite)
3850CR (DESFire EV1 +125kHz, Composite)	811FPP (DESFire EV3 + 125kHz Composite)
3850CV (DESFire EV1 +125kHz, Composite)	811FVN (DESFire EV3 + 125kHz Composite)
DESFire EV2 SIO Enabled Part Numbers	**Compatibility Profile DESFire EV3 Part Number**
3750DP (DESFire EV2, Composite)	801FP (DESFire EV3, Composite)
3750DV (DESFire EV2, Composite)	801FV (DESFire EV3, Composite)
3850DP (DESFire EV2 +125kHz, Composite)	811FPN (DESFire EV3 + 125kHz Composite)
3850DR (DESFire EV2 +125kHz, Composite)	811FPP (DESFire EV3 + 125kHz Composite)
3850DV (DESFire EV2 +125kHz, Composite)	811FVN (DESFire EV3 + 125kHz Composite)

Unprogrammed DESFire EV1 Part Numbers	Unprogrammed DESFire EV3 Part Number
1450CN (DESFire EV1, PVC)	800FN (DESFire EV3, Composite)
1456CN (DESFire EV1, Composite)	800FN (DESFire EV3, Composite)
1451CN (DESFire EV1 +125kHz, PVC)	810FNN (DESFire EV3 + 125kHz Composite)
1451CL (DESFire EV1 +125kHz, PVC)	810FNP (DESFire EV3 + 125kHz Composite)
1457CN (DESFire EV1 +125kHz, Composite)	810FNN (DESFire EV3 + 125kHz Composite)
1457CL (DESFire EV1 +125kHz, Composite)	810FNP (DESFire EV3 + 125kHz Composite)
Unprogrammed DESFire EV2 Part Numbers	**Unprogrammed DESFire EV3 Part Number**
1456DN (DESFire EV2, Composite)	800FN (DESFire EV3, Composite)
1457DN (DESFire EV1 +125kHz, Composite)	810FNN (DESFire EV3 + 125kHz Composite)
1457DL (DESFire EV1 +125kHz, Composite)	810FNP (DESFire EV3 + 125kHz Composite)

1.8 Signo Custom Profile DESFire Support

Signo Custom Profile supports the following custom (Non-SIO) DESFire features:

- 7 Byte static UID (note, 4 byte random UID not supported)
- EV1/EV2/EV3 Application and file management based on TDES/ 2TDEA/3TDEA/AES128
- EV1/EV2/EV3 File communication based on Plain, MAC, or Cyphered
- EV1/EV2/EV3 Diversification algorithms supported
  - NXP "AV1" 2TDEA/3TDEA/AES
- Datamapper compliant file data

1.9 iCLASS/MultiCLASS SE "W" Option Custom DESFire Support

iCLASS SE and multiCLASS Rev E HF migration readers ("W" option) are fully compatible with DESFire EV3 credentials operating with EV1 compatible features such as:

- EV1/EV2/EV3 7 Byte static UID (4 byte random UID not supported)
- EV1/EV2/EV3 Application and file management based on 2TDEA/3TDEA/AES128
- EV1/EV2/EV3 File communication based on Plain, MAC, or Cyphered
- Diversification algorithms supported:
  - NXP "AV1" 2TDEA/3TDEA/AES
- Datamapper compliant file data

1.10 Summary of HID DESFire EV3 Solution Compatibility

PACS Read Only

	Reader/Device Platform Capability (device configuration dependent)					
EV3 Base Part	**Signo (firmware =>10.0.2.2)**	**iCLASS SE/ multiCLASS SE/ pivCLASS**	**Signo (firmware <10.0.2.2)**	**OMNIKEY®/ Embedded Devices**	**HID Prox/ Indala**	**CP1000**
802FP	High Security SIO Application	Not Compatible	Not Compatible	Not Compatible	Not Compatible	Not Compatible
812FPP	High Security SIO Application HID Prox/Indala	HID Prox/Indala Only	HID Prox/Indala Only	HID Prox/Indala only (LF compatible models)	HID Prox/ Indala	HID Prox
801FP	High Security SIO Application ISO14443A UID	EV1 Compliant SIO Application ISO14443A UID	EV1 Compliant SIO Application ISO14443A UID	EV1 Compliant SIO Application (model dependent) ISO14443A UID	Not Compatible	EV1 Compliant SIO Application ISO14443A UID
811FPP	High Security SIO Application ISO14443A UID HID/Indala Prox	EV1 Compliant SIO Application ISO14443A UID HID/Indala Prox	EV1 Compliant SIO Application ISO14443A UID HID/Indala Prox	EV1 Compliant SIO Application ISO14443A UID HID Prox /Indala Prox (model dependent)	HID Prox/ Indala	EV1 Compliant SIO Application ISO14443A UID HID Prox
800FN	ISO14443A UID	ISO14443A UID	ISO14443A UID	ISO14443A UID (model dependent)	Not Compatible	ISO14443A UID
810FNP	ISO14443A UID HID Prox/Indala	ISO14443A UID HID Prox/Indala	ISO14443A UID HID Prox/Indala	ISO14443A UID HID Prox/Indala (model dependent)	HID Prox/ Indala	ISO14443A UID HID Prox

SE Express does not support DESFire credentials. Signo 25B and RB25F supports ISO14443A UID only. SIO read or template on card is not supported.

PACS Read - Custom Data

	Custom Reader/Device (device configuration dependent) File encoded by HID, third party or CP1000		
EV3 Base Part	**iCLASS SE/multiCLASS SE "W" Option**	**Signo Custom Profile**	**CP1000**
800FS/810FSP	Supported Custom File Features: TDEA 2TDEA 3TDEA AES128 Plain/MAC/Cyphered NXP "AV1" KDF 2TDEA/3TDEA/AES File Encoding Format Datamapper compliant	Supported Custom File Features TDEA 2TDEA 3TDEA AES128 Plain/MAC/Cyphered NXP "AV1" KDF 2TDEA/3TDEA/AES File Encoding Format Datamapper compliant	TDEA 3TDEA AES128 Plain/MAC/Cyphered NXP "AV1" KDF 2TDEA/3TDEA/AES NIST AES SENC HMAC KDF File Encoding Format: ASCII HEX

PACS Write - Custom Data

	Custom Reader/Device (device configuration dependent)
EV3 Base Part	**CP1000**
801F/811F 800FS/810FSP	Custom Data Application/ File Encoding TDEA 3TDEA AES128 Plain/MAC/Cyphered NXP "AV1" KDF 2TDEA/3TDEA/AES NIST AES SENC HMAC KDF File Encoding Format: ASCII HEX
802FP/812FP	Custom Data Application/ File Encoding TDEA 3TDEA AES128 Plain/MAC/Cyphered Key Diversification not supported (due to random UID) File Encoding Format: ASCII HEX

1.11 Frequently Asked Questions

Q: What is DESFire EV3?

A: EV3 is NXP's latest DESFire family member that combines enhanced performance with improved transaction speed compared to its predecessors. HID is committed to offering our customers the latest version of HID MIFARE DESFire solutions to ensure the best possible level of security and performance.

Q: What is the High Security Profile?

A: The High Security profile offers increased security and privacy when compared to our HID EV1 and EV2 Secure Identity Object (SIO) enabled cards.

- Application and file security is based on AES128 and benefits from improved secure messaging
- Utilizes NIST standards for key diversification
- Supports NXP's Proximity Check feature
- Provides enhanced privacy protection through random UID

Q: What is Proximity Check?

A: The Proximity Check function is a DESFire security feature that reduces the risk of relay attacks. Before the transmission of data is allowed the Proximity Check function validates that the card is in close proximity to the reader. This is achieved via accurate timing measurements between the reader and card. HID Signo Reader with firmware 10.0.2.2 or higher supports the Proximity Check function when reading the High Security Profile card or, if reading the High Security application from a Compatibility Profile card.

Q: If I want to use High Security Profile card do I have to upgrade my existing Signo Reader?

A: Yes, unless the reader is already operating with firmware 10.0.2.2 or higher. If the installed HID Signo reader is operating with a lower version of firmware use HID Reader Manager to upgrade.

Q: Are HID DESFire EV3 Compatibility Profile cards supported by iCLASS SE and multiCLASS SE readers?

A: Yes, Compatibility Profile part numbers offer full backward compatibility with iCLASS SE, multiCLASS SE and Signo readers reading Secure Identity Object (SIO) enabled HID DESFire EV1 or DESFire EV2 cards. If you are migrating from HID EV1 and EV2 part numbers, refer to the **DESFire EV1 and EV2 Part Number Conversion Table** for full details of compatible HID EV3 part numbers.

Q: Are HID DESFire EV3 cards compatible with HID's CP1000 field encoder?

A: Yes, using Compatibility Profile part numbers. The Compatibility Profile ensures full backward compatibility with the CP1000 when programming the EV1 Secure Identity Object (SIO) application or custom data that using EV1 compliant features.

Q: Are third party application compatible with HID DESFire EV3 High Security Profile cards?

A: Check with the application vendor. The High Security Profile supports the addition of applications to the card however, application vendors must be able to support the random UID feature. HID recommends that you check with application vendors in advance of deployment to confirm compatibility. If the application vendors are unable to support random UID, choose a Compatibility Profile card.

Q: Is it possible to convert profiles in the field?

A: No, profiles issues from the factory are not able to be updated in the field.

Q: If I order an unprogrammed, Custom Profile card, is it fully compatible with third party devices?

A: Yes, unprogrammed DESFire EV3 cards are shipped in the default NXP state allowing full personalization to any DESFire EV3 specification.

Revision history

Date	Description	Revision
April 2021	Initial release.	A.0

Powering
Trusted Identities

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