

uFCoder PC/SC Windows Driver User guide

Table of contents

Introduction	3
Installing	3
Uninstalling	5
Features	5
ATR Returned	5
Registered Application Provider Identifier (RID)	7
PIX	7
SS - Byte For Standard	7
NN – Bytes For Card Name	8
Contactless Storage Card Functionality Support	8
General Aspects	8
Common Error Codes for Storage Cards	8
Get Data Command	9
Load Keys Command	10
General Authenticate Command	12
Read Binary Command	13
Update Binary Command	14
ISO/IEC 14443-4 Cards	15
Appendix A: DevMsi License	16
The Code Project Open License (CPOL) 1.02	16
Appendix B: Change Log	20

Introduction

PC/SC (abbreviation for "Personal Computer / Smart Card") is a specification for smart card integration into computer operating systems. Core members of the PC/SC Workgroup are Microsoft, Infineon, Gemalto, Toshiba. Microsoft has implemented PC/SC in Microsoft Windows using Wincard library which exports Smart Card API functions.

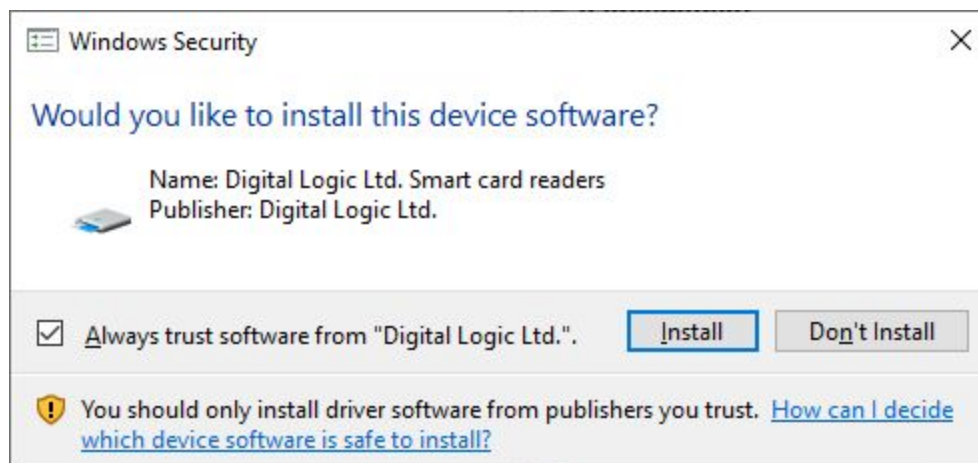
Digital Logic uFR is a NFC card reader device series which integrates into computing environments using proprietary API implemented using uFCoder software library.

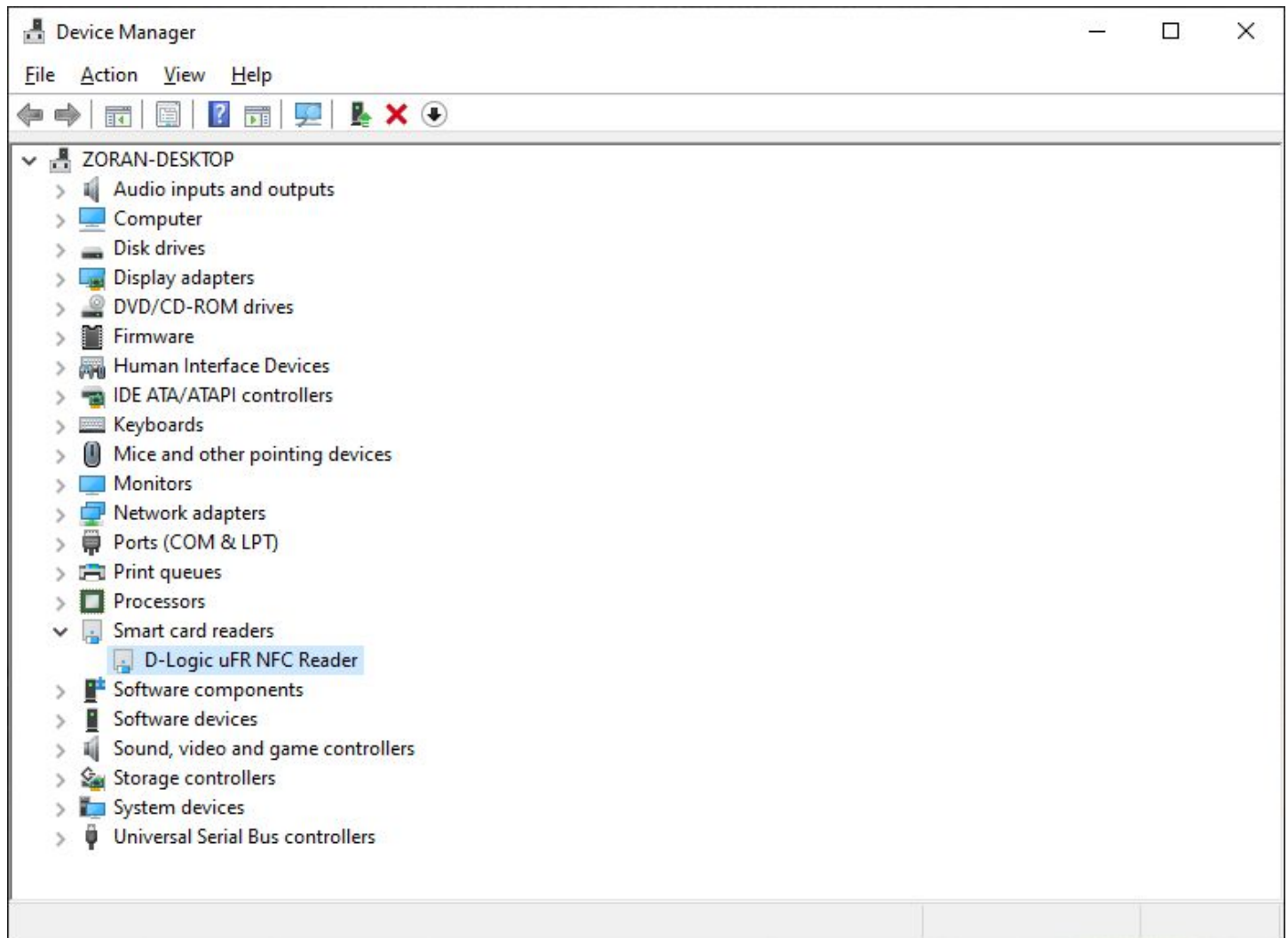
To maximize compatibility with existing Windows applications, we have created a uFCoder PC/SC driver. This driver supports Windows 8.1 and newer operating systems and enables communication with ISO/IEC 14443-4 contactless smart cards and ISO/IEC 14443-3 storage cards which includes NXP Mifare Classic and NFC T2T cards such as NXP Mifare Ultralight (basic model, Ultralight C and EV1), NXP NTAG 203, NXP NTAG 21x etc.

Installing

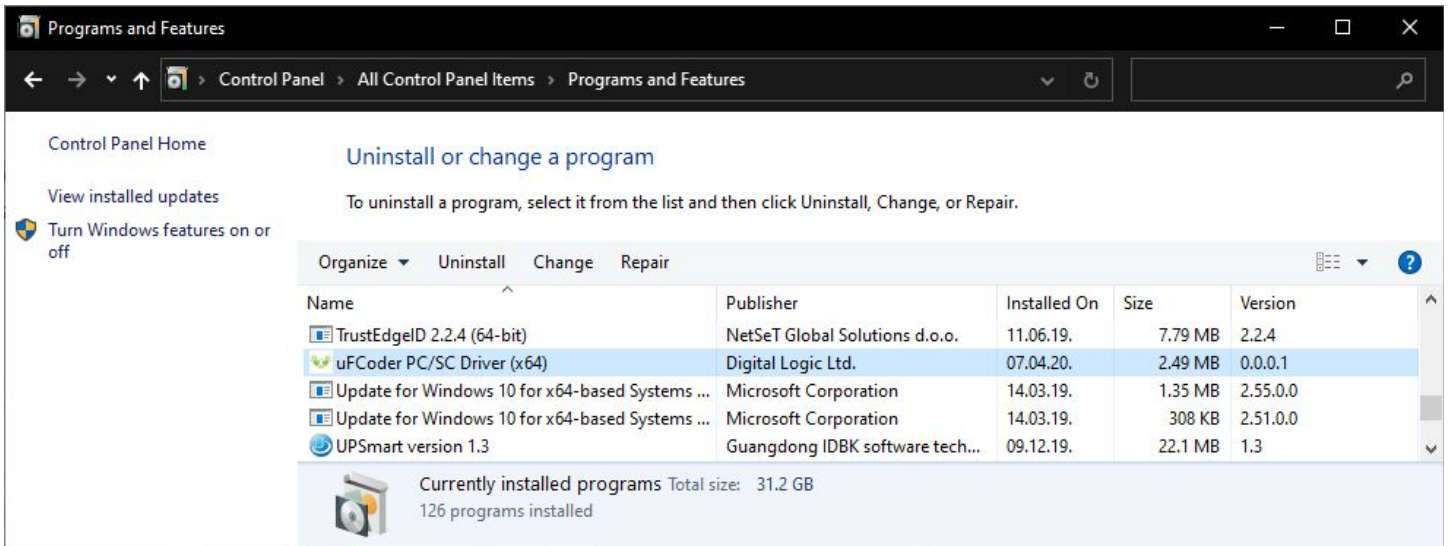
You can download uFCoder PC/SC driver from our Git repository: <https://www.d-logic.net/code/>

uFCoder PC/SC Windows driver **installer** use DevMsi project fork from the <https://github.com/nickrussler/DevMsi/tree/master>. DevMsi project is originated from <https://www.codeproject.com/Articles/570751/DevMSI-An-Example-Cplusplus-MSI-Wix-Deferred-Custo> and its author is Joe Marley. We have published DevMsi source code downloaded from <https://github.com/nickrussler/DevMsi/tree/master> in zip archive on our Git repository and DevMsi License (The Code Project Open License (CPOL) 1.02) is shown in Appendix A of this document.





Uninstalling



Features

ATR Returned

Contactless smart cards (ISO/IEC 14443-4) and Contactless storage cards don't report classic Answer To Reset (ATR) as Contact Smart Cards do. The ATR of a Contactless Storage Card is composed as described in the following table.

		Header	
1	8n	T0	Higher nibble 8 means: no TA1, TB1, TC1 only TD1 is following. Lower nibble n is the number of historical bytes (HistByte 0 to HistByte n-1)
2	80	TD1	Higher nibble 8 means: no TA2, TB2, TC2 only TD2 is following. Lower nibble 0 means T = 0
3	1	TD2	Higher nibble 0 means no TA3, TB3, TC3, TD3 following. Lower nibble 1 means T = 1
4 to 2+n	XX XX XX	Hist bytes	T1 Tk
			80
			4F
			YY
			R[0] R[1] R[4]
			5 bytes
			Registered application provider identifier (RID)
			PIX (maximum 7 bytes)
			PP PP
		 PP
			SS
			Byte for Standard
			NN NN
			Bytes for Card Name
			RU RU RU RU
			RFU: Shall be set to zero. Assigned by PC/SC for future extensions.
3+n	UU	TCK	Exclusive-oring of all the bytes T0 to Tk

In order to allow the application to identify a storage card type properly, its Standard and Card Name describing bytes must be interpreted according to the following rules.

Registered Application Provider Identifier (RID)

The PC/SC Workgroup has its own 5-byte RID:

R[0]	R[1]	R[2]	R[3]	R[4]
0xA0	0x00	0x00	0x03	0x06

PIX

SS - Byte For Standard

This describes the standard of a Storage Card. In a table below, only the standards which are supported by the uFR readers series are indicated.

SS - Byte For Standard								Description
b7	b6	b5	b4	b3	b2	b1	b0	
0	0	0	0	0	0	0	0	No information given
0	0	0	0	0	0	0	1	ISO 14443 A, part 1
0	0	0	0	0	0	1	0	ISO 14443 A, part 2
0	0	0	0	0	0	1	1	ISO 14443 A, part 3
0	0	0	0	0	1	0	0	RFU
0	0	0	0	0	1	0	1	ISO 14443 B, part 1
0	0	0	0	0	1	1	0	ISO 14443 B, part 2
0	0	0	0	0	1	1	1	ISO 14443 B, part 3

NN – Bytes For Card Name

The two bytes for Card Name represent a number which will be assigned by the PC/SC Workgroup. In a table below, only the cards supported by the uFR readers series are indicated:

Card Name	Two Byte - Identifier
No information given	'00 00'
Mifare Standard 1K	'00 01'
Mifare Standard 4K	'00 02'
Mifare Ultralight / NTAG21x	'00 03'
Mifare Mini	'00 26'
MIFARE Ultralight C	'00 3A'
MIFARE Ultralight EV1	'00 3D'

Contactless Storage Card Functionality Support

General Aspects

This section defines commands for Storage Cards (Exception : The Get Data Command, which returns UID or historical bytes from the ATS of a ISO 14443 A, may be used for all kinds of contactless cards).

Common Error Codes for Storage Cards

SW1	SW2	Meaning
0x67	0x00	Wrong length
0x68	0x00	Class byte is not correct
0x6A	0x81	Function not supported
0x6B	0x00	Wrong parameter P1-P2

The error codes defined in the Table above are valid for all commands defined within this section. Moreover command specific errors have been introduced as required in individual subsections.

Get Data Command

This Get Data command will retrieve information about the inserted command depending on the inserted card. It can be used for kind of contactless cards.

GET DATA Command APDU:

Class	INS	P1	P2	Lc	Data In	Le
0xFF	0xCA	0x00 0x01	0x00	-	-	XX

P1	P2	
0x00	0x00	UID is returned
0x01	0x00	all historical bytes from the ATS of a ISO 14443 A card without CRC are returned

Get Data Command Output:

Data Out
Data + SW1 SW2

Le = 0x00, this means: Return full length of the data (e.g. for ISO14443A single 4 bytes, double 7 bytes, triple 10 bytes, for ISO14443B 4 bytes PUP1, for 15693 8 bytes UID).

UID Format:

The format of the UID has to be the same for all IFD subsystem implementations:

- The UID has to be exposed as a string of the expected length. If the expected length is greater than the actual length the rest of the string has to be filled with zero-value padding bytes.
- No cast must be done over the UID or parts of it. For example, casting four bytes of the UID to a 32-bit Integer is illegal.
- The order of the bytes within the string must match the order of bytes received from the card during initial contact (e.g. Anti-collision). Consequently, the first byte received will be at index zero.
- The bit order of the string bytes must be such that the LSB (MSB) matches with the LSB (MSB) of the card-defined UID.

The following table introduces some examples of SW1SW2 and their meaning.

	SW1	SW2	Meaning
Warning	0x62	0x82	End of data reached before Le bytes (Le is greater than data length).
Error	0x6A	0x81	Function not supported
	0x6C	XX	Wrong length (wrong number Le; 'XX' encodes the exact number)

Load Keys Command

The 'Load keys' command will just load (write) the keys in the uFR reader's designated memory. The key can be only of the card key type. uFR reader does not protect the transmission of secure data e.g. card key from the application to the reader, for now. So the Reader Key type isn't supported. This command can be used to set keys for NXP Mifare Classic contactless cards.

Card Key: This is the card specific key (e.g. for Mifare it is Mifare key). This key can be volatile or non-volatile.

The coding of the command provides the following mechanisms:

- Load keys in either container: Reader key container to be used for transmission protection and card key container for card authentication.
- Transmission of the loaded key in plain using a key out of the reader key container: The key to be used is indicated in P1 by its number. P2 is indicating the address within the container, where the key shall be stored.
- The containers can be located in volatile or non-volatile memory.

Load Keys Command APDU:

Class	INS	P1	P2	Lc	Data In	Le
0xFF	0x82	Key Structure	Key number	Key Length	Key	-

Load Keys Command Output:

Data Out
SW1 SW2

P1 Structure:

b7	b6	b5	b4	b3	b2	b1	b0	Description
X								0: Card Key, 1: Not supported
	X							0: Plain Transmission, 1: Not supported
		X						0: Keys are loaded into the uFR volatile memory 1: Keys are loaded into the uFR non-volatile memory.
			X					RFU
				XXXX				Not supported

P2 (Key Number):

Load Keys Error Codes:

	SW1	SW2	Meaning
Warning	0x63	0x00	No information is given
Error	0x69	0x82	Card key not supported
		0x83	Reader key not supported
		0x84	Plain transmission not supported
		0x85	Secured transmission not supported
		0x86	Volatile memory is not available
		0x87	Non-volatile memory is not available
		0x88	Key number not valid
		0x89	Key length is not correct

General Authenticate Command

The application provides the number of the key used for the authentication. The specific key must be already in the uFR reader.

General Authenticate Command APDU:

Class	INS	P1	P2	Lc	Data In	Le
0xFF	0x86	0x00	0x00	5	See table	-

General Authenticate data bytes:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Version 0x01	Address MSB	Address LSB	Key type	Key Nr

General Authenticate Command Output:

Data Out
SW1 SW2

General Authenticate Error Codes:

	SW1	SW2	Meaning
Warning	0x63	0x00	No information is given
Error	0x65	0x81	P1, P2 have to be 0x00
	0x69	0x82	Security status not satisfied
		0x83	Authentication cannot be done
		0x84	Reference key not useable
		0x86	Key type not known
		0x88	Key number not valid

Read Binary Command

If the Le field contains only bytes set to 0x00 then all the bytes until the end of the file shall be read within the limit of 256 for a short Le field.

Read Binary Command APDU:

Class	INS	P1	P2	Lc	Data in	Le
0xFF	0xB0	Address MSB	Address LSB	-	-	XX

Read Binary Command Output:

Data Out
Data + SW1 SW2

Read Binary Error Codes:

	SW1	SW2	Meaning
Warning	0x62	0x81	Part of returned data may be corrupted.
		0x82	End of file reached before reading expected number of bytes.
Error	0x69	0x81	Command incompatible.
		0x82	Security status not satisfied.
		0x86	Command not allowed.
	0x6A	0x81	Function not supported.
		0x82	File not found / Addressed block or byte does not exist.
	0x6C	XX	Wrong length (wrong number Le; 'XX' is the exact number).

Update Binary Command

Update Binary Command APDU:

Class	INS	P1	P2	Lc	Data in	Le
0xFF	0xD6	Address MSB	Address LSB	XX	Data	-

Update Binary Command Output:

Data Out
SW1 SW2

Update Binary Error Codes:

	SW1	SW2	Meaning
Warning	0x62	0x81	A part of the returned data may be corrupted.
		0x82	End of file reached before writing Lc bytes.
Error	0x65	0x81	Memory failure (unsuccessful writing).
	0x69	0x81	Command incompatible.
		0x82	Security status not satisfied.
		0x86	Command not allowed.
	0x6A	0x81	Function not supported.
		0x82	File not found / Addressed block or byte does not exist.

ISO/IEC 14443-4 Cards

The Contactless Smart Card exposes its ATS or information bytes not directly, but via a specific ATR mapping. For Contactless Smart Card, the card reader subsystem must construct an ATR from the fixed elements that identify the cards. For those cards that provide such information, optionally with Historical Bytes (or Application Information respectively), the mapping in the following table applies.

Byte Nr	Value	Designation	Description						
0	3B	Initial Header							
1	8n	T0	Higher nibble 8 means no TA1, TB1, TC1 only TD1 is following. Lower nibble n is the number of historical bytes (HistByte 0 to HistByte n-1)						
2	80	TD1	Higher nibble 8 means no TA2, TB2, TC2 only TD2 is following. Lower nibble 0 means T = 0						
3	1	TD2	Higher nibble 0 means no TA3, TB3, TC3, TD3 following Lower nibble 1 means T = 1						
4 to 3+n	XX XX XX	T1 Tk	<div>Historical bytes: ISO14443A: The historical bytes from ATS response. Refer to the ISO14443-4 specification. ISO14443B:</div> <table><tr><th>Byte 1 - 4</th><th>Byte 5 –7</th><th>Byte 8</th></tr><tr><td>Application Data from ATQB</td><td>Protocol Info Byte from ATQB</td><td>Higher nibble = MBLI from ATTRIB command Lower nibble (RFU) = 0</td></tr></table>	Byte 1 - 4	Byte 5 –7	Byte 8	Application Data from ATQB	Protocol Info Byte from ATQB	Higher nibble = MBLI from ATTRIB command Lower nibble (RFU) = 0
Byte 1 - 4	Byte 5 –7	Byte 8							
Application Data from ATQB	Protocol Info Byte from ATQB	Higher nibble = MBLI from ATTRIB command Lower nibble (RFU) = 0							
4+n	XX	TCK	XOR of the bytes T0 to Tk						

Appendix A: DevMsi License

The Code Project Open License (CPOL) 1.02

Preamble

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Appendix B: Change Log

Datum	Verzija	Komentar
2020-04-13	1.3	ATR of a Contactless Storage Card composition.
2020-04-10	1.2	ISO/IEC 14443-4 Cards ATR mapping.
2020-04-09	1.1	Contactless Storage Card Functionality Support
2020-04-06	1.0	Initial revision