USER MANUAL

SecureHead™
Encrypted Magnetic Read Head

USB and UART Interface

80101505-001-C
09-20-2011

Agency Approved

Specifications for subpart B of part 15 of FCC rule for a Class A computing device.

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Revision History

Revision	Date	Description of Changes	By
50	10/20/2010	Initial Draft	Jenny W
51	10/25/2010	Revised read status command Added decryption examples	Jenny W
52	11/12/2010	Added UART interface cable pinout	Jenny W
A	05/09/2011	-Added SecureHead mounting option with drawing to indicate track 1 location -Edited original and enhanced encryption output format -Changed device serial number length from 8 byte to 10 byte	Jenny W
B	06/21/2011	Added design guidelines for head installation	Jenny W
C	9/20/2011	- Updated USB interface Cable Pin Out - Updated power information	Yvonne Y

Table of Contents

1. INTRODUCTION

ID TECH SecureHead reader delivers superior reading performance with the ability to encrypt sensitive card data. The data encryption process prevents card holder information from being accessed when the data is stored or in transit, so the data remains secure from end to end. The reader fully supports TDES and AES data encryption using DUKPT key management method. The SecureHead supports SPI, UART and USB interface. The information about SPI SecureHead can be found in a separate document, 80101502-001 SecureHead SPI user manual.

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2. SPECIFICATIONS

General

Card Speed	3 to 75 ips (7.6 to 190.5 cm/s)

Electrical

- UART

Power	3.0 to 3.6 VDC	
I/O Voltage Range	2.7 to 3.6 VDC	
Current		
Active Power Supply Current		5 mA
Standby Power supply Current		2 mA

- USB

Power	5.0 VDC +/- 10%	
I/O Voltage Range	2.7 to 3.6 VDC	
Current		
Active Power Supply Current		6 mA
Standby Power supply Current		5 mA

ESD	+4kV discharge to head can

Communication interface

- UART
  - Baud Rate – 9,600 bits/second as default
  - Data bits – 8
  - Stop bits – 1
  - Parity – None
  - Supports Xon-Xoff software handshaking

- USB
  - Complies with USB 2.0 specification

Environment

Operating Temperature	-40 °C to 70 °C
Storage Temperature	-40 °C to 70 °C
Humidity	-10% to 90% non-condensing

Mechanical

Weight	5.67 grams

Interface cable and connector

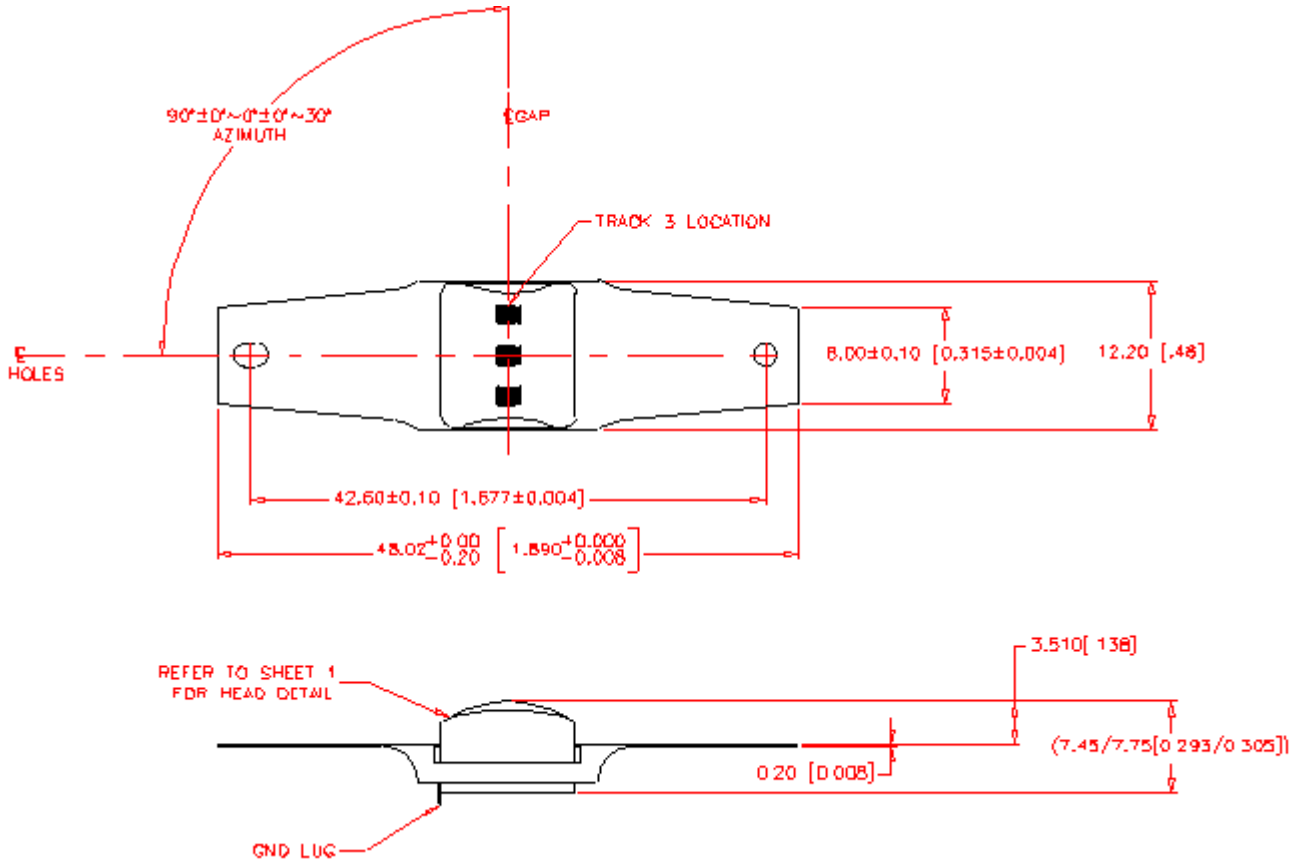
- USB
  - Cable connector: Molex 51021-0500 or equivalent
  - Standard cable length is 125mm
  - Pin Out Table

J1	Color	Signal
1	Red	VBUS
2	White	-DATA
3	Green	+DATA
4	Black	GND
5	Violet	HEAD_CASE

- UART
  - Cable connector: Molex 51021-0500 or equivalent
  - Standard cable length is 125mm
  - Pin Out Table

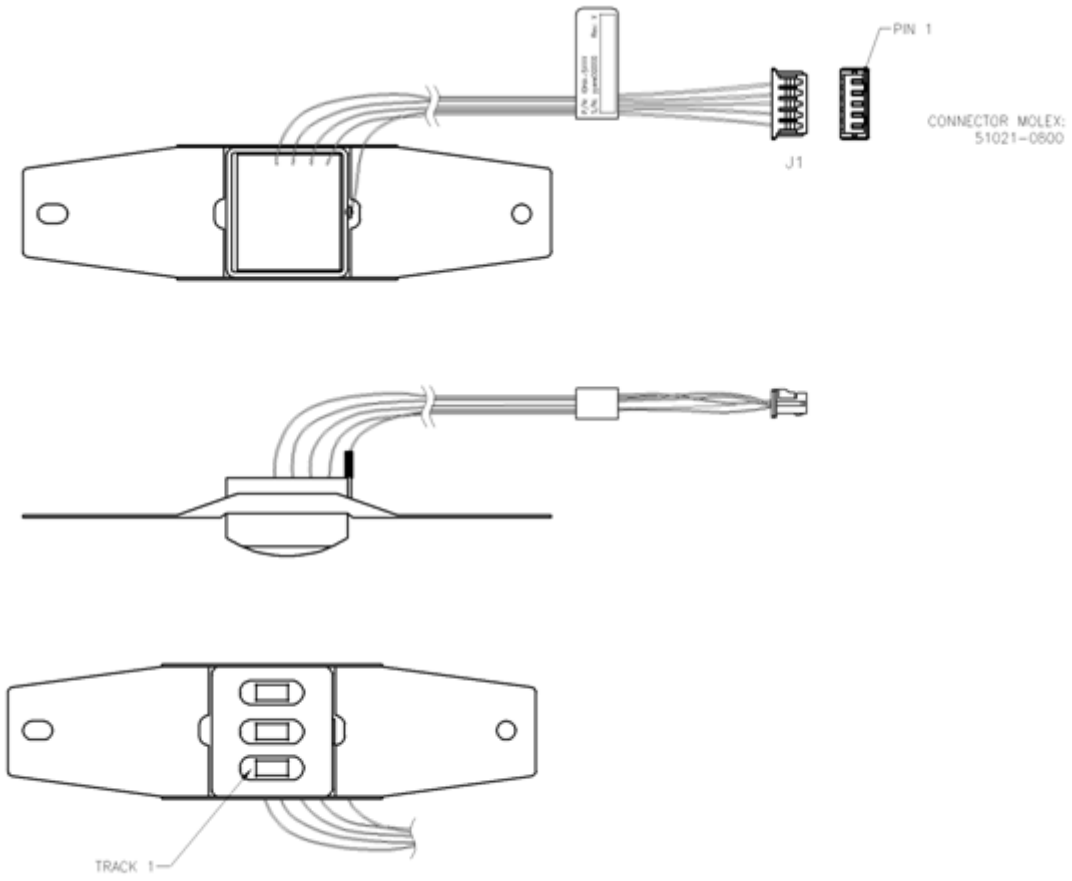
J1	Color	Signal
1	Violet	HEAD_CASE
2	White	RX
3	Yellow	TX
4	Red	3V
5	Black	GND

Dimension:

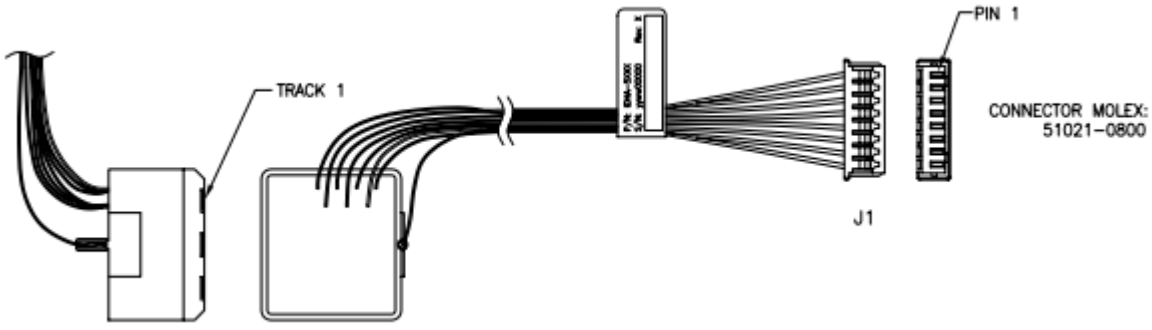


Mounting Options:

1. Wing spring mounting: this is the standard mounting option and can be used on most swipe readers. The protrusion of the head for the surface of the spring is 3.50 mm.



2. Head assembly only: This option is provided for special applications.



The mechanical interface is an eight pin male Molex Connector 51021-0800 for option 1 and 2.

3. CONFIGURATION

The SecureHead reader must be appropriately configured to your application. Configuration settings enable the reader to work with the host system. Once programmed, these configuration settings are stored in the reader's non-volatile memory (so they are not affected by the cycling of power).

3.1. Setup Commands Structure

Commands sent to SecureHead

a. Setting Command:
<STX><S>[<FuncID><Len><FuncData>…]<ETX><CheckSum>

b. Read Status Command:
<STX><R><FuncID><ETX><CheckSum>

c. Function Command:
<STX>[<FuncID><Len><FuncData>…]<ETX><CheckSum>

Response from SecureHead

a. Setting Command

Host		SecureHead
	Setting Command	→
←	<ACK> if OK	
	or	
←	<NAK> if Error	

b. Read Status Command

Host		SecureHead
	Read Status Command	→
←	<ACK> and <Response> if OK	
	or	
←	<NAK> if Error	

c. Other Command

Host		SecureHead
	Other Command	→
←	<ACK> and <Response> if OK	
	or	
←	<NAK> if Error	

Where:

<STX>	02h
<S>	Indicates setting commands. 53h
<R>	Indicates read status commands. 52h
<FuncID>	One byte Function ID identifies the particular function or settings affected.
<Len>	One byte length count for the following data block<FuncData>
<FuncData>	data block for the function
<ETX>	03h
<CheckSum>	Check Sum: The overall Modulo 2 (Exclusive OR) sum (from <STX> to <CheckSum>) should be zero.
<ACK>	06h
<NAK>	FD for USB KB interface 15 for all other interface

3.2. Communication Timing

The SecureHead takes time to process a command. During that processing time, it will not respond to a new command.

The typical delay for the reader to respond to a command is 20ms, the maximum delay for the reader to respond can be as much as 40ms. Caution must therefore be taken to maintain a minimum delay between two commands.

3.3. Default Settings

The SecureHead reader is shipped from the factory with the default settings already programmed. In the following sections, the default settings are shown in **boldface**.

For a table of default settings, see Appendix A.

3.4. General Selections

This group of configuration settings defines the basic operating parameters of SecureHead.

3.4.1. Change to Default Settings

<STX><S><18h><ETX><CheckSum>

This command does not have any <FuncData>. It returns all settings for all groups to their default values.

3.4.2. MSR Reading Settings

Enable or Disable the SecureHead. If the reader is disabled, no data will be sent out to the host.
<STX><S><1Ah><01h><MSR Reading
Settings><ETX><CheckSum>
MSR Reading Settings:

"0" MSR Reading Disabled

"1" MSR Reading Enabled

3.4.3. Decoding Method Settings

The SecureHead can support four kinds of decoded directions.
<STX><S><1Dh><01h><Decoding Method
Settings><ETX><CheckSum>
Decoding Method Settings:
"0" Raw Data Decoding in Both Directions, send out in ID TECH mode
"1" Decoding in Both Directions. If the encryption feature is enabled, the key management method used is DUKPT.
"2" Moving stripe along head in direction of encoding. If the encryption feature is enabled, the key management method used is DUKPT.
"3" Moving stripe along head against direction of encoding. If the encryption feature is enabled, the key management method used is DUKPT.
"4" Raw Data Decoding in Both Directions, send out in other mode. If the encryption feature is enabled, the key management method used is fixed key.

With the bi-directional method, the user can swipe the card in either direction and still read the data encoded on the magnetic stripe. Otherwise, the card can only be swiped in one specified direction to read the card. Raw Decoding just sends the card's magnetic data in groups of 4 bits per character. The head reads from the first byte of each track, starting from the most significant bit. The data starts to being collected when the first 1 bit is detected. No checking is done except to verify track has or does not have magnetic data.

3.5. Review Settings

<STX><R><1Fh><ETX><CheckSum>

This command does not have any <FuncData>. It activates the review settings command. SecureHead sends back an <ACK> and <Response>.
<Response> format:
The current setting data block is a collection of many function-setting blocks <FuncSETBLOCK> as follows:

<STX><FuncSETBLOCK1>…<FuncSETBLOCKn><ETX><CheckSum>

Each function-setting block <FuncSETBLOCK> has the following format:
<FuncID><Len><FuncData>

Where:

<FuncID> is one byte identifying the setting(s) for the function.
<Len> is a one byte length count for the following function-setting block <FuncData>
<FuncData> is the current setting for this function. It has the same format as in the sending command for this function.
<FuncSETBLOCK> are in the order of their Function ID<FuncID>

3.6. Review Serial Number

<STX><R><4Eh><ETX><CheckSum>

This command is to get device serial number.

3.7. Message Formatting Selections(Only for Security Level 1 & 2)

3.7.1. Terminator Setting

Terminator characters are used to end a string of data in some applications.

<STX><S><21h><01h><Terminator Settings><ETX><CheckSum>

<Terminator Settings>: Any one character, 00h is none; default is **CR** (0Dh).

3.7.2. Preamble Setting

Characters can be added to the beginning of a string of data. These can be special characters for identifying a specific reading station, to format a message header expected by the receiving host, or any other character string. Up to fifteen ASCII characters can be defined.

<STX><S><D2h><Len><Preamble><ETX><CheckSum>

Where:
<Len>= the number of bytes of preamble string
<Preamble> = {string length}{string}
NOTE: String length is one byte, maximum fifteen <0Fh>.

3.7.3. Postamble Setting

The postamble serves the same purpose as the preamble, except it is added to the end of the data string, after any terminator characters.

<STX><S><D3h><Len><Postamble><ETX><CheckSum>

Where:
<Len> = the number of bytes of postamble string
<Postamble> = {string length}{string}

NOTE: String length is one byte, maximum fifteen <0Fh>.

3.7.4. Track n Prefix Setting

Characters can be added to the beginning of a track data. These can be special characters to identify the specific track to the receiving host, or any other character string. Up to six ASCII characters can be defined.

<STX><S><n><Len><Prefix><ETX><CheckSum>

Where:
<n> = 34h for track 1; 35h for track 2 and 36h for track 3
<Len> = the number of bytes of prefix string
<Prefix> = {string length}{string}
NOTE: String length is one byte, maximum six.

3.7.5. Track n Suffix Setting

Characters can be added to the end of track data. These can be special characters to identify the specific track to the receiving host, or any other character string. Up to six ASCII characters can be defined.

<STX><S><n><Len><Suffix><ETX><CheckSum>

Where:

<n> = 37h for track 1; 38h for track 2 and 39h for track 3
<Len> = the number of bytes of suffix string
<Suffix> = {string length}{string}
NOTE: String length is one byte, maximum six.

3.8. Magnetic Track Selections

3.8.1. Track Selection

There are up to three tracks of encoded data on a magnetic stripe.

This option selects the tracks that will be read and decoded.

<STX><S><13h><01h><Track_Selection Settings><ETX><CheckSum>

Track_Selection Settings:

"0" Any Track
"1" Require Track 1 Only
"2" Require Track 2 Only
"3" Require Track 1 & Track 2

"4" Require Track 3 Only
"5" Require Track 1 & Track 3
"6" Require Track 2 & Track 3
"7" Require All Three Tracks
"8" Any Track 1 & 2
"9" Any Track 2 & 3

Note: If any of the required multiple tracks fail to read for any reason, no data for any track will be sent.

3.8.2. Track Separator Selection

This option allows the user to select the character to be used to separate data decoded by a multiple-track reader.

<STX><S><17h><01h><Track_Separator><ETX><CheckSum>

<Track_Separator> is one ASCII Character. The default value is **CR,** 0h means no track separator.

3.8.3. Start/End Sentinel and Track 2 Account Number Only

The SecureHead can be set to either send, or not send, the Start/End sentinel, and to send either the Track 2 account number only, or all the encoded data on Track 2. (The Track 2 account number setting doesn't affect the output of Track 1 and Track 3.)

<STX><S><19h><01h><SendOption><ETX><CheckSum>

SendOption:
"0" Don't send start/end sentinel and send all data on Track 2
"1" Send start/end sentinel and send all data on Track 2
"2" Don't send start/end sentinel and send account # on Track 2
"3" Send start/end sentinel and send account number on Track 2

3.9.Security Settings

3.9.1. Select Key Management Type

<STX><S><58h><01h><Key Management Type><ETX><CheckSum>

Key Management Type:
"0" Fix key management
"1" DUKPT Key management

3.9.2. Load Device key Command

The Encrypted swipe read supports TDES and AES encryption standards for data encryption. Encryption can be turned on via a command. TDES is the default.

If the reader is in security level 3, for the encrypted fields, the original data is encrypted using the TDES/AES CBC mode with an Initialization Vector starting at all binary zeroes and the Encryption Key associated with the current DUKPT KSN.

Fixed Key Management

The load device key command loads a sixteen bytes key to the device. This key is used to encrypt the card data using triple DES or AES encryption algorithm. For triple DES, if the first 8 bytes of key equals to the second 8 bytes of the key, then the encryption algorithm becomes the single DES encryption.

Default value of device key in hex is 0000 0000 0000 0000 0000 0000 0000 0000.

Load Device Key Command

Host -> Device:
<STX><S><76h><10h><16 bytes Device key><ETX><CheckSum>

Device -> Host:
<ACK> (success)
<NAK> (fail)

DUKPT Key Management

When DUKPT key management is used, it is necessary to load Key Serial Number (KSN) and Initially Loaded Device Key before transaction.

The encryption key is TDES with 128 bit keys or AES encryption with double length keys (128 bit keys including parity).

DUKPT Key injection can only be done once.

KSN and Device Key loading commands and responses protocol:
Command:
<STX><'F'><'F'><Command Data (BASE64)><0x0D><0x0A><ETX><LRC>

Response:
<ACK/NAK><STX><'F'><'F'>< Respond Data (BASE64)><0x0D><0x0A><ETX> <LRC>

STX: 0x02
ETX: 0x03
ACK: 0x06

NAK: 0x15
BASE64: Data encoded with base64 algorithm
LRC: Xor'd all the data before LRC except STX.

A successful key loading process includes the following steps:

- Get Key status
  Command Data: <FF><13><01><02><LRC>
  Response Data: <FF><00><01><04><LRC>

  For Example:
  Command: \02\46\46\2F\78\4D\42\41\75\38\3D\0D\0A\03\LRC
  Response: \06\02\46\46\.....\0D\0A\03\LRC

- Load KSN
  Command Data: <FF><0A><11><KSN#><KSN bytes><LRC>
  Response Data: <FF><00><06><RESPONSE CODE><LRC>
  <KSN#>: 0x32
  <KSN bytes>: 0x10 bytes ASCII for KSN
  <RESPONSE CODE>: 6 bytes data in ASCII format which is converted from the first 3 cipher hex data. These cipher data are generated by encrypting KSN bytes and "00 00 00 00 00 00 00 00".

  For Example:
  Command:
  \02\46\46\2F\77\6F\52\4D\6B\5A\47\52\6B\59\35\4F\44\63\32\4E\54\51\7A\4D\6A
  \45\77\52\54\43\69\0D\0A\03\5D
  Response: \06\02\46\46\.....\0D\0A\03\LRC

- Load Encryption Key
  Command Data: <FF><0A><LENGTH><KEY#><KEY bytes><LRC>
  Response Data: <FF><00><06><RESPONSE CODE><LRC>
  <LENGTH>: 0x21
  <KEY#>: 0x33
  <KEY bytes>: 0x20 bytes ASCII for KEY
  <RESPONSE CODE>: 6 bytes data in ASCII format which is converted from the first 3 cipher hex data. These cipher data are generated by encrypting KEY bytes and "00 00 00 00 00 00 00 00".

  For Example:
  Command:
  \02\46\46\2F\77\6F\68\4D\7A\5A\42\51\7A\49\35\4D\6B\5A\42\51\54\45\7A\4D\5

4\56\43\4E\45\51\34\4E\54\68\42\51\6A\4E\42\4D\30\51\33\52\44\55\35\4D\7A\4E
\42\6C\51\3D\3D\0D\0A\03\2D
Response: \06\02\46\46\.....\0D\0A\03\LRC

3.9.3. External Authenticate Command (Fixed Key Only)

Before a security related command is executed, an authentication process is required to make sure the device key used is correct. For example, authentication is needed whenever the encryption is enabled/ disabled or the device key is changed. Once the authentication process is finished successfully, the same process would not be needed again until the device is restarted.

- First, the host would get a data block which is generated by encrypting a random 8-byte data using TDES algorithm.
- The host then decrypts the data block using TDES algorithm using the current device key.
- The host initiates an External Authenticate Command to verify the decrypted 8 bytes of random data
- The device checks to see if the data matches the random data generated. If the data are the same, authentication process is successful. If it fails, the host must start the authentication process again until it's succeed, before any security related featured can be changed.

Commands:

1) Retrieve Encrypted Challenge Command

Host -> Device:
<STX><R><74h><ETX><CheckSum>

Device -> Host:
<ACK><STX><8 bytes of TDES-encrypted random data><ETX><CheckSum> (success)
<NAK> (fail)

2) Send External Authenticate Command

Host -> Device:
<STX><S><74h><08h><8 bytes of original random data><ETX><CheckSum>

Device -> Host:
<ACK> (success)
<NAK> (fail)

3.9.4. Encryption Settings

Enable or disable the SecureHead Encryption output in ID TECH protocol. If encryption is disabled, original data will be sent out to the host. If it enabled, encrypted data will be send out to the host.

<STX><S><4Ch><01h><Encryption Settings><ETX><CheckSum>

Encryption Settings:

"0" Encryption Disabled

"1" Enable TDES Encryption

"2" Enable AES Encryption (Not for Raw Data Decoding in Both Directions, send out in other mode.)

3.10. Review KSN (DUKPT Key management only)

<STX><R><51h><ETX><CheckSum>

This command is to get DUKPT key serial number and counter.

3.11. Review Security Level

<STX><R><7Eh><ETX><CheckSum>

This command is to get the current security level.

3.12. Encrypt External Data Command

This command encrypts the data passed to the SecureHead and sends back the encrypted data to the host. The command is valid when the security level is set to 3 and 4.

Command:
Host->Device:
<STX><41h><Length<Data To Be Encrypted><ETX><CheckSum>

Where
<Length> is the 2-byte length of <Data To Be Encrypted> in hex, represented as <Length_L> and <Lengh_H>

Device->Host:
<ACK><STX><Length><Encrypted Data><SessionID><KSN><ETX><LRC> (success)
<NAK> (fail)

Where
<Length> is the 2-byte length of <Encrypted Data> in hex, represented as <Length_L> and <Length_H>
<SessionID> is only used at security level 4, it is part of the encrypted data
<KSN> is a 10 bytes string, in the case of fix key management, use serial number plus two bytes null characters instead of KSN.

After each successful response, the KSN will increment automatically.

3.13. Encrypted Output for Decoded Data

3.13.1.Encrypt Functions

When a card is swiped through the Reader, the track data will be TDEA (Triple Data Encryption Algorithm, aka, Triple DES) or AES (Advanced Encryption Standard) encrypted using Fixed key management or DUKPT (Derived Unique Key Per Transaction) key management. DUKPT key management uses a base derivation key to encrypt a key serial number that produces an initial encryption key which is injected into the Reader prior to deployment. After each transaction, the encryption key is modified per the DUKPT algorithm so that each transaction uses a unique key. Thus, the data will be encrypted with a different encryption key for each transaction.

3.13.2.Security Related Function ID

Security Related Function IDs are listed below. Their functions are described in other sections.

Characters	Hex Value	Description
PrePANID	49	First N Digits in PAN which can be clear data
PostPANID	4A	Last M Digits in PAN which can be clear data
MaskCharID	4B	Character used to mask PAN
EncryptionID	4C	Security Algorithm
SecurityLevelID	7E	Security Level (Read Only)
Device Serial Number ID	4E	Device Serial Number (Can be write once. After that, can only be read)
DisplayExpirationDataID	50	Display expiration data as mask data or clear data
KSN and Counter ID	51	Review the Key Serial Number and Encryption Counter
Session ID	54	Set current Session ID
Key Management Type ID	58	Select Key Management Type

Feasible settings of these new functions are listed below.

Characters	Default Setting	Description
PrePANID	04h	00h ~ 06h Allowed clear text from start of PAN Command format:

		02 53 49 01 04 03 LRC
PostPANID	04h	00h ~ 04h Allowed clear text from end of PAN Command format: 02 53 4A 01 04 03 LRC
MaskCharID	'*'	20h ~ 7Eh Command format: 02 53 4B 01 3A 03 LRC
DisplayExpirationDataID	'0'	'0' Display expiration data as mask data '1' Display expiration data as clear data
EncryptionID	'0'	'0' Clear Text '1' Triple DES '2' AES Command format: 02 53 4C 01 31 03 LRC
SecurityLevelID	'1'	'0' ~ '3' Command format: 02 52 7E 03 LRC
Device Serial Number ID	00, 00, 00, 00, 00, 00, 00, 00, 00, 00	10 bytes number: Command format: Set Serial Number: 02 53 01 4E 09 08 37 36 35 34 33 32 31 30 03 LRC Get Serial Number: 02 52 4E 03 LRC
KSN and Counter ID	00, 00, 00, 00, 00, 00, 00, 00, 00, 00	This field includes the Initial Key Serial Number in the leftmost 59 bits and a value for the Encryption Counter in the right most 21 bits. Get DUKPT KSN and Counter: 02 52 51 03 LRC
Session ID	00, 00, 00, 00, 00, 00, 00, 00	This Session ID is an eight bytes string which contains any hex data. This filed is used by the host to uniquely identify the present transaction. Its primary purpose is to prevent replays. It is only be used at Security Level 4. After a card is read, the Session ID will be encrypted, along with the card data, a supplied as part of the transaction message. The clear text version of this will never be transmitted.

		New Session ID stays in effect until one of the following ocurrs: 1. Another Set Session ID command is received. 2. The reader is powered down. 3. The reader is put into Suspend mode.
Key Management Type ID	'1'	Fixed key management by default. '0': Fixed Key '1': DUKPT Key

3.13.3.Security Management

This reader is intended to be a secure reader. Security features include:

- Can include Device Serial Number
- Can encrypt track 1 and track 2 data for all bank cards
- Provides clear text confirmation data including card holder's name and a portion of the PAN as part of the Masked Track Data
- Optional display expiration data
- Security Level is settable

The reader features configurable security settings. Before encryption can be enabled, Key Serial Number (KSN) and Base Derivation Key (BDK) must be loaded before encrypted transactions can take place. The keys are to be injected by certified key injection facility.

There are five security levels available when using the DUKPT key management:

- Level 0
  Security Level 0 is a special case where all DUKPT keys have been used and is set automatically when it runs out of DUKPT keys. The lifetime of DUKPT keys is 1 million. Once the key's end of life time is reached, user should inject DUKPT keys again before doing any more transactions.

- Level 1
  By default, readers from the factory are configured to have this security level. There is no encryption process, no key serial number transmitted with decoded data. The reader functions as a non-encrypting reader and the decoded track data is sent out in default mode.

- Level 2
  Key Serial Number and Base Derivation Key have been injected but the encryption process is not yet activated. The reader will send out decoded track data in default

format. Setting the encryption type to TDES and AES will change the reader to security level 3.

- Level 3
  Both Key Serial Number and Base Derivation Keys are injected and encryption mode is turned on. For payment cards, both encrypted data and masked clear text data are sent out. Users can select the data masking of the PAN area; the encrypted data format cannot be modified. Users can choose whether to send hashed data and whether to reveal the card expiration date. When the encryption is turned on, level 3 is the default security level.

- Level 4
  When the reader is at Security Level 4, a correctly executed Authentication Sequence is required before the reader sends out data for each card swipe.

3.13.4.Encryption Management

The Encrypted swipe read supports TDES and AES encryption standards for data encryption. Encryption can be turned on via a command. TDES is the default.

If the reader is in security level 3, for the encrypted fields, the original data is encrypted using the TDES/AES CBC mode with an Initialization Vector starting at all binary zeroes and the Encryption Key associated with the current DUKPT KSN.

3.13.5.Check Card Format

- ISO/ABA (American Banking Association) Card

Encoding method

Track1 is 7 bits encoding.
Track1 is 7 bits encoding. Track2 is 5 bits encoding. Track3 is 5 bits encoding.
Track1 is 7 bits encoding. Track2 is 5 bits encoding.
Track2 is 5 bits encoding.

Additional check

Track1 2nd byte is 'B'.
There is only one '=' in track 2 and the position of '=' is between 12th ~ 20th character.
Total length of track 2 should above 21 characters.

- AAMVA (American Association of Motor Vehicle Administration) Card

Encoding method

Track1 is 7 bits encoding. Track2 is 5 bits encoding. Track3 is 7 bits encoding.

- Others (Customer card)

3.13.6.MSR Data Masking

For cards need to be encrypted, both encrypted data and clear text data are sent.
Masked Area

The data format of each masked track is ASCII.
The clear data include start and end sentinels, separators, first N, last M digits of the PAN, card holder name (for Track1).
The rest of the characters should be masked using mask character.

Set PrePANClrData (N), PostPANClrData (M), MaskChar (Mask Character)

N and M are configurable and default to 4 first and 4 last digits. They follow the current PCI constraints requirements (N 6, M 4 maximum).
Mask character default value is '*'.

- Set PrePANClrDataID (N), parameter range 00h ~ 06h, default value 04h
- Set PostPANClrDataID (M), parameter range 00h ~ 04h, default value 04h
- MaskCharID (Mask Character), parameter range 20h ~ 7Eh, default value 2Ah
- DisplayExpirationDataID, parameter range '0'~'1', default value '0'

4. Data Format

The USB version of the reader can be operated in two different modes:
- HID ID TECH mode (herein referred to as "***HID*** mode")
- HID with Keyboard Emulation (herein referred to as "***KB*** mode").

When the reader is operated in the HID mode, it behaves like a vendor defined HID device. A direct communication path can be established between the host application and the reader without interference from other HID devices.

4.1. Level 1 and level 2 Standard Mode Data Output Format

Magnetic Track Basic Decoded Data Format

Track 1: <SS1><T1 Data><ES><Track Separator>
Track 2: <SS2><T2 Data><ES><Track Separator>
Track 3: <SS3><T3 Data><ES><Terminator>

Where: SS1 (start sentinel track 1) = %
SS2 (start sentinel track 2) = ;
SS3 (start sentinel track 3) = ; for ISO, % for AAMVA
ES (end sentinel all tracks) = ?
Track Separator = Carriage Return
Terminator = Carriage Return

Language: US English

Magnetic Track Basic Raw Data Format

Track 1: <01><T1 Raw Data><CR>
Track 2: <01><T2 Raw Data><CR>
Track 3: <T3 Raw Data><CR>

Where: The length of T1 Raw Data, T2 Raw Data, T3 Raw Data is 0x60 for each field. Pad with 0 if the original data length doesn't reach 0x60.

Language: US English

Definitions

Start or End Sentinel: Characters in encoding format which come before the first data character (start) and after the last data character (end), indicating the beginning and end, respectively, of data.
Track Separator: A designated character which separates data tracks.
Terminator: A designated character which comes at the end of the last track of data, to separate card reads.

Card data is only sent to the host on the Interrupt In pipe using an Input Report. The reader will send only one Input Report per card swipe. If the host requests data from the reader when no data is available, the reader will send a NAK to the host to indicate that it has nothing to send.

Data Format Setting:
– USB HID Data Format (default setting), Product ID: 2010

- USB Keyboard Format, Product ID: 2030

When the reader is plugged in, the firmware will read the "Data Format Setting" from non-volatile memory and send current Product ID in enumeration. After the setting is changed, the firmware will save the setting then do enumeration process.

4.1.1. USB HID Data Format

ID TECH HID Reader Data Structure

Offset	Usage Name
0	T1 decode status
1	T2 decode status
2	T3 decode status
3	T1 data length
4	T2 data length
5	T3 data length
6	Card encode type
7, 8	Total Output Length
9-512	Output Data

In this approach, the reader will keep all of the ID TECH data editing and other features like preamble, postamble, etc. The output data is always 512 bytes; the "Total Output Length" field indicates the valid data length in the output data

4.1.2. Descriptor Tables

Device Descriptor:

Field	Value	Description
Length	12	
Des type	01	
bcd USB	00 02	USB 2.0
Device Class	00	Unused
Sub Class	00	Unused
Device Protocol	00	Unused
Max Packet Size	08	
VID	0A CD	
PID	20 10 20 20 20 30	HID ID TECH Structure HID Other Structure HID Keyboard
BCD Device Release	00 01	
i-Manufacture	01	
i-Product	02	
i-Serial-Number	00	
# Configuration	01	

Configuration Descriptor:

Field	Value	Description
Length	09	
Des type	02	
Total Length	22 00	
No. Interface	01	
Configuration Value	01	
iConfiguration	00	
Attributes	80	Bus power, no remove wakeup
Power	32	100 mA

Interface Descriptor:

Field	Value	Description
Length	09	
Des type	04	
Interface No.	00	
Alternator Setting	00	
# EP	01	
Interface Class	03	HID
Sub Class	01	
Interface Protocol	01	
iInterface	00	

HID Descriptor:

Field	Value	Description
Length	09	
Des type	21	HID
bcdHID	11 01	
Control Code	00	
numDescriptors	01	Number of Class Descriptors to follow
DescriptorType	22	Report Descriptor
Descriptor Length	37 00 3D 00 52 00	HID ID TECH format HID Other format HID Keyboard format

End Pointer Descriptor:

Field	Value	Description

Length	07	
Des Type	05	End Point
EP Addr	83	EP3 – In
Attributes	03	Interrupt
MaxPacketSize	40 00	
bInterval	01	

Report Descriptor: (USB-HID Setting)

Value	**Description**
06 00 FF	Usage Page (MSR)
09 01	Usage(Decoding Reader Device)
A1 01	Collection (Application)
15 00	Logical Minimum
26 FF 00	Logical Maximum
75 08	Report Size
09 20	Usage (Tk1 Decode Status)
09 21	Usage (Tk2 Decode Status)
09 22	Usage (Tk3 Decode Status)
09 28	Usage (Tk1 Data Length)
09 29	Usage (Tk2 Data Length)
09 2A	Usage (Tk3 Data Length)
09 38	Usage (Card Encode Type)
95 07	Report Count
81 02	Input (Data,Var,Abs,Bit Field)
09 30	Usage (Total Sending Length)
95 02	Report Count (2)
82 02 01	Input (Data, Var, Abs, Bit Field)
09 31	Usage (Output Data)
96 10 02	Report Count (512 + 16)
82 02 01	Input (Data, Var, Abs, Bit Field)
09 20	Usage (Command Message)
95 08	Report Count
B2 02 01	Feature (Data,Var, Abs, Buffered Bytes)
C0	End Collection

Report Descriptor: (USB KB Interface)

Value	Description
05 01	Usage Page (Generic Desktop)
09 06	Usage(Keyboard)
A1 01	Collection (Application)
05 07	Usage Page (Key Codes)
19 E0	Usage Minimum
29 E7	Usage Maximum
15 00	Logical Minimum
25 01	Logical Maximum
75 01	Report Size
95 08	Report Count
81 02	Input (Data,Variable,Absolute)
95 01	Report Count (1)
75 08	Report Size
81 01	Input Constant
95 05	Report Count
75 01	Report Size
05 08	Usage Page (LED)
19 01	Usage Minimum
29 05	Usage maximum
91 02	Output(Data Variable Absolute)
95 01	Report Count
75 03	Report Size
91 01	Output (Constant)
95 06	Report Count
75 08	Report Size
15 00	Logical Minimum
25 66	Logical Maximum (102)
05 07	Usage Page (key Code)
19 00	Usage Minimum
29 66	Usage Maximum (102)
81 00	Input(Data, Array)
06 2D FF	Usage Page (ID TECH)
95 01	Report Count
26 FF 00	Logical maximum (255)
15 01	Logical Minimum
75 08	Report Size (8)
09 20	Usage (Setup data byte)

95 08	Report Count (8)
B2 02 01	Feature (Data Var, Abs)
C0	End Collection

4.2. Level 1 and level 2 POS Mode Data Output Format

In POS mode use the special envelope to send out card data, envelope is in the following format:

[Right Shift, Left Shift, Right Ctrl, Left Ctrl,] Read Error, Track x ID; Track x Error; Track x Data Length; Track x Data; Card Track x LEC code; Track x data LRC.

Reader will send out card data in Alt mode if its ASCII code less than H'20'.

Byte NO.	Name
0	Right Shift
1	Left Shift
2	Right Ctrl
3	Left Ctrl
4	Read Error 1
5	Read Error 2
6	Track x ID
7	Track x Error
8	Track x Length 1
9	Track x Length 2
10	Track Data (no extra Track ID for raw data)
	…
10 + Track len -1	Card Track x LRC
10 + Track len	Track x LRC
10 + Track len +1	0x0D
10 + Track len + 2	Track x ID
….	Repeat Track

The data format is independent with MSR setting. No Track x data if track x sampling data does not exist.

OPOS header:

Only HID KB interface has [Right Shift, Left Shift, Right Ctrl, Left Ctrl] under POS mode.

Read Error:

Read Error 1 byte bits:

MB LB

0	B6	B5	B4	B3	B2	B1	B0

B0 1: Track 1 sampling data exists (0: Track 1 sampling data does not exist)
B1 1: Track 2 sampling data exists (0: Track 2 sampling data does not exist)
B2 1: Track 3 sampling data exists (0: Track 3 sampling data does not exist)
B3 1: Track 1 decode success (0: Track 1 decode fail)
B4 1: Track 2 decode success (0: Track 2 decode fail)
B5 1: Track 3 decode success (0: Track 3 decode fail)
B6 0: if b0 to b5 are all 1, otherwise 1 (make it printable)

Read Error byte 2:

MB LB

0	1	B12	B11	B10	B9	B8	B7

B7 1: Track 4 sampling data exists (0: Track 4 sampling data does not exist)
B8 1: Track 4 JIS II decode success (0: Track4 JIS II decode fail)
B9, B10, B11
000: ISO Card (7, 5) or (7, 5, 5) encoding
001: Old CADL Card (6, 5, 6) encoding (no longer included)
010: AAMVA Card (7, 5, 7) encoding
011: JIS I Card (8, 5, 8) encoding
100: JIS II card (8) or ISO+JIS II
110: OPOS Raw Data Output
111: JIS I + JIS II
B12 Reserved for future use
Decode flag will set to 1 (B3, B4 and B5 all set to 1) in OPOS raw data mode.

Track ID

Track ID is a byte of ID, it will be '1', '2' and '3' for track 1, 2 and 3; it is not accurate to use start sentinel to identify track.

Track x Error

Track x error is a byte of flags, it will be in format of: 0 0 1 b4, b3, b2 b1 b0
b0 1: Start sentinel error (0: Not start sentinel error)
b1 1: End sentinel error (0: Not end sentinel error)
b2 1: Parity error (0: Not parity error)
b3 1: LRC error (0: Not LRC error)
b4 1: Other error (0: Not other error)
Track x Error is set to 0x20 in OPOS raw data mode.

Track Length

Assume actual "Track x Data Length" is hex code xy; the Track x data length for OPOS mode output will be hex code 3x, 3y.
Track x data length does not include the byte of "Track x data LRC", it is <30> <30> in case of read error on track x.

Track Data
"Card Track x LRC code" is track x card data.

Track x LRC
"Track x data LRC" is a LRC to check track x data communication; XOR all characters start from "Track x ID" to "Track x data LRC" should be 0.

4.3. DUKPT Key Management Level 3 Data Output Format

For ISO card, both clear and encrypted data are sent. For other card, only clear data are sent. A card swipe returns the following data:

Card data is sent out in format of
<STX><LenL><LenH><Card Data><CheckLRC><CheckSum><ETX>

<STX> = 02h, <ETX> = 03h
<LenL><LenH> is a two byte length of <Card Data>.
<CheckLRC> is a one byte Exclusive-OR sum calculated for all <Card Data>.
<CheckSum> is a one byte Sum value calculated for all <Card data>.
<Card Data> card data format is shown below.

ISO/ABA Data Output Format:

- card encoding type (0: ISO/ABA, 4: for Raw Mode)
- track status (bit 0,1,2:T1,2,3 decode, bit 3,4,5:T1,2,3 sampling)
- track 1 unencrypted length (1 byte, 0 for no track1 data)
- track 2 unencrypted length (1 byte, 0 for no track2 data)
- track 3 unencrypted length (1 byte, 0 for no track3 data)
- track 1 masked (Omitted if in Raw mode)
- track 2 masked (Omitted if in Raw mode)
- track 3 data (Omitted if in Raw mode)
- track 1 encrypted (AES/TDES encrypted data)
- track 2 encrypted (AES/TDES encrypted data)
- track 3 encrypted (Only used in Raw mode)
- track 1 hashed (20 bytes SHA1-Xor)
- track 2 hashed (20 bytes SHA1-Xor)
- DUKPT serial number (10 bytes)

Non ISO/ABA Data Output Format

- card encoding type (1: AAMVA, 3: Others)
- track status (bit 0,1,2:T1,2,3 decode, bit 3,4,5:T1,2,3 sampling)
- track 1 length (1 byte, 0 for no track1 data)
- track 2 length (1 byte, 0 for no track2 data)
- track 3 length (1 byte, 0 for no track3 data)
- track 1 data
- track 2 data
- track 3 data

4.4. Fixed Key Management Encrypted Output Format

Same as 4.3 DUKPT Key Management Level 3 Data Output Format, only change <DUKPT serial number> to <device serial number> plus two NULL bytes.

4.5. DUKPT Enhanced Level 3 Data Output Format

This mode is used when all tracks must be encrypted, or encrypted OPOS support is required, or when the tracks must be encrypted separately or when cards other than type 0 (ABA bank cards) must be encrypted or when track 3 must be encrypted. This format is the standard encryption format, but not yet the default encryption format.

1. Encryption Output Format Setting:

   Command: 53 85 01 <Encryption Format>

   Encryption Format:
   '0': Original Encryption Format
   '1': Enhanced Encryption Format

2. Encryption Option Setting: (for enhanced encryption format only)

   Command: 53 84 01 <Encryption Option>

   Encryption Option: (**default 08h**)
   bit0: 1 – track 1 force encrypt
   bit1: 1 – track 2 force encrypt
   bit2: 1 – track 3 force encrypt
   bit3: 1 – track 3 force encrypt when card type is 0

   Note:
   1) When force encrypt is set, this track will always be encrypted, regardless of card type. No clear/mask text will be sent.
   2) If and only if in enhanced encryption format, each track is encrypted separately. Encrypted data length will round up to 8 or 16 bytes.
   3) When force encrypt is not set, the data will be encrypted in original encryption format, that is, only track 1 and track 2 of type 0 cards (ABA bank cards) will be encrypted.

3. Hash Option Setting:

   Command: 53 5C 01 <Hash Option>

   Hash Option: ('0' – **'7'**)
   Bit0: 1 – track1 hash will be sent if data is encrypted
   Bit1: 1 – track2 hash will be sent if data is encrypted

Bit2: 1 – track3 hash will be sent if data is encrypted

4. Mask Option Setting: (for enhanced encryption format only)

   Command: 53 86 01 <Mask Option>

   Mask Option: (**Default: 0x07**)
   bit0: 1 – tk1 mask data allow to send when encrypted
   bit1: 1 – tk2 mask data allow to send when encrypted
   bit2: 1 – tk3 mask data allow to send when encrypted

   When mask option bit is set – if data is encrypted (but not forced encrypted),
   the mask data will be sent; If mask option is not set, the mask data will not be sent under the same condition.

   Card data is sent out in the following format
   <STX><LenL><LenH><Card Data><CheckLRC><CheckSum><ETX>

0	STX
1	Data Length low byte
2	Data Length high byte
3	Card Encode Type[1]
4	Track 1-3 Status[2]
5	Track 1 data length
6	Track 2 data length
7	Track 3 data length
8	Clear/masked data sent status [3]
9	Encrypted/Hash data sent status [4]
10	Track 1 clear/mask data
	Track 2 clear/mask data
	Track 3 clear/mask data
	Track 1 encrypted data
	Track 2 encrypted data
	Track 3 encrypted data
	Session ID (8 bytes) (Security level 4 only)
	Track 1 hashed (20 bytes each) (if encrypted and hash track 1 allowed)
	Track 2 hashed (20 bytes each) (if encrypted and hash track 2 allowed)
	Track 3 hashed (20 bytes each) (if encrypted and hash track 3 allowed)
	KSN (10 bytes)
	CheckLRC
	CheckSum
	ETX

   Where <STX> = 02h, <ETX> = 03h

Note 1 : Card Encode Type

Card Type will be 8x for enhanced encryption format and 0x for original encryption format

Value	Encode Type Description
00h / 80h	ISO/ABA format
01h / 81h	AAMVA format
03h / 83h	Other
04h / 84h	Raw; un-decoded format

For Type 04 or 84 Raw data format, all tracks are encrypted and no mask data is sent. No track indicator '01', '02' or '03' in front of each track. Track indicator '01','02' and '03' will still exist for non-encrypted mode.

Note 2: Track 1-3 status byte

Field 4:
Bit 0: 1— track 1 decoded data present
Bit 1: 1— track 2 decoded data present
Bit 2: 1— track 3 decoded data present
Bit 3: 1— track 1 sampling data present
Bit 4: 1— track 2 sampling data present
Bit 5: 1— track 3 sampling data present
Bit 6, 7 — Reserved for future use

Note 3: Clear/mask data sent status

Field 8 (Clear/mask data sent status) and field 9 (Encrypted/Hash data sent status) will only be sent out in enhanced encryption format.

Field 8: Clear/masked data sent status byte:
Bit 0: 1 —track 1 clear/mask data present
Bit 1: 1— track 2 clear/mask data present
Bit 2: 1— track 3 clear/mask data present
Bit 3: 0— reserved for future use
Bit 4: 0— reserved for future use
Bit 5: 0— reserved for future use

Note 4: Encrypted/Hash data sent status

Field 9: Encrypted data sent status
Bit 0: 1— track 1 encrypted data present
Bit 1: 1— track 2 encrypted data present

Bit 2: 1— track 3 encrypted data present
Bit 3: 1— track 1 hash data present
Bit 4: 1— track 2 hash data present
Bit 5: 1— track 3 hash data present
Bit 6: 1—session ID present
Bit 7: 1—KSN present

4.6. Fix Key Management Enhanced Output Data Format

Same as 4.5 DUKPT Enhanced Level 3 Data Output Format, only change <KSN> to <device serial number> plus two NULL bytes.

4.7. DUKPT Level 4 Data Output Format

For ISO card, both clear and encrypted data are sent. For other card, only clear data are sent. A card swipe returns the following data:

Card data is sent out in format of
<STX><LenL><LenH><Card Data><CheckLRC><CheckSum><ETX>

<STX> = 02h, <ETX> = 03h
<LenL><LenH> is a two byte length of <Card Data>.
<CheckLRC> is a one byte Exclusive-OR sum calculated for all <Card Data>.
<CheckSum> is a one byte Sum value calculated for all <Card data>.

<Card Data> card data format is shown below.

ISO/ABA Data Output Format

- card encoding type (0: ISO/ABA, 4: for Raw Mode)
- track status (bit 0,1,2:T1,2,3 decode, bit 3,4,5:T1,2,3 sampling)
- track 1 unencrypted length (1 byte, 0 for no track1 data)
- track 2 unencrypted length (1 byte, 0 for no track2 data)
- track 3 unencrypted length (1 byte, 0 for no track3 data)
- track 1 masked (Omitted if in Raw mode)
- track 2 masked (Omitted if in Raw mode)
- track 3 data (Omitted if in Raw mode)
- track 1 encrypted (AES/TDES encrypted data)
- track 2 encrypted (AES/TDES encrypted data)
- track 3 encrypted (Only used in Raw mode)
- sessionID encrypted (AES/TDES encrypted data)
- track 1 hashed (20 bytes SHA1-Xor)

- track 2 hashed (20 bytes SHA1-Xor)
- DUKPT serial number (10 bytes)

Non ISO/ABA Data Output Format:

- card encoding type (1: AAMVA, 3: Others)
- track status (bit 0,1,2:T1,2,3 decode, bit 3,4,5:T1,2,3 sampling)
- track 1 length (1 byte, 0 for no track1 data)
- track 2 length (1 byte, 0 for no track2 data)
- track 3 length (1 byte, 0 for no track3 data)
- track 1 data
- track 2 data
- track 3 data

Description:

Track 1, Track 2 and Track 3 Unencrypted Length

This one-byte value is the length of the original Track data. It indicates the number of bytes in the Track masked data field. It should be used to separate Track 1, Track 2 and Track 3data after decrypting Track encrypted data field.

Track 3 Unencrypted Length

This one-byte value indicates the number of bytes in Track 3 data field.

Track 1 and Track 2 Masked

Track data masked with the MaskCharID (default is '*'). The first PrePANID (up to 6 for BIN, default is 4) and last PostPANID (up to 4, default is 4) characters can be in the clear (unencrypted).

Track 1, Track 2 and Track 3 Encrypted

This field is the encrypted Track data, using either TDES-CBC or AES-CBC with initial vector of 0. If the original data is not a multiple of 8 bytes for TDES or a multiple of 16 bytes for AES, the reader right pads the data with 0.

The key management scheme is DUKPT or Fixed Key. For DUKPT, the key used for encrypting data is called the Data Key. Data Key is generated by first taking the DUKPT Derived Key exclusive or'ed with 0000000000FF0000 0000000000FF0000 to get the resulting intermediate variant key. The left side of the intermediate variant key is then TDES encrypted with the entire 16-byte variant as the key. After the same steps are preformed for the right side of the key, combine the two key parts to create the Data Key.

Encrypted Data Length

Track 1 and Track 2 data are encrypted as a single block. In order to get the number of bytes for encrypted data field, we need to get Track 1 and Track 2 unencrypted length first. The field length is always a multiple of 8 bytes for TDES or multiple of 16 bytes for AES. This value will be zero if there was no data on both tracks or if there was an error decoding both tracks. Once the encrypted data is decrypted, all padding 0 need to be removed. The number of bytes of decoded track 1 data is indicated by track 1 unencrypted length field. The remaining bytes are track 2 data, the length of which is indicated by track 2 unencrypted length filed.

Track 1 and Track 2 Hashed

SecureHead reader uses SHA-1 to generate hashed data for both track 1 and track 2 unencrypted data. It is 20 bytes long for each track. This is provided with two purposes in mind: One is for the host to ensure data integrity by comparing this field with a SHA-1 hash of the decrypted Track data, prevent unexpected noise in data transmission. The other purpose is to enable the host to store a token of card data for future use without keeping the sensitive card holder data. This token may be used for comparison with the stored hash data to determine if they are from the same card.

4.8.Level 4 Activate Authentication Sequence

The security level changes from 3 to 4 when the device enters authentication mode successfully. Once the security level is changed to level 3 or 4, it cannot go back to a lower level.

Activate Authentication Mode Command

When the reader is in security level 4, it would only transmit the card data when it is in Authenticated Mode.

Authentication Mode Request

When sending the authentication request, the user also needs to specify a time limit for the reader to wait for the activation challenge reply command. The minimum timeout duration required is 120 seconds. If the specified time is less than the minimum, 120 seconds would be used for timeout duration. The maximum time allowed is 3600 seconds (one hour). If the reader times out while waiting for the activation challenge reply, the authentication failed.

Device Response

When authentication mode is requested, the device responds with two challenges: Challenge 1 and challenge 2. The challenges are encrypted using the current DUKPT key exclusive- or'ed with <F0F0 F0F0 F0F0 F0F0 F0F0 F0F0 F0F0 F0F0>.

The decrypted challenge 1 contains 6 bytes of random number followed by the last two bytes of KSN. The two bytes of KSN may be compared with the last two bytes of the clear text KSN sent in

the message to authenticate the reader. The user should complete the Activate Authentication sequence using Activation Challenge Reply command.

Command Structure
Host -> Device:
<STX><R><80h><02h><Pre-Authentication Time Limit><ETX><CheckSum>

Device -> Host:
<ACK><STX><Device Response Data><ETX><CheckSum> (success)
<NAK> (fail)

Pre-Authentication Time Limit: 2 bytes of time in seconds
Device Response Data: 26 bytes data, consists of <Current Key Serial Number> <Challenge 1> <Challenge 2>

Current Key Serial Number: 10 bytes data with Initial Key Serial Number in the leftmost 59 bits and Encryption Counter in the rightmost 21 bits.
Challenge 1: 8 bytes challenge used to activate authentication. Encrypted using the key derived from the current DUKPT key.
Challenge 2: 8 bytes challenge used to deactivate authentication. Encrypted using the key derived from the current DUKPT key.

Activation Challenge Reply Command

This command serves as the second part of an Activate Authentication sequence. The host sends the first 6 bytes of Challenge 1 from the response of Activate Authenticated Mode command, two bytes of Authenticated mode timeout duration, and eight bytes Session ID encrypted with the result of current DUKPT Key exclusive- or'ed with <3C3C 3C3C 3C3C 3C3C 3C3C 3C3C 3C3C 3C3C>.

The Authenticated mode timeout duration specifies the maximum time in seconds which the reader would remain in Authenticated Mode. A value of zero forces the reader to stay in Authenticated Mode until a card swipe or power down occurs. The minimum timeout duration required is 120 seconds. If the specified time is less than the minimum, 120 seconds would be used for timeout duration. The maximum time allowed is 3600 seconds (one hour).

Session ID information is included. If the command is successful, the Session ID will be changed.

The Activate Authenticated Mode succeeds if the device decrypts Challenge Reply response correctly. If the device cannot decrypt Challenge Reply command, Activate Authenticated Mode fails and DUKPT KSN advances.

Command Structure
Host -> Device:
<STX><S><82h><10h><Activation Data><ETX><CheckSum>

Device -> Host:
<ACK> (success)
<NAK> (fail)

Activation Data: 16 bytes, structured as <Challenge 1 Response> <Session ID>

Challenge 1 Response: 6 bytes of Challenge 1 random data with 2 bytes of Authenticated mode timeout duration. It's encrypted using the key derived from the current DUKPT key.
Session ID: Optional 8 bytes Session ID, encrypted using the key derived from the current DUKPT key.

Deactivate Authenticated Mode Command

This command is used to exit Authenticated Mode. Host needs to send the first 7 bytes of Challenge 2 (from the response of Activate Authenticated Mode command) and the Increment Flag (00h indicates no increment, 01h indicates increment of the KSN) encrypted with current DUKPT Key exclusive- or'ed with <3C3C 3C3C 3C3C 3C3C 3C3C 3C3C 3C3C 3C3C>.

If device decrypts Challenge 2 successfully, the device will exit Authenticated Mode. The KSN will increase if the Increment flag is set to 01h. If device cannot decrypt Challenge 2 successfully, it will stay in Authenticated Mode until timeout occurs or when customer swipes a card.

The KSN is incremented every time the authenticated mode is exited by timeout or card swipe action. When the authenticated mode is exited by Deactivate Authenticated Mode command, the KSN will increment when the increment flag is set to 01h.

Command Structure
Host -> Device:
<STX><S><81h><08h for TDES or 10h for AES><Deactivation Data><ETX><CheckSum>

Device -> Host:
<ACK> (success)
<NAK> (fail)

<Deactivation data>: 8-bytes response to Challenge 2. It contains 7 bytes of Challenge 2 with 1 byte of Increment Flag, encrypted by the specified variant of current DUKPT Key

Get Reader Status Command

Command Structure
Host -> Device:
<STX><R><83h><ETX><CheckSum>

Device -> Host:
<ACK><STX><83h><02h><Current Reader Status><Pre-conditon><ETX><CheckSum> (success)
<NAK> (fail)

Current Reader Status: 2-bytes data with one byte of <Reader State> and one byte of <Pre-Condition>
Reader State: indicates the current state of the reader

00h: The reader is waiting for Activate Authentication Mode Command. The command must be sent before the card can be read.

01h: The authentication request has been sent, the reader is waiting for the Activation Challenge Reply Command.

02h: The reader is waiting for a card swipe.

Pre-condition: specifies how the reader goes to its current state as follows

00h: The reader has no card swipes and has not been authenticated since it was powered up.

01h: Authentication Mode was activated successfully. The reader processed a valid Activation Challenge Reply command.

02h: The reader receives a good card swipe.

03h: The reader receives a bad card swipe or the card is invalid.

04h: Authentication Activation Failed.

05h: Authentication Deactivation Failed.

06h: Authentication Activation Timed Out. The Host fails to send an Activation Challenge Reply command within the time specified in the Activate Authentication Mode command.

07h: Swipe Timed Out. The user fails to swipe a card within the time specified in the Activation Challenge Reply command.

4.9. Other Command Protocol Settings

4.9.1. Set/Get Device Serial Number

Set/Get eight byte device serial number.

Command:
Set Device Serial Number: 01 00 0B 00 01 01 <8 bytes of Device Serial Number>
Get Device Serial Number: 01 00 03 00 00 01

Command Response:
Set Device Serial Number: 01 00 02 01 00
Get Device Serial Number: 01 00 0A 01 00 <8 bytes of Device Serial Number >

4.9.2. Enable/Disable Encryption

Enable or Disable the SecureHead Encryption output in other mode (non-ID TECH protocol). If encryption is disabled, original data will be sent out to the host. If it enabled, encrypted data will be send out to the host

Command:

01 00 04 00 01 02 01	Enable Encryption
01 00 04 00 01 02 00	Disable Encryption

Command Response
01 00 02 01 00

4.9.3. Get Challenge

Host gets 8 bytes random number from SecureHead in order to do external authentication.

Command
01 00 03 00 00 04

Command Response
01 00 0A 01 00 <8 bytes of Challenge Data>

4.9.4. External Authenticate

SecureHead will use this command to authenticate the host by comparing the decrypted data from the host with its random data.

Command Format:
01 00 06 00 05 <First four bytes of decrypted random data from Get Challenge>

Command Response

01 00 02 01 00	Success
01 00 02 01 01	Fail

4.9.5. Load Security Key

The sixteen bytes key is used encryption, and its default value is 0000 0000 0000 0000 0000 0000 0000 0000.

For security purpose, key injection only allowed after successful external authentication, and will be loaded by two components each with 16 bytes of key.
Those two components will be XORed to generate key for encryption.

Command Format
01 00 13 00 04 01 <16 bytes of First Key Component>

01 00 13 00 04 02 <16 bytes of Second Key Component>

Command Response
01 00 02 01 00

Appendix A Setting Parameters and Values

Following is a table of default setting and available settings (value within parentheses) for each function ID.

Function ID	Hex	Description	Default Setting	Description	
HTypeID*	10	Terminal Type	'0' (‘0’~’2’,'4'~'6')	PC/AT, Scan Code Set 2, 1, 3, PC/AT with external Keyboard and PC/AT without External Keyboard	u
BeepID	11	Beep Setting	‘2’ (‘0’~’4’)	Beep volume high and frequency high	
ChaDelayID*	12	Character Delay	‘0’ (‘0’~’5’)	2 ms inter-character delay	k
TrackSelectID	13	Track Selection	‘0’ (‘0’~’9’)	Any Track 0-any; 1-7—bit 1 tk1, bit 2 tk2; bit 3 tk3. ‘8’—tk1-2; ‘9’ tk2-3	
PollingIntervalID	14	Polling Interval	1 (1 ~ 255)	USB HID Polling Interval	u
DataFmtID	15	Data Output Format	‘0’ (‘0’~’2’)	ID TECH Format;	-
FmtOptionID	16	UIC, Mag-Tek	H’59’	Refer to MiniMag RS232 User’s Manual	-
TrackSepID	17	Track Separator	CR/Enter 0 for Port Powered IV	CR for RS232, Enter for KB any character supported except 00 which means none.	
SendOptionID	19	Send Option	‘1’ (‘0’~’F’) ‘5’ for Port Powered IV	Sentinel and Account number control	
MSRReadingID	1A	MSR Reading	‘1’ (‘0’~’2’)	Enable MSR Reading ‘0’ MSR disable; ‘2’ Buffer Mode	
DTEnableSendID*	1B	DT Enable Send	‘0’(‘0’,’1’,’3’)	Data Editing Control	-
DecodingMethodID	1D	Decoding Direction	‘1’ (‘0’~’3’)	Decoding in both direction; ‘0’ Raw data ‘2’ forward ‘3’ reverse	
ReviewID	1F	Review All Settings	None		
TerminatorI	21	Terminator	CR/Enter	CR for RS232, Enter for	

D				KB	
FmVerID	22	Firmware Version			
USBHIDFmtID	23	USB HID Fmt	'0' ('0'~'1')	ID TECH Format	ur
ForeignKBID	24	Foreign KB	'0' ('0' ~ '9')	Foreign Keyboard	k
SecureKeyID*	25	Obsolescent encryption	'@' (0x20-0x7F)	No simple encryption	-
ArmtoReadID*	30				-
ReaderResetID*	32		None		-
Track1PrefixID	34	Track 1 Prefix	0	No prefix for track 1, 6 char max	
Track2PrefixID	35	Track 2 Prefix	0	No prefix for track 2, 6 char max	
Track3PrefixID	36	Track 3 Prefix	0	No prefix for track 3, 6 char max	
Track1SuffixID	37	Track 1 Suffix	0	No suffix for track 1, 6 char max	
Track2SuffixID	38	Track 2 Suffix	0	No suffix for track 2, 6 char max	
Track3SuffixID	39	Track 3 Suffix	0	No suffix for track 3, 6 char max	
LZ1ID*	3C		0xD		-
LZ2ID*	3D		0xD		-
LZ3ID*	3E		0xD		-
LZ4ID*	3F		0xD		-
EpVerID*	40		None		
BaudID	41	Baud Rate	'5' ('2'~'9')	9600 bps, '2' is 1200, '7' is 38,400 bps; '9' is 115.2 kbps	s
DataID	42	Data Bit	'0' ('0'~'1')	8 Bits required in secure mode	s
ParityID	43	Data Parity	'0' ('0'~'4')	None	s
HandID	44	Hand Shake	'0' ('0'~'1')	Software (Xon/Xoff) hand shake	s
StopID	45	Stop Bit	'0' ('0'~'1')	1 Bit	s
XOnID	47	XOn Character	DC1	0x11 as XOn	s
XOffID	48	XOff	DC3	0x13 as XOff	s

		Character			
PrePANID	49	PAN to not mask	4 (0-6)	# leading PAN digits to display	
PostPANID	4A	PAN to not mask	4 (0-4)	# of trailing PAN digits to display	
MaskCharID	4B	mask the PAN with this character	'*' 20-7E	any printable character	
CrypTypeID	4C	encryption type	'1' ('1'-'2')	'1' 3DES '2' AES	r
OutputModeID	4D	Std, OPOS or JPOS	'0' ('0' ~ '1')	Standard mode	
SerialNumberID	4E	device serial #	any 8 bytes	8 hex digit serial number	r
DispExpDateID,	50	mask or display expiration date	'0"0'-'1'	'1' don't mask expiration date	
CapsCaseID*	51		None		
DataSeqID*	52		None		
StartCharID*	53		None		
SessionID	54	8 byte hex not stored in EEPROM	None	always init to all 'FF'	
Mod10ID	55	include mod10 check digit	'0' '0'-'2'	don't include mod10, '1' display mod10, '2' display wrong mod10	
DesKeyID	56	DES Key Value	0	internal use only	r n
AesKeyID	57	AES Key Value	0	internal use only	r n
KeyManageTypeID	58	DUKPT	'1'('0'-'1')	'0' fixed key	
T1GENERICFMTID*	59		None		
T2GENERICFMTID*	5A		None		
T3GENERICFMTID*	5B		None		
HashOptID,	5C		'3' ('0'-'7')	Send tk1-2 hash bit 0:1 send tk1 hash; bit 1:1 send tk2 hash; bit2:1 send tk3 hash.	
HexCaseID,	5D		'0' ('0'-'1')		k

LRCID	60	LRC character	'0' ('0'~'1')	Without LRC in output	
T17BStartID	61	Track 1 7 Bit Start Char	'%'	'%' as Track 1 7 Bit Start Sentinel	
T16BStartID	62	T16B Start	'%'	'%' as Track 1 6 Bit Start Sentinel	
T15BStartID	63	T15B Start	';'	';' as Track 1 5 Bit Start Sentinel	
T27BStartID	64	Track 2 7 Bit Start Char	'%' ';' for Port Powered IV	'%' as Track 2 7 Bit Start Sentinel	
T25BStartID	65	T25BStart	';'	';' as Track 2 5 Bit Start Sentinel	
T37BStartID	66	Track 3 7 Bit Start Char	'%' '+' for Port Powered IV	'%' as Track 3 7 Bit Start Sentinel	
T36BStartID	67	T36BStart	'!' '+' for Port Powered IV	'!' as Track 3 6 Bit Start Sentinel	
T35BStartID	68	T35BStart	';' '+' for Port Powered IV	';' as Track 3 5 Bit Start Sentinel	
T1EndID	69	Track 1 End Sentinel	'?'	'?' as End Sentinel	
T2EndID	6A	Track 2 End Sentinel	'?'	'?' as End Sentinel	
T3EndID	6B	Track 3 End Sentinel	'?'	'?' as End Sentinel	
T1ERRSTARTID	6C	Track 1 error code	'%'	start sentinel if track 1 error report	
T2ERRSTARTID	6D	Track 2 error code	';'	start sentinel if track 2 error report	
T3ERRSTARTID	6E	Track 3 error code	'+'	start sentinel if track 3 error report	
T4ERRSTARTID*	6F		None		-
BootloaderID*	70	Boot Loader Mode	None		-
T344EndID*	71		None		
T28BStartID	72	JIS T12 SS/ES	0		
T38BStartID	73	JIS T3 SS/ES	0		
EquipFwID	77	feature option setting	0-7	Reader firmware configuration	nr

BeepOffComID*	7A	Turn off Beep	'0'		
SyncCheckID	7B	check for track sync bits	'0' ('0'-2')	check leading & trailing sync bits on track data (if poorly encoded card)	
ErrorZoneID*	7C		None		
SecurityLevelID	7E				nr
WinCETestID*	AA		None		
PrefixID	D2	Preamble	0	No Preamble, 15 char max	
PostfixID	D3	Postamble	0	No Postamble, 15 char max	
AddedFieldID*	FA	DE Added Field	0	No Added Field	-
SearchCmdID*	FB	DE Search Cmd	0	No Search Command	-
SendCmdID*	FC	DE Send Cmd	0	No Send Command	-

*Unused entries in this table were left for completeness even though unused in the SecureMag reader to avoid conflicting definitions between products.

Note not all function ID are present in different hardware version of the SecureMag the last column above has some codes:

'-' feature not currently supported; exists for compatibility
's' feature available on in the RS232 serial version of the reader
'u' feature available only in the USB version;
'k' feature available on in the keyboard version
'r' reset all does not affect this value
'n' not directly settable

Most function ID settings that relate to the content of formatting of the track output do not work in secure mode. Exceptions to this are Preamble and Postamble in keyboard mode only.

It is currently not possible to mix security with OPOS and JPOS support.

Appendix B Key Code Table in USB Keyboard Interface

For most characters, "Shift On" and "Without Shift" will be reverse if Caps Lock is on. Firmware needs to check current Caps Lock status before sending out data.

For Function code B1 to BA, if "Num Lock" is not set, then set it and clear it after finishing sending out code.

For Function code BB to C2, C9 to CC, if "Num Lock" is set then clear it and set it after finishing sending out code.

Keystroke	Hex Value	Functional Code	USB KB Code
Ctrl+2	00		1F Ctrl On
Ctrl+A	01		04 Ctrl On
Ctrl+B	02		05 Ctrl On
Ctrl+C	03		06 Ctrl On
Ctrl+D	04		07 Ctrl On
Ctrl+E	05		08 Ctrl On
Ctrl+F	06		09 Ctrl On
Ctrl+G	07		0A Ctrl On
BS	08	\bs	2A
Tab	09	\tab	2B
Ctrl+J	0A		0D Ctrl On
Ctrl+K	0B		0E Ctrl On
Ctrl+L	0C		0F Ctrl On
Enter	0D	\enter	28
Ctrl+N	0E		11 Ctrl On
Ctrl+O	0F		12 Ctrl On
Ctrl+P	10		13 Ctrl On
Ctrl+Q	11		14 Ctrl On
Ctrl+R	12		15 Ctrl On
Ctrl+S	13		16 Ctrl On
Ctrl+T	14		17 Ctrl On
Ctrl+U	15		18 Ctrl On
Ctrl+V	16		19 Ctrl On
Ctrl+W	17		1A Ctrl On
Ctrl+X	18		1B Ctrl On
Ctrl+Y	19		1C Ctrl On
Ctrl+Z	1A		1D Ctrl On
ESC	1B	\esc	29

Ctrl+\	1C		31 Ctrl On
Ctrl+]	1D		30 Ctrl On
Ctrl+6	1E		23 Ctrl On
Ctrl+-	1F		2D Ctrl On
SPACE	20		2C
!	21		1E Shift On
"	22		34 Shift On
#	23		20 Shift On
$	24		21 Shift On
%	25		22 Shift On
&	26		24 Shift On
'	27		34
(	28		26 Shift On
)	29		27 Shift On
*	2A		25 Shift On
+	2B		2E Shift On
,	2C		36
-	2D		2D
.	2E		37
/	2F		38
0	30		27 Shift On
1	31		1E Shift On
2	32		1F Shift On
3	33		20 Shift On
4	34		21 Shift On
5	35		22 Shift On
6	36		23 Shift On
7	37		24 Shift On
8	38		25 Shift On
9	39		26 Shift On
:	3A		33 Shift On
;	3B		33
<	3C		36 Shift On
=	3D		2E
>	3E		37 Shift On
?	3F		38 Shift On
@	40		1F
A	41		04 Shift On
B	42		05 Shift On
C	43		06 Shift On
D	44		07 Shift On

E	45		08 Shift On
F	46		09 Shift On
G	47		0A Shift On
H	48		0B Shift On
I	49		0C Shift On
J	4A		0D Shift On
K	4B		0E Shift On
L	4C		0F Shift On
M	4D		10 Shift On
N	4E		11 Shift On
O	4F		12 Shift On
P	50		13 Shift On
Q	51		14 Shift On
R	52		15 Shift On
S	53		16 Shift On
T	54		17 Shift On
U	55		18 Shift On
V	56		19 Shift On
W	57		1A Shift On
X	58		1B Shift On
Y	59		1C Shift On
Z	5A		1D Shift On
[	5B		2F
\	5C		31
]	5D		30
^	5E		23 Shift On
_	5F		2D Shift On
`	60		35
a	61		04
b	62		05
c	63		06
d	64		07
e	65		08
f	66		09
g	67		0A
h	68		0B
i	69		0C
j	6A		0D
k	6B		0E
l	6C		0F
m	6D		10

n	6E		11
o	6F		12
p	70		13
q	71		14
r	72		15
s	73		16
t	74		17
u	75		18
v	76		19
w	77		1A
x	78		1B
y	79		1C
z	7A		1D
{	7B		2F Shift On
|	7C		31 Shift On
}	7D		30 Shift On
~	7E		35 Shift On
DEL	7F		2A
F1	81	\f1	3A
F2	82	\f2	3B
F3	83	\f3	3C
F4	84	\f4	3D
F5	85	\f5	3E
F6	86	\f6	3F
F7	87	\f7	40
F8	88	\f8	41
F9	89	\f9	42
F10	8A	\fa	43
F11	8B	\fb	44
F12	8C	\fc	45
Home	8D	\home	4A
End	8E	\end	4D
→	8F	\right	4F
←	90	\left	50
↑	91	\up	52
↓	92	\down	51
PgUp	93	\pgup	4B
PgDn	94	\pgdn	4E
Tab	95	\tab	2B
bTab	96	\btab	2B Shift On

Esc	97	\esc	29
Enter	98	\enter	28
Num_Enter	99	\num_enter	58
Delete	9A	\del	4C
Insert	9B	\ins	49
Backspace	9C	\bs	2A
SPACE	9D	\sp	2C
Pause	9C	\ps	48
Ctrl+[	9F	\ctr1	2F Ctrl On
Ctrl+]	A0	\ctr2	30 Ctrl On
Ctrl+\	A1	\ctr3	31 Ctrl On
Left_Ctrl_Break	A2	\l_ctrl_bk	Clear Ctrl Flag
Left_Ctrl_Make	A3	\l_ctrl_mk	Set Ctrl Flag for following char(s)
Left_Shift_Break	A4	\l_shift_bk	Clear Shift Flag
Left_Shift_Make	A5	\l_shift_mk	Set Shift Flag for following char(s)
Left_Windows	A6	\l_windows	E3 (left GUI)
Left_Alt_Break	A7	\l_alt_bk	Clear Alt Flag
Left_Alt_Make	A8	\l_alt_mk	Set Alt Flag for following char(s)
Right_Ctrl_Break	A9	\r_ctrl_bk	Clear Ctrl Flag
Right_Ctrl_Make	AA	\r_ctrl_mk	Set Ctrl Flag for following char(s)
Right_Shift_Break	AB	\r_shift_bk	Clear Shift Flag
Right_Shift_Make	AC	\r_shift_mk	Set Shift Flag for following char(s)
Right_Windows	AD	\r_windows	E7 (right GUI)
Right_Alt_Break	AE	\r_alt_bk	Clear Alt Flag
Right_Alt_Make	AF	\r_alt_mk	Set Alt Flag for following char(s)
Num_Lock	B0	\num_lock	53
Num_0	B1	\num0	62 Num Lock On
Num_1	B2	\num1	59 Num Lock On
Num_2	B3	\num2	5A Num Lock On
Num_3	B4	\num3	5B Num Lock On
Num_4	B5	\num4	5C Num Lock On
Num_5	B6	\num5	5D Num Lock On
Num_6	B7	\num6	5E Num Lock On
Num_7	B8	\num7	5F Num Lock On
Num_8	B9	\num8	60 Num Lock On
Num_9	BA	\num9	61 Num Lock On
Num_Home	BB	\num_home	5F
Num_PageUp	BC	\num_pgup	61

Num_PageDown	BD	\num_pgdn	5B
Num_End	BE	\num_end	59
Num_↑	BF	\num_up	60
Num_→	C0	\num_right	5E
Num_↓	C1	\num_down	5A
Num_←	C2	\num_left	5C
Print_Scrn	C3	\prt_sc	46
System_Request	C4	\sysrq	9A
Scroll_Lock	C5	\scroll	47
Pause	C6	\menu	76
Break	C7	\break	
Caps_Lock	C8	\caps_lock	39
Num_/	C9	\num_/	54
Num_*	CA	\num_*	55
Num_-	CB	\num_-	56
Num_+	CC	\num_+	57
Num_.	CD	\num_.	63 Num Lock On
Num_DEL	CE	\num_del	63
Num_INS	CF	\num_ins	62
Delay_100ms	D0	\delay	Delay 100 ms

Table of Ctrl or Alt output for non printable characters

ASCII Code SendOptionID	Control Code Bit 3: 0	Alt Code Bit 3: 1
00:	Ctrl-2	Alt-000
01:	Ctrl-A	Alt-001
02:	Ctrl-B	Alt-002
03:	Ctrl-C	Alt-003
04:	Ctrl-D	Alt-004
05:	Ctrl-E	Alt-005
06:	Ctrl-F	Alt-006
07:	Ctrl-G	Alt-007
08:	BS	Alt-008
09:	Tab	Alt-009
0A:	Ctrl-J	Alt-010
0B:	Ctrl-K	Alt-011
0C:	Ctrl-L	Alt-012
0D:	Enter	Alt-013
0E:	Ctrl-N	Alt-014
0F:	Ctrl-O	Alt-015
10:	Ctrl-P	Alt-016

11:	Ctrl-Q	Alt-017
12:	Ctrl-R	Alt-018
13:	Ctrl-S	Alt-019
14:	Ctrl-T	Alt-020
15:	Ctrl-U	Alt-021
16:	Ctrl-V	Alt-022
17:	Ctrl-W	Alt-023
18:	Ctrl-X	Alt-024
19:	Ctrl-Y	Alt-025
1A:	Ctrl-Z	Alt-026
1B:	ESC	Alt-027
1C:	Ctrl-\	Alt-028
1D:	Ctrl-]	Alt-029
1E:	Ctrl-6	Alt-030
1F:	Ctrl--	Alt-031

Appendix C Default Setting Table

Default Setting Table

MSR Reading	Enable
Decoding Method	Both Swiping Direction Decode mode
Track Separator Settings	CR
Terminator Settings	CR
Preamble Settings	None
Postamble Settings	None
Track Selected Settings	Any Track
Sentinel and T2 Account No	Send Sentinels and all T2 data
Data Edit Setting	Disabled
Track Prefix	None
Track Suffix	None

Appendix D Magnetic Stripe Standard Formats

ISO Credit Card Format

ISO stands for International Standards Organization

Track 1

Field ID Character	Contents	Length
a	Start Sentinel	1
b	Format Code “B”	1
c	Account Number	12 or 19
d	Separator “^”	1
e	Cardholder Name	variable
f	Separator “^”	1
g	Expiration date 4	
h	Optional Discretionary data	variable
i	End Sentinel	1
j	Linear Redundancy Check (LRC) Character	1

Track 2

a	Start Sentinel	1
b	Account Number	12 or 19
c	Separator “=”	1
d	Expiration date “YYMM”	4
e	Optional discretionary data	variable
f	End Sentinel	1
g	Linear Redundancy Check (LRC) Character	1

AAMVA Driver's License Format

Track 1

a	Start Sentinel	1
b	State or Province	2
c	City	13
d	Name	35
e	Address	29
f	End Sentinel	1
g	Linear Redundancy Check (LRC) Character	1

Track 2

a	Start Sentinel	1
b	ANSI User Code	1
c	ANSI User ID	5
d	Jurisdiction ID/DL	14
e	Expiration date	4
f	Birth Date	8
g	Remainder of Jurisdiction	
	ID/DL	5
h	End Sentinel	1
I	Linear Redundancy Check (LRC) Character	1

Track 3

a	Start Sentinel	1
b	Template Version #	1
c	Security Version #	1
d	Postal Code	11
e	Class	2
f	Restrictions	10
g	Endorsements	4
h	Sex	1
I	Height	3
j	Weight	3
k	Hair Color	3
l	Eye Color	3
m	ID #	10
n	Reserved Space	16
o	Error Correction	6
p	Security	5
q	End Sentinel	1

r	Linear Redundancy Check (LRC) Character	1

Appendix E Other Mode Card Data Output

There is an optional data output format supported by SecureHead in order to be compatible with specific software requirement.

<01h> <01h> <1Ah> <02h> <00h> <Left 8 bytes Device Serial Number> <6 Byte Random data> <30h> <31h> <264 bytes of Sampling data>.

Appendix F Guide to Encrypting and Decrypting Data

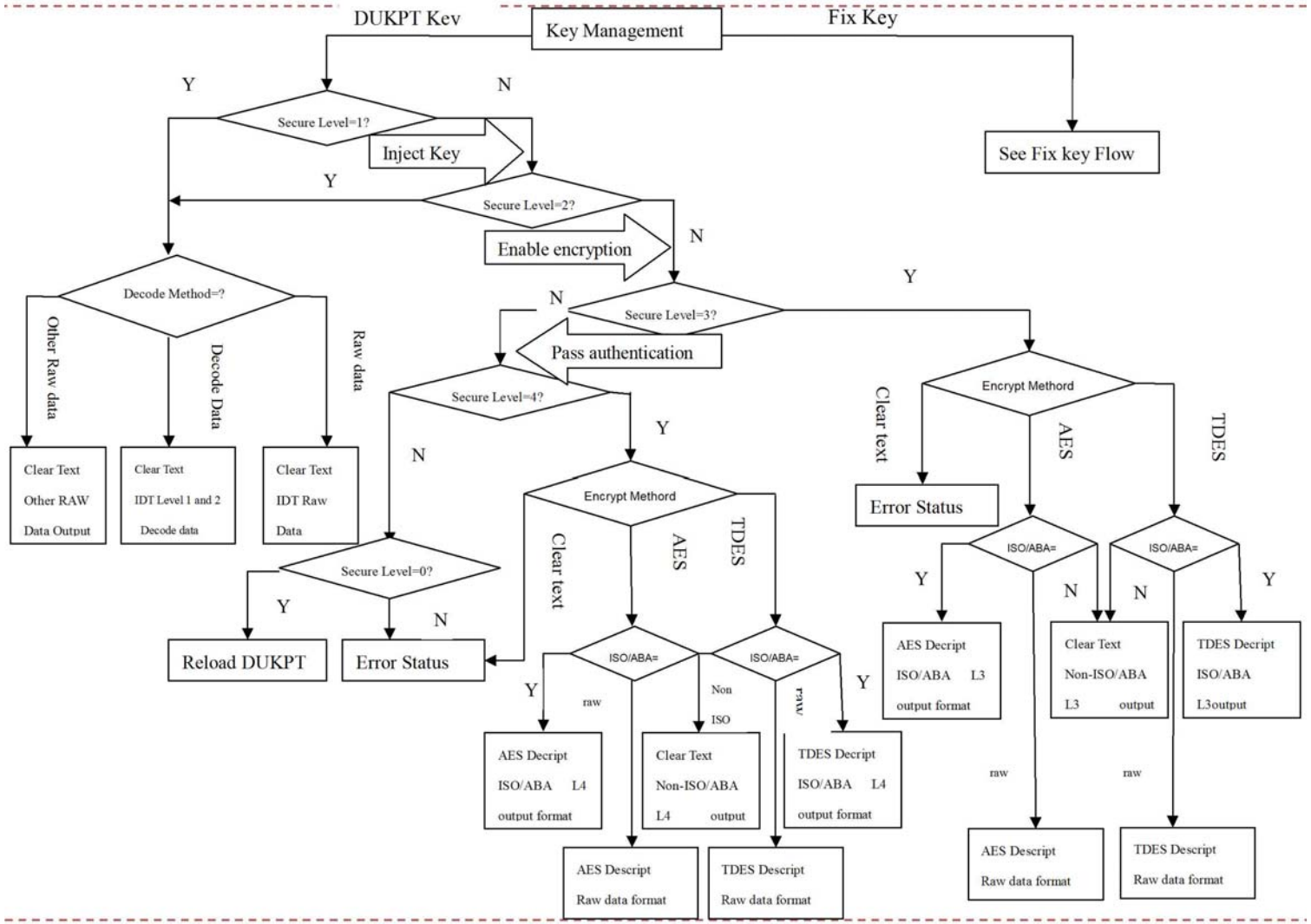
The encryption method used by SecureHead is called Cipher-block Chaining (CBC). With this method, each block of data is XOR'ed with the previous data block before being encrypted. The encryption of each block depends on all the previous blocks. As a result, each encrypted data block would need to be decrypted sequentially.

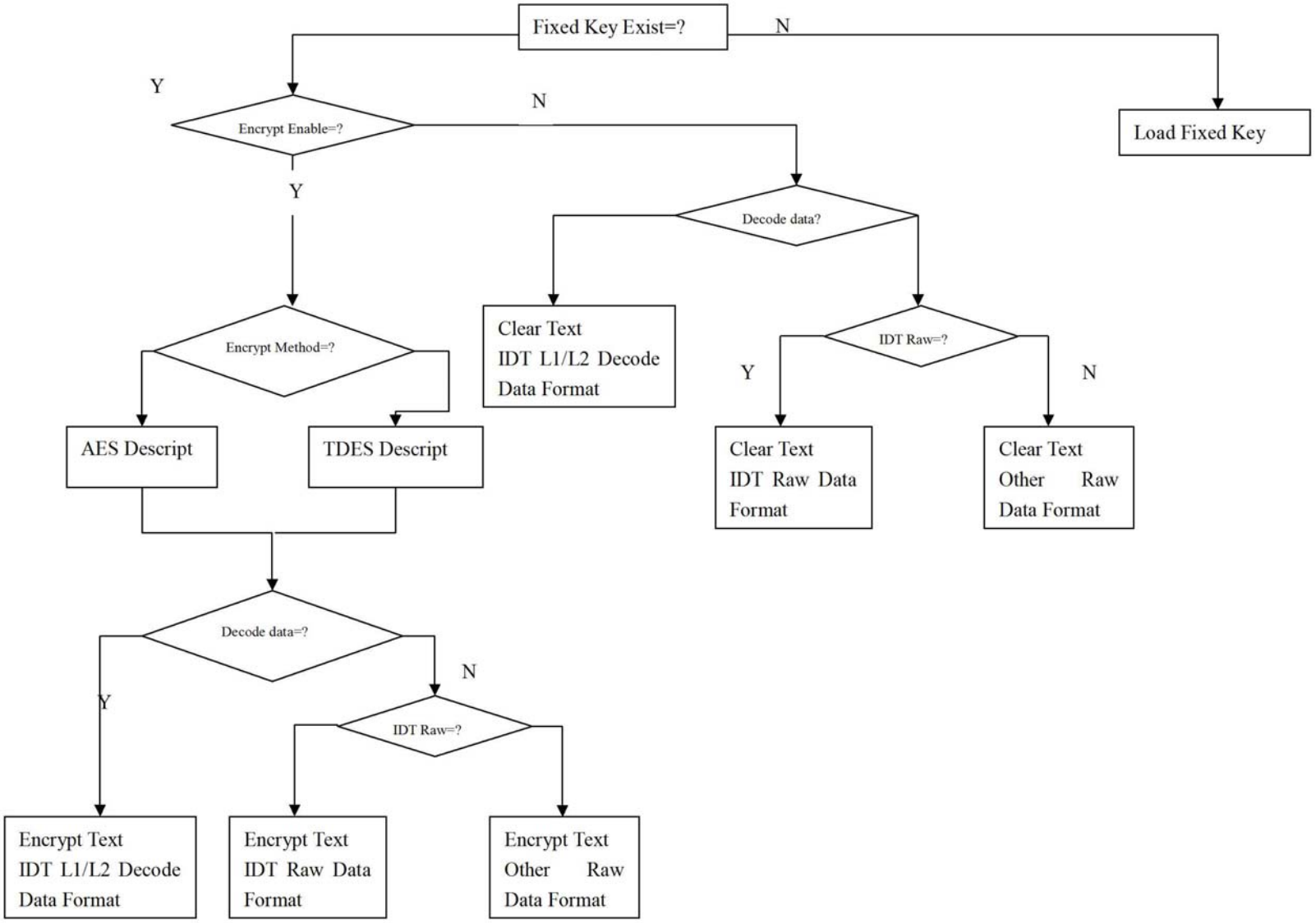
To encrypt the data, first generate an 8-byte random initialization vector which is XOR'ed with the first data block before it is encrypted. Then the data is encrypted with the device key using TDES algorithm. The result is again XOR'ed with the next 8-byte data block before it is encrypted. The process repeats until all the data blocks have been encrypted.

The host can decrypt the cipher text from the beginning of the block when the data is received. However, it must keep track of both the encrypted and clear text data. Or alternatively, the data can be decrypted backward form that last data block to the first, so that the decrypted data can replace the original data as the decryption is in process.

To decrypt the data using reverse method, first decrypt the last 8-byte of data using TDES decryption. Then perform an XOR operation with result and the preceding data block to get the last data block in clear text. Continue to decrypt the next previous block with the same method till it reaches the first block. For the first data block, the XOR operation can be skipped, since it is XOR'ing with 00h bytes.

Appendix G Key Management Flow Chart





Appendix H Example of Decoded Data Decryption

Key for all examples is
0123456789ABCDEFFEDCBA9876543210

Security Level 3 Decryption - Original Encryption Format

Example of decryption of a three track ABA card with the original encryption format.
SecureHead Reader with default settings

Original encryption structure (if your structure starts original encryption format (this can be recognized because the high bit of the fourth byte underlined (00) is 0.
027D0100 3F48236B252A343236362A2A2A2A2A2A2A2A393939395E42555348204A522F47454F5
2474520572E4D525E2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A3B343236362A2A2A2A2A2A2A2A393939393D2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A3B3333333333333333333337363736373630373037303737363736373633333333333333333333373637363736303730373037373637363736333333333333333333333737363736373630373037303737363736373633333333333333333333373637363736303730373F32863E9E3DA28E455B28F7736B77E47A64EDDA3BF03A06E44F31D1818C0BCD7A353FB1AD70EFD30FFC3DA08A4FBC9372E57E8B40848BAEAA3FE724B3550E2F4B223E6BF264BEAE9E39142B648CDB51FB8DAF8EA5B63913D29419B67582FCCCE9B372660F03668CC453216D9449C6B67EF33418AC88F65E1DB7ED4D10973F99DFC8463FF6DF113B6226C4898A9D355057ECAF11A5598F02CA3162994901190000000001399F03

STX, Length (LSB, MSB), card type, track status, length track 1, length track 2, length track 3
02 7D01 00 3F 48 23 6B

The above broken down and interpreted
02—STX character
7D—low byte of total length
01—high byte of total length
00—card type byte (interpretation old format ABA card)
3F—3 tracks of data all good
48—length of track 1
23—length of track 2
6B—length of track 3

Track 1 data masked (length 0x48)
252A343236362A2A2A2A2A2A2A2A393939395E42555348204A522F47454F52474520572E4D525E2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A

Track 2 data in hex masked (length 0x23)
3B343236362A2A2A2A2A2A2A2A393939393D2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A

Track 3 data unencrypted (length 0x6B)
3B33333333333333333333736373637363037303730373736373637363333333333333333333333736
373637363037303730373736373637363333333333333333333337363736373630373037303730373637
363736333333333333333333337363736373630373037373F32

Track 1 & 2 encrypted length 0x48+0x23 rounded up to 8 bytes =0x6B -> 0x70 (112 decimal)
863E9E3DA28E455B28F7736B77E47A64EDDA3BF03A06E44F31D1818C0BCD7A35
3FB1AD70EFD30FFC3DA08A4FBC9372E57E8B40848BAEAA3FE724B3550E2F4B22
3E6BF264BEAE9E39142B648CDB51FB8DAF8EA5B63913D29419B67582FCCCE9B3
72660F03668CC453216D9449C6B67EF3

Track 1 hashed
3418AC88F65E1DB7ED4D10973F99DFC8463FF6DF

Track 2 hashed
113B6226C4898A9D355057ECAF11A5598F02CA31

KSN
62994901190000000001

LRC, checksum and ETX
39 9F 03

Masked Data:
Track 1 data masked in ASCII:
%*4266********9999^BUSH JR/GEORGE W.MR^********************************?*
Track 2 data masked in ASCII:
;4266********9999=****************?*
Track 3 data unencrypted in ASCII:
;333333333767676070707767676333333333376767607070776767633333333337676760707077676
763333333333767676070?2

Key Value: F8 2A 7A 0D 7C 67 46 F1 96 18 9A FB 54 2C 65 A3
KSN: 62 99 49 01 19 00 00 00 00 01

Decrypted Data in ASCII:
%B4266841088889999^BUSH JR/GEORGE
W.MR^0809101100001100000000046000000?!;4266841088889999=0809101100000046?0
;333333333767676070707767676333333333376767607070776767633333333337676760707077676
763333333333767676070?2

Decrypted Data in Hex:
254234323636383431303838383839393995E42555348204A522F47454F52474520572E4D525E303
830393130313130303030313130303030303030303034363030303030303F213B34323636383431303
838383839393939393D303830393130313130303030303034363F300000000000

-=-=-=-

Security Level 4 Decryption - Original Encryption Format

028501003F48236B252A343236362A2A2A2A2A2A2A2A393939395E42555348204A522F47454F5
2474520572E4D525E2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2
A2A2A2A2A3F2A3B343236362A2A2A2A2A2A2A2A393939393D2A2A2A2A2A2A2A2A2A2A2
A2A2A2A2A3F2A3B333333333333333333333736373637363037303730373736373637363333333333
333333333333736373637363037303730373736373637363733333333333333333333337363736373630
373037303737363736373633333333333333333333373637363736303730373F32ED9DB728814F150
D177F769B0441C52B2B1994C83D058F1DDA5DAA6753CF0F61BB7690C7E8A276D3D606513D
1F8B79423C70594A0849CBB4C7B5A8DAC2B1A21B11F1C47EF4F12AC07D59A79E9369372D3
F906A7F6C6D2B9076BCF05B334441FAEC8B4EFBEB9DD20EBF97B29D910C415FCEA8DA8FE
B9775343418AC88F65E1DB7ED4D10973F99DFC8463FF6DF113B6226C4898A9D355057ECAF11
A5598F02CA3162994901190000000044B6F03
Masked Data:
Track 1: %*4266********9999^BUSH JR/GEORGE
W.MR^********************************?*
Track 2: ;4266********9999=****************?*
Track 3:
;333333333767676070707767676333333333376767607070776767633333333337676760707077676
763333333333767676070?2

Key Value: 8A 92 F6 74 00 BF 25 2E 57 9A A9 01 FF 27 48 41
KSN: 62 99 49 01 19 00 00 00 00 04
Session ID: AA AA AA AA AA AA AA AA

Decrypted Data in ASCII:
%B4266841088889999^BUSH JR/GEORGE
W.MR^0809101100001100000000046000000?!;4266841088889999=0809101100000046?0
;333333333767676070707767676333333333376767607070776767633333333337676760707077676
763333333333767676070?2

Decrypted Data in Hex:
254234323636383431303838383838393939395E42555348204A522F47454F52474520572E4D525E303
830393130313130303030313130303030303030303034363030303030303F213B34323636383431303
838383838393939393D303830393130313130303030303034363F30AAAAAAAAAAAAAAAA00000000
00

Security Level 3 Decryption - Enhanced Encryption Format

Example of decryption of a three track ABA card with the enhanced encryption format.
SecureHead Reader with default settings except enhanced encryption structure format.

Enhanced encryption Format (this can be recognized because the high bit of the fourth byte underlined (80) is 1.

02980180<u>8</u>03F48236B03BF252A343236362A2A2A2A2A2A2A2A393939395E42555348204A522F474
54F52474520572E4D525E2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2
A2A2A2A2A2A2A2A3F2A3B343236362A2A2A2A2A2A2A2A393939393D2A2A2A2A2A2A2A2A2
A2A2A2A2A2A2A2A3F2ADA7F2A52BD3F6DD8B96C50FC39C7E6AF22F06ED1F033BE0FB23D6B
D33DC5A1F808512F7AE18D47A60CC3F4559B1B093563BE7E07459072ABF8FAAB5338C6CC8
815FF87797AE3A7BEAB3B10A3FBC230FBFB941FAC9E82649981AE79F2632156E775A06AED
AFAF6F0A184318C5209E55AD44A9CCF6A78AC240F791B63284E15B4019102BA6C505814B58
5816CA3C2D2F42A99B1B9773EF1B116E005B7CD8681860D174E6AD316A0ECDBC687115FC8
9360AEE7E430140A7B791589CCAADB6D6872B78433C3A25DA9DDAE83F12FEFAB530CE405
B701131D2FBAAD970248A456000933418AC88F65E1DB7ED4D10973F99DFC8463FF6DF113B6
226C4898A9D355057ECAF11A5598F02CA31688861C157C1CE2E0F72CE0F3BB598A614EAABB
16299490119000000000206E203

STX, Length(LSB, MSB), card type, track status, length track 1, length track 2, length track 3
02 9801 80 3F 48-23-6B 03BF

The above broken down and interpreted
02—STX character
98—low byte of total length
01—high byte of total length
80—card type byte (interpretation new format ABA card)
3F—3 tracks of data all good
48—length of track 1
23—length of track 2
6B—length of track 3
03—tracks 1 and 2 have masked/clear data
BF—bit 7=1—KSN included
Bit 6=0—no Session ID included so not level 4 encryption
Bit 5=1—track 3 hash data present
Bit 4=1—track 2 hash data present
Bit 3-1—track 1 hash data present
Bit 2=1—track 3 encrypted data present
Bit 1=1—track 2 encrypted data present
Bit 0=1—track 1 encrypted data present

Track 1 data masked (length 0x48)
252A343236362A2A2A2A2A2A2A393939395E42555348204A522F47454F52474520572E4D525
E2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A

Track 1 masked data in ASCII

%*4266********9999^BUSH JR/GEORGE W.MR^********************************?*

Track 2 data in hex masked (length 0x23)
3B343236362A2A2A2A2A2A2A2A393939393D2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A

Track2 masked data in ASCII
;4266********9999=****************?*

In this example there is no Track 3 data either clear or masked (encrypted and hashed data is below)

Track 1 encrypted length 0x48 rounded up to 8 bytes = 0x48 (72 decimal)
DA7F2A52BD3F6DD8B96C50FC39C7E6AF22F06ED1F033BE0FB23D6BD33DC5A1F8
08512F7AE18D47A60CC3F4559B1B093563BE7E07459072ABF8FAAB5338C6CC88
15FF87797AE3A7BE

Track 2 encrypted length 0x32 rounded up to 8 bytes =0x38 (56 decimal)
AB3B10A3FBC230FBFB941FAC9E82649981AE79F2632156E775A06AEDAFAF6F0A
184318C5209E55AD

Track 3 encrypted length 0x6B rounded up to 8 bytes =0x70 (64 decimal)
44A9CCF6A78AC240F791B63284E15B4019102BA6C505814B585816CA3C2D2F42
A99B1B9773EF1B116E005B7CD8681860D174E6AD316A0ECDBC687115FC89360A
EE7E430140A7B791589CCAADB6D6872B78433C3A25DA9DDAE83F12FEFAB530CE
405B701131D2FBAAD970248A45600093

Track 1 data hashed length 20 bytes
3418AC88F65E1DB7ED4D10973F99DFC8463FF6DF

Track 2 data hashed length 20 bytes
113B6226C4898A9D355057ECAF11A5598F02CA31

Track 3 data hashed length 20 bytes
688861C157C1CE2E0F72CE0F3BB598A614EAABB1

KSN length 10 bytes
62994901190000000002

LCR, check sum and ETX
06E203

Clear/Masked Data in ASCII:
Track 1: %*4266********9999^BUSH JR/GEORGE
W.MR^********************************?*
Track 2: ;4266********9999=****************?*

Key Value: 1A 99 4C 3E 09 D9 AC EF 3E A9 BD 43 81 EF A3 34
KSN: 62 99 49 01 19 00 00 00 00 02

Decrypted Data:
Track 1 decrypted
%B4266841088889999^BUSH JR/GEORGE W.MR^0809101100001100000000046000000?!
Track 2 decrypted
;4266841088889999=08091011000046?0
Track 3 decrypted
;3333333337676760707077676763333333333767676070707767676333333333376767607070776767633333333337676760707077676763333333333767676070?2

Track 1 decrypted data in hex including padding zeros (but there are no pad bytes here)
254234323636383431303838383839393395E42555348204A522F47454F52474520572E4D525E303830393130313130303030313130303030303030303034363030303030303F21

Track 2 decrypted data in hex including padding zeros
3B343236363834313038383838393939393D303830393130313130303030303034363F300000000000

Track 3 decrypted data in hex including padding zeros
3B333333333333333333333736373637363037303730373737363736373633333333333333333333333736373637363037303730373737363736373633333333333333333333333736373637363037303730373737363736373633333333333333333333333736373637363037303730373F320000000000

Security Level 4 decryption—Enhanced Encryption Format

02A001803F48236B03FF252A343236362A2A2A2A2A2A2A2A393939395E42555348204A522F47454F52474520572E4D525E2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A3B343236362A2A2A2A2A2A2A2A393939393D2A2A2A2A2A2A2A2A2A2A2A2A2A2A2A3F2A6D7D5B204D3579694E148F3FB2565544D35825EA89BA30C966D34363151BF592F995EDA86B94A47EBFDF6434CB3A075DDD18F616E21F1E2038BC3AD5F96C1387177BD89409DA2E92A684543E007087F8694AEA8D3DB36BA10BC4D4B2771C622FEC8271A6E021AA5644ED559EC09CABF19F36B422CA2016B48A7241B2DA9584ED4415B4F30637734CF5031AF475DAF27C188A1A771264011BAA090E91893BC2A52EDD56F8E6E9554BC0C5207C04E3C21B6DA2A48F2257DC6946DBFBC87F3189E5C8B954BF7303D01E443155911E4137AEAD52441567AA1D50924A7597EC9D758AB4F3A8E82BF81A2E3418AC88F65E1DB7ED4D10973F99DFC8463FF6DF113B6226C4898A9D355057ECAF11A5598F02CA31688861C157C1CE2E0F72CE0F3BB598A614EAABB16299490119000000000 3D67C03

Clear/Masked Data:
Track 1: %*4266********9999^BUSH JR/GEORGE W.MR^*********************************?*
Track 2: ;4266********9999=****************?*

Key Value: 89 52 50 33 61 75 51 5C 41 20 CF 45 F4 1A BF 1C
KSN: 62 99 49 01 19 00 00 00 00 03
Session ID: AA AA AA AA AA AA AA AA

Decrypted Data in ASCII:
%B4266841088889999^BUSH JR/GEORGE W.MR^08091011000011000000000460000000?!
;4266841088889999=08091011000000460?0
;3333333337676760707077676763333333333767676070707767676333333333376767607070776767633333333337676760707077676763333333333767676070707?2

Decrypted Data in Hex
2542343236363834313038383838393939395E42555348204A522F47454F52474520572E4D525E303830393130313130303030313130303030303030303436303030303030303F21
3B34323636383431303838383839393939393D303830393130313130303030303034363F300000000000
3B333333333333333333333373637363736303730373037373637363736333333333333333333333333736373637363037303730373736373637363733333333333333333333337363736373630373037373637363736373633333333333333333333337363736373630373037373637363736373633333333333333333333337363736373630373037373637363736373633333333333333333333337363736373630373037373637363736373633333333333333333333337363736373630373037373637363736373F320000000000

Appendix I Example of IDTECH Raw Data Decryption

Original Raw Data Forward Direction:
01D67C81020408102D448102040810204289 0A350854A2FB3EE4BA3D4065B67A9C391F582A42
B99A858A90AF60852B14AA628A0D
028FC210842C18421084030092040B51581F24B56074404811160D

Original Raw Data Backward Direction:
01A28CAA51A9420DEA12A342B33A84A835F13872BCDB4C0578BA4EF9BE8A542158A122840
810204081024568102040810 27CD60D
02D11024045C0D5A49F03515A0409201804210843068421087E20D

Note:

1. There is track number before each track. Track 1 is 01, Track 2 is 02, Track 3 is 03.
2. There is track separator after each track: 0D

Example of decryption of a two track ABA card with the original encryption format. For both Fix & DUKPT key management.
SecureHead Reader with default settings

Key for all examples is
0123456789ABCDEFFEDCBA9876543210

Original Encryption Format
original encryption format (this can be recognized because the high bit of the fourth byte underlined (00) is 0.
028700041B331A0027D2E435CEE303F007E977B598B7E3C57C76F4445E309F6916C0321A0F915
B6E490813498839049FE5204762327C3C758C5BF82542DEEDD8D6AF88019149A702FF2D43BD
4AD60031FA450720B00D7808E15F3D5B29AE712C64A1212E9AF6F483BD40798A9FF2DDE77D
046620B55BCE94A4D5534CF57E7E07629949011A0000000001871D03

STX, Length (LSB, MSB), card type, track status, length track 1, length track 2, length track 3
02 8700 04 1B 33 1A 00

Track 1 & 2 encrypted length 0x33+0x1A rounded up to 8 bytes =0x4D -> 0x50 (80 decimal)
27D2E435CEE303F007E977B598B7E3C57C76F4445E309F6916C0321A0F915B6E4908134988390
49FE5204762327C3C758C5BF82542DEEDD8D6AF88019149A702FF2D43BD4AD60031FA45072
0B00D7808

Track 1 hashed
E15F3D5B29AE712C64A1212E9AF6F483BD40798A

Track 2 hashed
9FF2DDE77D046620B55BCE94A4D5534CF57E7E07

KSN
629949011A0000000001

LRC, checksum and ETX
87 1D 03

Key Value: 8A 60 A3 EB 80 87 63 52 B8 F5 05 CD A8 3C 33 70
KSN: 62 99 49 01 1A 00 00 00 00 01

Decrypted Raw Data:
01D67C81020408102D4481020408102042890A350854A2FB3EE4BA3D4065B67A9C391F582A42
B99A858A90AF60852B14AA628A
028FC210842C18421084030092040B51581F24B5607440481116

-=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-=-=--=-

Security Level 4 Original Encryption Format
028F00041B331A0070756B86C0B670DAAA78EEA454F5A7BAFB5CDA91BA9A5B62BB49F67C
D21484D3138DB3468C80F3468688AE61E3FB25FEEB630B81717CC405F8A73430FCAFEF98C4
CEDE76AB7AAC0D9090E2B25F7E77F7888306B57CB67A9BE15F3D5B29AE712C64A1212E9AF
6F483BD40798A9FF2DDE77D046620B55BCE94A4D5534CF57E7E07629949011A0000000002DD
5D03

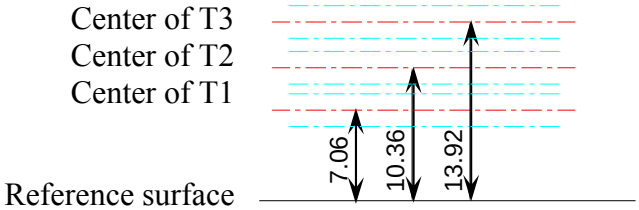
Key Value: 06 A9 B3 23 2A 69 B4 57 61 76 5E C3 CB A3 33 37
KSN: 62 99 49 01 1A 00 00 00 00 02
Session ID: AA AA AA AA AA AA AA AA

Decrypted Data:
01D67C81020408102D4481020408102042890A350854A2FB3EE4BA3D4065B67A9C391F582A42
B99A858A90AF60852B14AA628A
028FC210842C18421084030092040B51581F24B5607440481116

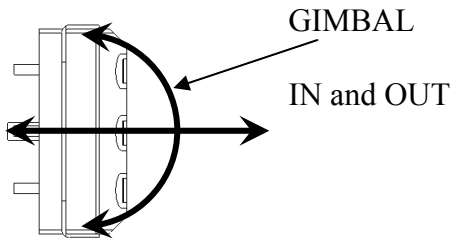
Appendix J Magnetic Heads Mechanical Design Guidelines

This installation guide is specifically to be used when installing ID TECH's magnetic spring heads.

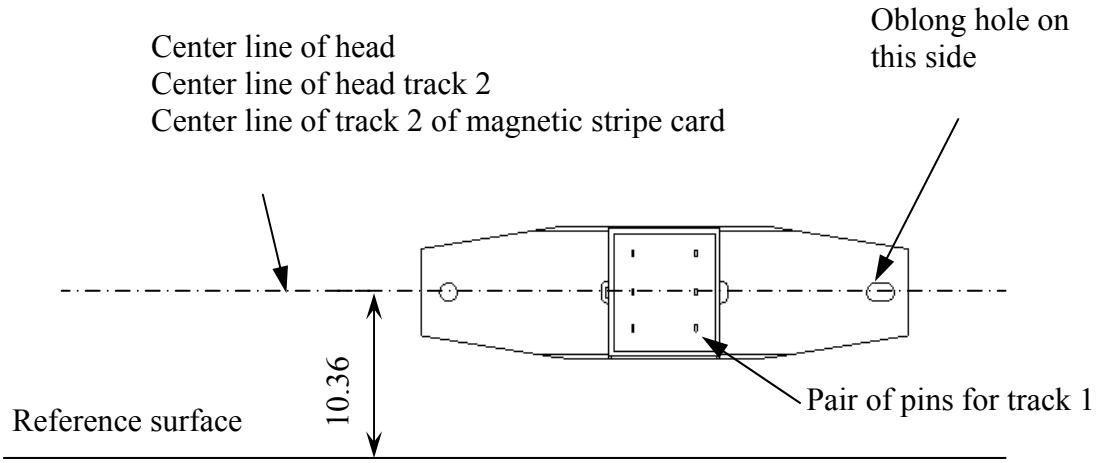
1. ISO 7810 and ISO 7811 standards define the specification for all "standard" magnetic stripe cards. The location of each magnetic track's centerline is shown in below figure (Note: the reference surface for the card is the edge of the card; and it is the surface the card rides on when referring to the magnetic head).



2. The head mounting should allow the head to follow the magnetic stripe on the card. In other words, the magnetic head needs to have the freedom to gimbal and move in/out to remain in contact with the surface of the card, after head is assembled to the rail. The movements are shown in below figure should be considered.



3. The head has to be mounted in relation to the reference surface on which the card slides so that the magnetic tracks of the head are positioned at the same distance from the reference (bottom of slot) as the magnetic tracks on the card (refer to dimensions in #1 above). A typical ID TECH magnetic head with 'spring' is shown below. The mounting holes in the spring are used for mounting the head and positioning the track locations. (Note: the oblong hole in the spring must be oriented as shown in the drawing to locate tracks 1 through 3 properly)



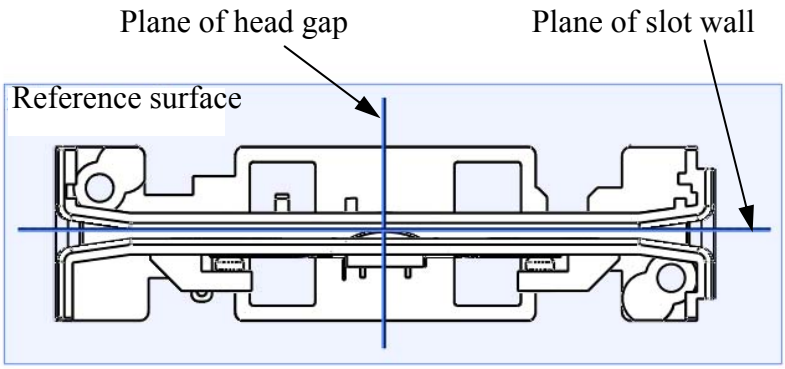
4. The card thickness must be considered when designing the rail and head mounting. The head gap (located on the crown of the head) must be positioned so that it has a minimum of 0.010 inches (0.25mm) movement when a minimum card thickness is swiped, any less movement could result in unreliable reading. Or put another way: the distance between the crown of the head and the opposing slot wall should be only a fraction of the minimum card thickness that will slide through the reader, so the magnetic head always exerts pressure on the card. The pressure allows for proper contact of the head to stripe especially at high speeds.

5. Standard card thickness is 0.76mm±10%, if only standard cards are to be used, the rule should be the Apex (crown of head) of the head should be a maximum of 0.25mm from opposing card slot wall. If a thinner or thicker than standard card is used, the distance the head is positioned from the opposing wall needs to be adjusted (this will require a unique rail design with either wider or narrower card slot width).

   The minimum slot width should be maximum card thickness plus 0.15~0.30mm. The suggested minimum slot width is $1.03^{+0.08}_{-0}$ mm when a standard card is used.

6. The design should ensure there is no excessive force or deformation of head spring during the assembly of head to the rail or after head is assembled to prevent permanent deformation of the head spring. The head spring must be mounted so that it is free to gimbal about the spring holes.

7. The bottom of slot and the slot walls should not have any discontinuities and have to be flat (no deformation is allowed). The portion of the slot wall, about 10mm on each side of the magnetic head's crown, should not have draft and must be perpendicular to the bottom of slot (reference surface). The slot width in lead-in and lead-out area shall be greater and must have gradual transition with no edges, or angles to interfere with the smooth swiping of a card.



8. Depending on the requirement of swipe life cycles, a suitable material for the rail shall be decided. If the life of the reader is to be greater than 50,000 passes, the bottom of slot must embed a metal wear plate (stainless steel is the metal of preference to avoid corrosion), or the plastic material used for the slot needs to be significantly harder than the card material to ensure adequate rail life.

9. The back side (pin side) of magnetic head shall have enough reserved space to prevent interference with other parts during swiping of maximum thickness cards. A minimum of 1.25~1.52mm spacing behind the head is required to allow for proper gimbal and head movement during card swiping. The head opening in the rail must allow room for maximum gimbal action.

10. The length, width and height of rail's slot will affect the stability of reading performance.
    a. The length of the slot to be maximum permitted by dimensional constraints (if possible it should be 2 times the length of the card).
    b. The slot width to be approx. 0.20 mm bigger than the maximum thickness card that will be swiped through the slot.
    c. The height of the slot should be as big as the dimensional constraints allow, but shall not extend over the embossing area of the card unless there is a provision (recess) in the rail wall design to allow for such embossing.

11. ID TECH can provide samples of a rail and magnetic head for design reference. Order these through your local sales representative using the following part numbers:
    90mm rail 80006248-001 and
    Standard wing spring head 80027236-001