System Tools for Apollo Lake: Intel® Trusted Execution Environment 3.0

User Guide

November 2017

Revision: 1.02 Release

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Revision History

Revision Number	Description	Revision Date
0.3	Pre-Alpha Release	September 2015
0.4	Updated OS matrix with Linux library support	
0.6	Alpha version release	
0.7	Updated OS matrix with Win10 32-bit support Added details to MEU on key hash generation	October 2015
0.8	Updated OS matrix Updated MEU error codes, and additional functionality	November 2015
0.81	Removed CommitFPF command, updated details of –TXE flag, updated details of –CLOSEMNF flag Windows 10 DT 32-bit will be supported post-TTM Updated FIT settings location, based on Beta build locations. Added note about Disable Boot Source FPFs. Multiple minor clarfications and corrections	January 2016
0.85	Added Appendix on using Local Android* Intel® System Tools Added chapter and Appendix on Google Widevine provisioning and processes Added usage of –ISH –fwstat combination flag in Intel® TXEInfo Removal of Win10 32-bit OS support from all tools, impacting Win10 PE 32-bit and EFI Shell 32 bit as well Removed NFC flags from tools	April 2016
1.0	Removed all mention of Broxton	July 2016
1.01	Updated FPT -CLOSEMNF	June 2017
1.02	Updated Tools Error Code List and OS Support Table	November 2017

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1 Introduction

The purpose of this document is to describe the tools that are used in the platform design, manufacturing, testing, and validation process.

1.1 Terminology

Acronym/Term	Definition
AC	Alternating Current
Agent	Software that runs on a client PC with OS running
API	Application Programming Interface
BIN	Binary file
BIOS	Basic Input Output System
BIOS-FW	Basic Input Output System Firmware
BIST	Built In Self-Test
CLI	Command Line Interface
CRB	Customer Reference Board
CVAR	Changeable Variable
DLL	Dynamic Link Library
DNS	Domain Naming System
DnX	Download and Execute Technology
EC	Embedded Controller
EFI	Extensible Firmware Interface
EHCI	Enhanced Host Controller Interface
End User	The person who uses the computer (either Desktop or Mobile). The user usually may not have administrator privileges.
EOP	End Of Post
Intel® FIT	Intel® Flash Image Tool
FLOCKDN	Flash Configuration Lock-Down
FOV	Fixed Offset Variable
Intel® FPT	Intel® Flash Programming Tool
FQDN	Fully Qualified Domain Name
FW	Firmware
G3	A system state of Mechanical Off where all power is disconnected from the system. A G3 power state does not necessarily indicate that RTC power is removed.
GPIO	General Purpose Input/output

Acronym/Term	Definition
GUI	Graphical User Interface
GUID	Globally Unique Identifier
HECI (deprecated)	Host Embedded Controller Interface
Host or Host CPU	The processor running the operating system. This is different than the processor running the Intel® TXE FW.
Host Service/ Application	An application running on the host CPU
HW	Hardware
IBV	Independent BIOS Vendor
ICC	Integrated Clock Configuration
ID	Identification
INF	An information file (.inf) used by Microsoft operating systems that support the Plug & Play feature. When installing a driver, this file provides the OS with the necessary information about driver filenames, driver components, and supported hardware.
Intel® DAL	Intel® Dynamic Application Loader (Intel® DAL)
Intel® TXE	Intel® Trusted Execution Engine. The embedded processor residing in the chipset MCH.
Intel® TXEI driver	Intel® TXE host driver that runs on the host and interfaces between ISV Agent and the Intel® TXE HW.
ISV	Independent Software Vendor
IT User	Information Technology User. Typically very technical and uses a management console to ensure multiple PCs on a network function.
LAN	Local Area Network
LED	Light Emitting Diode
LPC	Low Pin Count Bus
CM0	Intel® TXE power state where all HW power planes are activated. Host power state is S0.
CM1	Intel® TXE power state where all HW power planes are activated but the host power state is different than S0. (Some host power planes are not activated.) The Host PCI-E* interface is unavailable to the host SW. This power state is not available in Cougar Point.
CM3	Intel® TXE power state where all HW power planes are activated but the host power state is different than S0. (Some host power planes are not activated.) The Host PCI-E* interface is unavailable to the host SW. The main memory is not available for Intel® TXE use.
CM-Off	No power is applied to the processor subsystem. Intel® TXE is shut down.
MAC address	Media Access Control address
MCP	Multi-Chip Package (Central Processing Unit / Platform Controller Hub)

Acronym/Term	Definition
NM	Number of Masters
NVM	Non-Volatile Memory
NVRAM	Non-Volatile Random Access Memory
ODM	Original Device Manufacturer
OEM	Original Equipment Manufacturer
OEM ID	Original Equipment Manufacturer Identification
OS	Operating System
OS Hibernate	OS state where the OS state is saved on the hard drive.
OS not Functional	The Host OS is considered non-functional in Sx power state in any one of the following cases when the system is in S0 power state: • OS is hung • After PCI reset • OS watch dog expires • OS is not present
PAVP	Protected Video and Audio Path
PC	Personal Computer
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect Express
PHY	Physical Layer
PID	Provisioning ID
PKI	Public Key Infrastructure
PM	Power Management
ROM	Read Only Memory
RSA	A public key encryption method
RTC	Real Time Clock
S0	A system state where power is applied to all HW devices and the system is running normally.
S1, S2, S3	A system state where the host CPU is not running but power is connected to the memory system (memory is in self refresh).
S4	A system states where the host CPU and memory are not active.
S5	A system state where all power to the host system is off but the power cord is still connected.
SDK	Software Development Kit
SHA	Secure Hash Algorithm
SMBus	System Management Bus
SPI	Serial Peripheral Interface
SPI Flash	Serial Peripheral Interface Flash

Acronym/Term	Definition
Sx	All S states which are different than S0
SW	Software
System States	Operating System power states such as S0, S1, S2, S3, S4, and S5.
UI	User Interface
UMA	Unified Memory Access
Un-configured state	The state of the Intel® TXE FW when it leaves the OEM factory. At this stage the Intel® TXE FW is not functional and must be configured.
USB	Universal Serial Bus
VSCC	Vendor Specific Component Capabilities
Windows* PE	Windows* Pre installation Environment
XML	Extensible Markup Language.

1.2 Reference Documents

Document	Document No./Location
Apollo Lake- Intel®Trusted Execution Engine (Intel®TXE) Firmware Bring-Up Guide	Release kit
EDS	CDI
Apollo Lake Soc SPI and Signed Master Image Profile(SMIP) Programming Guide	Release kit
Apollo Lake Signing and Manifesting Guide	Release kit

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2 Preface

2.1 Overview

This document covers the system tools used for creating, modifying, and writing binary image files, manufacturing testing, Intel® TXE setting information gathering, and Intel® TXE FW updating. The tools are located in **Kit directory\Tools\System tools**. For information about other tools, see the tool's user guides in the other directories in the FW release.

The system tools described in this document are platform specific in the following ways:

- Apollo Lake (APL) platforms – All tools in the Apollo Lake FW release kit are designed for Apollo Lake platforms only. These tools do not work properly on any other legacy platforms. Tools designed for other platforms also do not work properly on the Apollo Lake platforms.
- Intel® TXE Firmware 3.0 SKU – The tools are provided for the Intel® TXE FW 3.0 SKUs.

2.2 Image Editing Tools

The following tools create and write flash images:

- Intel® FIT:

  Combines the BIOS, Intel® TXE FW and other binaries into one image.

  Configures SMIPs and CVARs for Intel® TXE settings that can be programmed by a flash programming device or the FPT Tool.
- FPT:

  Programs the SPI flash memory of individual regions or the entire SPI flash device.

  Modifies some Intel® TXE settings (CVAR) after Intel® TXE is flashed on the flash memory part.
- Platform Flash Tool (using DnX)

2.3 Manufacturing Line Validation Tool

The manufacturing line validation tool (Intel® TXEManuf) allows the Intel® TXE functionality to be tested immediately after the chipset is generated. This tool is designed to be able to run quickly. It can run on simple operating systems, such as EFI, Windows* 98. The Windows* version is written to run on Windows* 7, Windows* 8.1 and Win* PE 32 and 64. This tool is mostly run on the manufacturing line to do manufacturing testing.

2.4 Intel® TXE Setting Checker Tool

The Intel® TXE setting checker tool (Intel® TXEInfo) retrieves and displays information about some of the Intel® TXE settings, the Intel® TXE FW version, and the FW capability on the platform.

2.5 Operating System Support

Table 2-1: OS Support for Tools

Intel® TXE and Manufacturing Tools	EFI Shell 64 bit	Windows * 7 SP1 32bit	Windows* 7 SP1 64bit	Windows* PE 3.1 64bit	Windows* 8.1 32bit	Windows 8.1 64bit	Windows* PE 5.1 64bit	Windows* 10 DT 64bit	Windows * 10 PE 64bit	Windows 10 Mobile
Intel® Flash Image Tool		X	X		X	X		X		
Intel® Flash Programming Tool	X		X	X			X	X	X	X
Intel® TXEManuf Tool	X		X	X			X	X	X	X
Intel® TXE Info Tool	X		X	X			X	X	X	X
Manifest Extension Tool		X	X		X	X		X		
Platform Flash Tool and Token Manager Tool		X	X		X	X				

2.6 Generic System Requirements

The installation of the following driver is required by integration validation tools that run locally on the system under test with the Intel® TXE:

- Intel® TXEI driver.

See the description of each tool for its exact requirements.

2.7 Error Return

Intel® FIT and Intel® MEU return a non-0 number on an error, and the final error code is printed.

Other tools return 0/1/2 for the error level (0 = success, 1= error, 2 = Success with warning). A detailed error code is displayed on the screen and stored on an error.log file in the same directory as the tools. (See Appendix B for a list of these error codes.)

2.8 Usage of the Double-Quote Character (")

The EFI version of the tools handle multi-word argument is different than the DOS/Windows* version. If there is a single argument that consists of multiple words delimitated by spaces, the argument needs to be entered as following:

FPT.efi –f “” arguments ””.

The command shell used to invoke the tools in EFI and Windows* has a built-in CLI.

The command shell was intended to be used for invoking applications as well as running in batch mode and performing basic system and file operations. For this reason, the CLI has special characters that perform additional processing upon command.

The double-quote is the only character which needs special consideration as input. The various quoting mechanisms are the backslash escape character (/), single-quotes ('), and double-quotes ("). A common issue encountered with this is the need to have a double-quote as part of the input string rather than using a double-quote to define the beginning and end of a string with spaces.

For example, the user may want these words – one two – to be entered as a single string for a vector instead of dividing it into two strings ("one", "two"). In that case, the entry – including the space between the words – must begin and end with double-quotes ("one two") in order to define this as a single string.

When double-quotes are used in this way in the CLI, they define the string to be passed to a vector, but are NOT included as part of the vector. The issue encountered with this is how to have the double-quote character included as part of the vector as well as bypassed during the initial processing of the string by the CLI. This can be resolved by preceding the double-quote character with a backslash (\").

For example, if the user wants these words to be input – input"string – the command line is: input\"string.

2.9 PMX Driver Limitation

Several tools (Intel® TXEInfo, Intel® TXEInfo, and Intel® FPT) use the PMX library to get access to the PCI device. Only one tool can get access to the PMX library at a time because of library limitation. Therefore, running multiple tools to get access to PMX library will result in an error (failure to load driver).

The PMX driver is not designed to work with the latest Windows* driver model (it does not conform to the new driver's API architecture).

In Windows* 7 (and higher), the verifier sits in kernel mode, performing continual checks or making calls to selected driver APIs with simulations of well-known driver related issues.

Warning: Running the PMX driver with the Windows* 7 (and higher) driver verifier turned on causes the OS to crash. Do not include PMX as part of the verifier driver list if the user is running Windows* 7 (and higher) with the driver verifier turned on.

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3 Intel® Flash Image Tool (Intel® FIT)

The Intel® Flash Image Tool (Intel® FIT) creates and configures a complete SPI, eMMc or UFS flash image file for Apollo Lake platforms in the following way:

1. Intel FIT creates and allows configuration of the SPI Flash Descriptor Region, which contains configuration information for platform hardware and FW (SPI images only)
2. Intel FIT assembles the following into a single firmware image:
    BIOS
    IUnit
    PMC
    uCode
    Intel® TXE
    SMIP configuration settings
    Manifest files
    SPI Flash Descriptor Region (SPI images only)
3. The user can manipulate the firmware image before its generation via a GUI or xml file and change the various chipset parameters to match the target hardware. Various configurations can be saved to independent files, so the user does not have to recreate a new image each time.

Intel FIT supports a set of command line parameters that can be used to build an image from the CLI or from a makefile. When a previously stored configuration is used to define the image layout, the user does not have to interact with the GUI.

Note: Intel FIT just generates a complete firmware image file; it does not program the flash device. This complete firmware image must be programmed into the flash with Intel® FPT, DnX, any third-party flash burning tool, or some other flash burner device.

3.1 System Requirements

Intel® FIT runs on the OSs described in section 2.5. The tool does not have to run on an Intel® TXE-enabled system.

3.2 Required Files

The Intel FIT main executable is **FIT.exe**. The following files must be in the same directory as **FIT.exe**:

- vsccommn.bin

3.3 Intel® FIT

See the following for further information:

- General configuration information – See the FW Bring Up Guide from the appropriate Intel® TXE FW kit.
- Detailed information on how to configure SPI descriptor and SMIPs – See Apollo Lake Soc SPI and Signed Master Image Profile(SMIP) Programming Guide.

3.3.1 Configuration Files

The flash image can be configured in many different ways, depending on the target hardware and the required FW options. Intel FIT lets the user change this configuration in a graphical manner (via the GUI). Each configuration can be saved to an XML file. These XML files can be loaded at a later time and used to build subsequent flash images.

3.3.2 Creating a New Configuration

Intel FIT provides a XML configuration file template that will help the user can use to create their own configuration XML. This template configuration XML file can be created by clicking **File** > **New and then save**. It can also be created from the command line using –save option.

3.3.3 Opening an Existing Configuration

To open an existing configuration file:

1. Choose File **> Open**; the **Open File** dialog appears.
2. Select the XML file to load
3. Click Open.

Note: The user can also open a file by dragging and dropping a configuration file into the main window of the application.

3.3.4 Saving a Configuration

To save the current configuration in an XML file:

Choose File **> Save** or File **> Save As**; the Save File dialog appears if the configuration has not been given a name or if File **> Save As** was chosen.

1. Select the path and enter the file name for the configuration.
2. Click Save.

3.3.5 Environment Variables

A set of environment variables is provided to make the image configuration files more portable. The configuration is not tied to a particular root directory structure because all of the paths in the configuration are relative to environment variables. The user can set the environment variables appropriate for the platform being used, or override the variables with command line options.

It is recommended that the environment variables be the first thing that the user sets when working with a new configuration. This ensures that Intel FIT can properly substitute environment variables into paths to keep them relative. Doing this also speeds up configuration because many of the **Open File** dialogs default to particular environment variable paths.

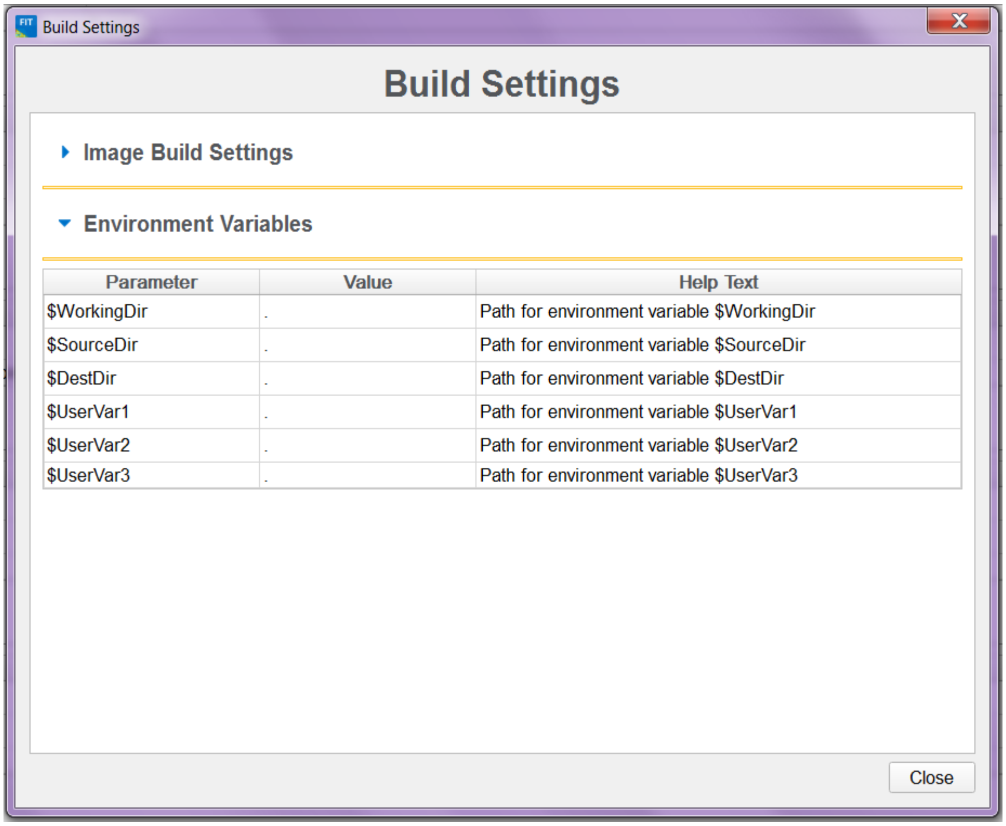
To modify the environment variables:

1. Choose Build **> Build Settings**; a dialog appears displaying the current working directory on top, followed by the current values of all the environment variables:

Table 3-1. Environment Variables Options

Option	Description
$WorkingDir	the directory functions as a basic path variable when modified in the GUI. If $WorkingDir CLI flag is used when launching FIT GUI, then the fit.log will be created in $WorkingDir directory.
$SourceDir	the directory that contains the base image binary files from which a complete flash image is prepared. Usually these base image binary files are obtained from Intel® VIP on the Web, a BIOS programming resource, or another source.
$DestDir	the directory in which the final combined image is saved, as well as intermediate files generated during the build. Also the directory where the components of an image are stored when an image is decomposed.
$UserVar1-3	used when the above variables are not populated

Figure 3-1. Environment Variables in Build Settings Dialog



Parameter	Value	Help Text
$WorkingDir	.	Path for environment variable $WorkingDir
$SourceDir	.	Path for environment variable $SourceDir
$DestDir	.	Path for environment variable $DestDir
$UserVar1	.	Path for environment variable $UserVar1
$UserVar2	.	Path for environment variable $UserVar2
$UserVar3	.	Path for environment variable $UserVar3

2. Click the ... button next to an environment variable and select the directory where that variable's files will be stored; the name and relative path of that directory appears in the field next to the variable's name.
3. Repeat Step 2 until the directories of all relevant environment variables have been defined.
4. Click **OK**.
5. The environment variables are saved in the XML file. They can be overridden on the command line if using the XML file on multiple systems.

3.3.6 Image Build Settings

Intel FIT lets the user set several options that control how the image is built. The options that can be modified are described in Table 3-2.

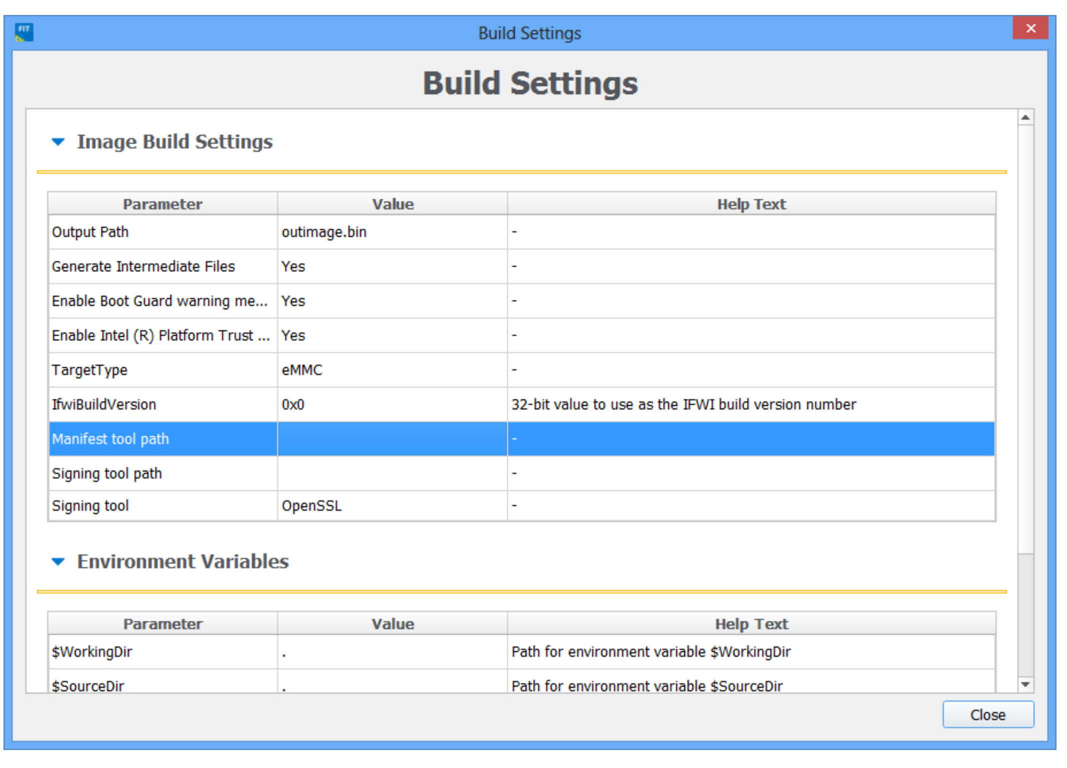
To modify the build setting:

1. Choose **Build** > **Build Settings**; a dialog appears showing the current build settings.
2. Modify the relevant settings in the **Build Settings** dialog.
3. Click **OK**; the modified build settings are saved in the XML configuration file.

Table 3-2: Build Settings Dialog Options

Option	Description
Output filename	The path and filename where the final image should be saved after it is built. (Note: Using the $DestDir environment variable makes the configuration more portable.)
Generate intermediate build files	Causes the application to generate separate (intermediate) binary files, in addition to the final image file. These files are located in the specified output folder's INT subfolder.
Enable Boot Guard Warning message at build time	Enables Boot Guard warning messages at build time
Enable Intel® Platform Trust Technology messages at build time	Enables Intel® Platform Trust Technology warning messages at build time
Target Type	If building an SPI/eMMc/UFS image
IFWI Build Version	32-bit value to use as the IFWI build version number
Manifest Extension Utility Path	Path to the Intel MEU application, which creates and adds a manifest to the SMIP data
Signing Tool Path	Path to the signing tool (normally OpenSSL), to sign the SMIP data
Signing Tool	Name of the signing tool (normally OpenSSL) to sign the SMIP data

Figure 3-2. Image Build Settings in Build Settings Dialog



Build Settings

Image Build Settings

Parameter	Value	Help Text
Output Path	outimage.bin	-
Generate Intermediate Files	Yes	-
Enable Boot Guard warning me...	Yes	-
Enable Intel (R) Platform Trust ...	Yes	-
TargetType	eMMC	-
IfwiBuildVersion	0x0	32-bit value to use as the IFWI build version number
Manifest tool path		-
Signing tool path		-
Signing tool	OpenSSL	-

Environment Variables

Parameter	Value	Help Text
$WorkingDir	.	Path for environment variable $WorkingDir
$SourceDir	.	Path for environment variable $SourceDir

3.3.7 DnX Build Settings

Intel FIT lets the user set several options that control if and how a DnX image is built. The options that can be modified are described in Table 3-2.

NOTE: In early versions of the tool, these settings are visible in the DnX tab of the tool, and not the Build Settings Dialog.

To modify the build setting:

1. Choose **Build** > **Build Settings**; a dialog appears showing the current build settings.
2. Modify the relevant settings in the **Build Settings** dialog.
3. Click **OK**; the modified build settings are saved in the XML configuration file.

Table 3-3: DnX Build Settings Dialog Options

Option	Description
Build DnX image	Should Intel FIT build a DnX image
DnX Output Filename	The path and filename where the final DnX image should be saved after it is built. (Note: Using the $DestDir environment variable makes the configuration more portable.)

Option	Description
Signing Key	Private key for signing the DnX image. Must be the same private key used to sign the OEM Key Manifest, and whose public key hash is entered into OEM Public Key Hash field in Platform Protection tab, and which gets burned to an FPF.
Platform ID	Platform ID that DnX uses to verify the image is suitable for the platform.
OEM ID	OEM ID that DnX uses to verify the image is suitable for the platform.

3.3.8 Target Platform and Flash Settings

Intel FIT lets the user define the target platform and flash type of the final image. These options are displayed in drop-down combo boxes on the toolbar.

NOTE: In early versions of the tool, the Flash Type setting is visible in the Build Settings Dialog.

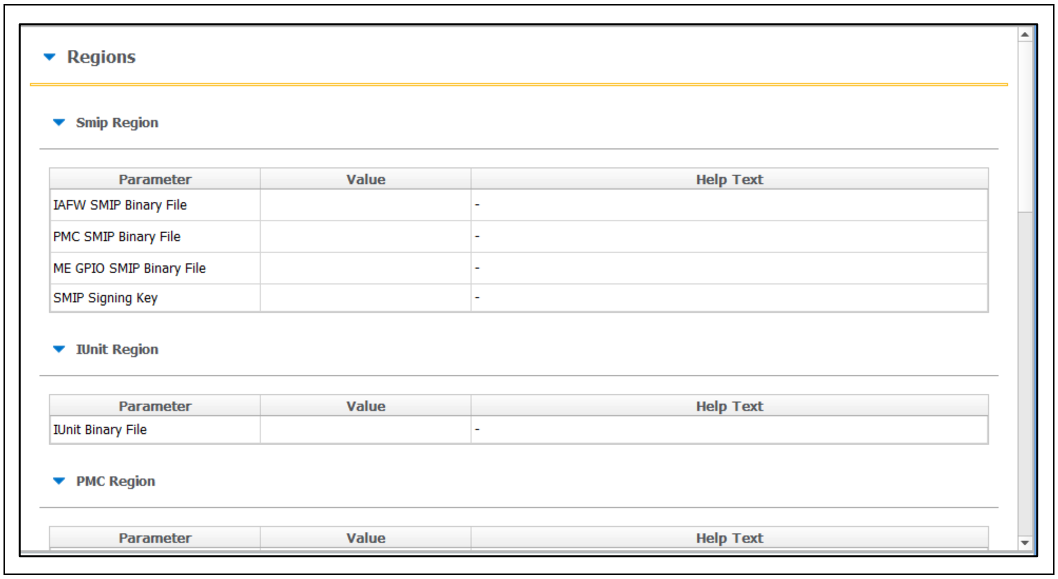
Table 3-4: Target Platform and Flash Options

Combo	Options
Target Platform	Apollo Lake
Flash Type	eMMc / UFS / SPI

3.3.9 Flash Layout Tab

The Flash Layout tab contains information about the various binaries that need to be stitched together in the final image. It allows uploading the paths of these binaries that need to be present on the same system as Intel FIT. During image compilation, these binary files are stitched into the image.

Figure 3-3. Flash Layout Tab



Regions

Smip Region

Parameter	Value	Help Text
IAFW SMIP Binary File		-
PMC SMIP Binary File		-
ME GPIO SMIP Binary File		-
SMIP Signing Key		-

IUnit Region

Parameter	Value	Help Text
IUnit Binary File		-

PMC Region

Parameter	Value	Help Text

3.3.10 Flash Settings Tab

The Flash Settings tab contains information about the flash image and the target hardware. It is important for this region to be configured correctly or the target computer may not function as expected. This region also needs to be configured correctly in order to ensure that the system is secure. Most of the settings here are relevant only to SPI images, but there are also some settings relevant to eMMc or UFS. Based on the selections in the Target Platform and Flash combo boxes, only relevant fields will be editable.

There is a section in this tab called "Boot Source Selection" which enables the setting of FPFs to disable boot sources that the platform will not support. Note that while setting these FPFs can speed platform boot, since they are burned to fuses at End of Manufacture, the system can then never be changed to boot from a different boot source.

3.3.10.1 SPI Region Access Control

Regions of the SPI flash can be protected from read or write access by setting a protection parameter in the Descriptor Region. The Descriptor Region must be locked before Intel® TXE devices are shipped. If the Descriptor Region is not locked, the Intel® TXE device is vulnerable to security attacks. The level of read/write access provided is at the discretion of the OEM/ODM. Intel FIT gives 3 options for access control

- full access, which is suitable for pre-production images
- Intel recommended settings, which lock the regions based on the recommendations in the APL SPI and SMIP Programming Guide, allowing host OS access to the PDR region.
- Intel recommended settings, which lock the regions based on the recommendations in the APL SPI and SMIP Programming Guide, forbidding host OS access to the PDR region.

3.3.10.2 SPI VSCC Table

This section is used to store information to setup SPI flash access for Intel® TXE. This does not have any effect on the usage of the FPT. **If the information in this section is incorrect, Intel® TXE FW may not communicate with the flash device.** The information provided is dependent on the flash device used on the system. (For more information, see the Apollo Lake Soc SPI and Signed Master Image Profile(SMIP) Programming Guide, Section 6.4.)

VSCC Table can be accessed:

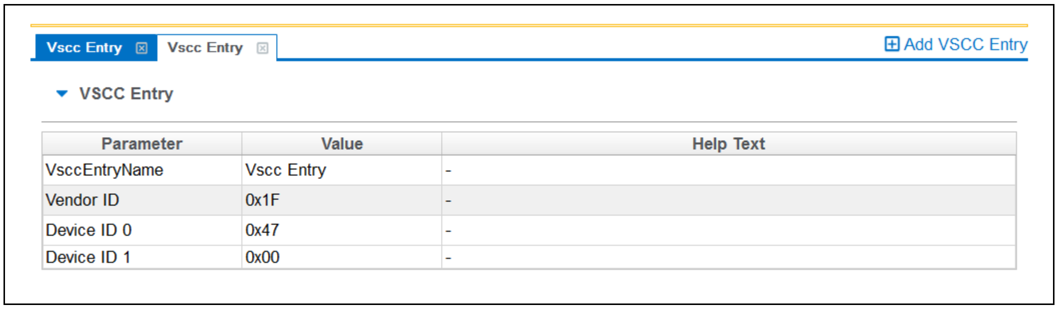
1. Select Flash Settings Tab on the left pan
2. Expand VSCC Entries on the right pan as shown in Figure 9 below:

3.3.10.3 Adding a New Table

To add a new table:

1. Choose ⊞ Add VSCC Entry **on top left > VSCC Entry**.

Figure 3-4. Add VSCC Table Entry Dialog



Parameter	Value	Help Text
VsccEntryName	Vscc Entry	-
Vendor ID	0x1F	-
Device ID 0	0x47	-
Device ID 1	0x00	-

2. Enter a name into the **Entry Name** field. (**Note**: To avoid confusion it is recommended that each table entry name be unique. There is no checking mechanism in Intel FIT to prevent table entries that have the same name and no error message is displayed in such cases.)
3. User can enter into the values for the flash device.

NOTES: The VSCC register value will be automatically populated by Intel FIT using the vsccommn.bin file the appropriate information for the Vendor and Device ID.

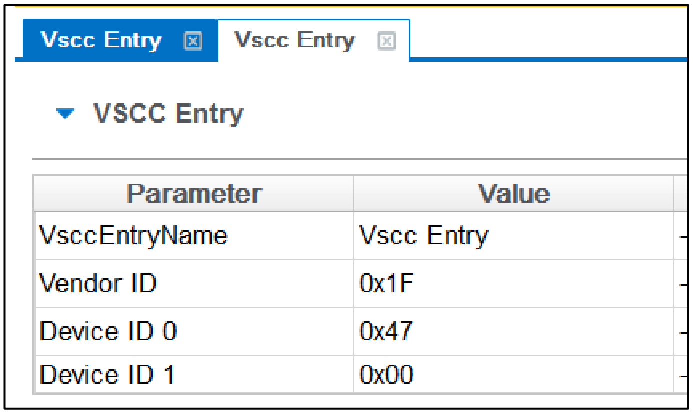
NOTES: If the descriptor region is being built manually the user will need to reference the VSCC table information for the parts being supported from the manufacturers' serial flash data sheet. The Apollo Lake SPI Programming Guide should be used to calculate the VSSC values.

3.3.10.4 Removing an Existing VSCC Table

To remove an existing table:

1. Click on the name of the table in the top tab that the user wants to remove as shown in Figure 12.

Figure 3-5. Deleting VSCC Table Entry Dialog



Parameter	Value
VsccEntryName	Vscc Entry
Vendor ID	0x1F
Device ID 0	0x47
Device ID 1	0x00

2. Click close; the table and all of the information will be removed.

3.3.11 Platform Protection

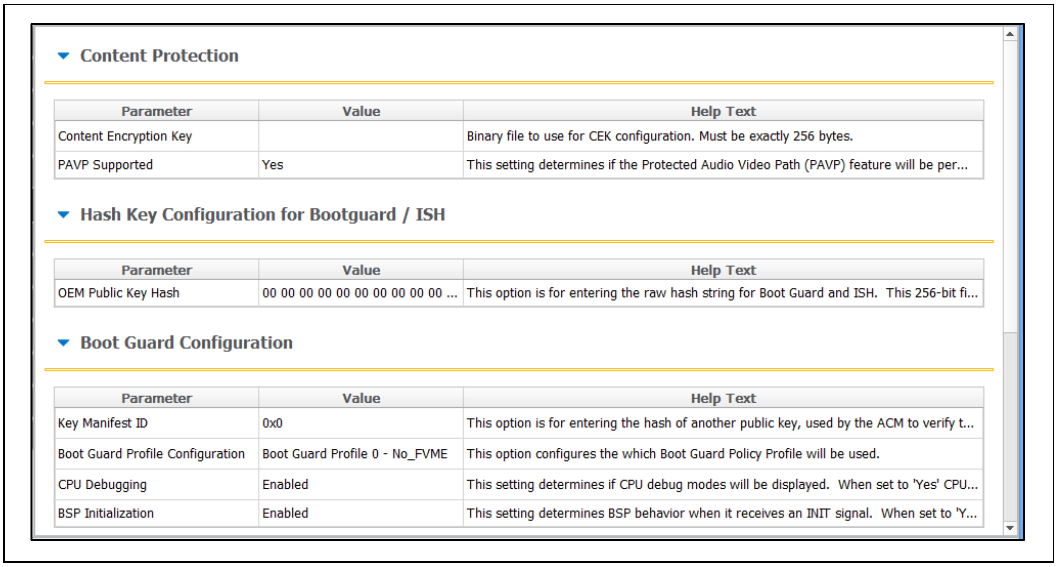
This tab includes many settings relating to the protection of the platform, and its integrity. In particular, it includes

Table 3-5. Key Platform Protection Fields

Option	Description
SMIP signing key	This is the path to the private key used to sign the SMIP, while public key hash of it is included in the OEM hash manifest.
OEM Public Key Hash	This option is for entering the raw hash string or certificate file for the SHA-256 hash of the OEM public key corresponding to the private key used to sign the OEM Key hash manifest. When manufacture is completed, this hash value is burned into an FPF. This value is used to verify the OEM Key hash, and also DnX images
OEM Key Manifest Binary	Signed manifest file (created by Intel MEU) containing hashes of keys used for signing components of image

There are also fields for configuring Boot Guard and Intel® PTT.

Figure 3-6. Platform Protection Tab



▾ Content Protection

Parameter	Value	Help Text
Content Encryption Key		Binary file to use for CEK configuration. Must be exactly 256 bytes.
PAVP Supported	Yes	This setting determines if the Protected Audio Video Path (PAVP) feature will be per...

▾ Hash Key Configuration for Bootguard / ISH

Parameter	Value	Help Text
OEM Public Key Hash	00 00 00 00 00 00 00 00 00 00 ...	This option is for entering the raw hash string for Boot Guard and ISH. This 256-bit fi...

▾ Boot Guard Configuration

Parameter	Value	Help Text
Key Manifest ID	0x0	This option is for entering the hash of another public key, used by the ACM to verify t...
Boot Guard Profile Configuration	Boot Guard Profile 0 - No_FVME	This option configures the which Boot Guard Policy Profile will be used.
CPU Debugging	Enabled	This setting determines if CPU debug modes will be displayed. When set to 'Yes' CPU...
BSP Initialization	Enabled	This setting determines BSP behavior when it receives an INIT signal. When set to 'Y...

3.3.12 Integrated Sensor Hub

This tab allows the enabling of Integrated Sensor Hub (ISH) in the image, and inclusion of a binary file for it.

3.3.13 Download and Execute

This tab allows the configuration of settings related to Download and Execute (DnX).

Table 3-6. DnX Fields

Option	Description
DnX Enabled	Permanently enable/disable DnX on the platform. This variable gets burned into a fuse (FPF) at close of manufacture, and can never be changed after that.
Platform ID	Platform ID that DnX uses to verify the image is suitable for the platform. This variable gets burned into a fuse (FPF) at close of manufacture, and can never be changed after that.
OEM ID	OEM ID that DnX uses to verify the image is suitable for the platform. This variable gets burned into a fuse (FPF) at close of manufacture, and can never be changed after that.
USB configurations	Series of settings for USB for DnX

3.3.14 GPIO Profiles

Intel FIT supports the configuration of up to 5 sets of GPIO profiles, as defined in the SPI and SMIP programming guide. By default, Intel FIT creates a single profile, further ones can be added, and extra ones removed, in the same method as VSCC tables are added and removed (see section 3.3.10.2). When building the image, only the first profile is compiled into the IFWI image. All of the profiles are built as binary files, and placed in the build output directory. They can be used later by Intel® FPT to update the profile in the image to one of the other profiles defined within FIT.

3.3.15 End Of Manufacturing State

In SPI platforms, End of Manufacturing state is implicitly set in the image if the SPI regions are locked with the flash settings. If the regions are not locked, End of Manufacturing state can be set during manufacturing using the FPT tool.

On eMMc and UFS platforms, which do not have region locking, End of Manufacturing state can be explicitly set in the Intel FIT image using a dedicated setting.

This field is un the Intel® TXE Kernel tab, in the 'Manufacturing Settings' section, and is called 'End of Manufacturing Enable'.

3.3.16 Platform Configuration Tab

The PMIC/VR Configuration option in the Platform Configuration tab is new in APL platforms. This allows users to select from a dropdown with 4 voltage regulator (VR) options for the Power Management IC (PMIC) supported on the platform. Selecting the correct option is critical – the platform will not boot if the wrong one is selected.

3.3.17 Other Configuration Tabs

Intel FIT has multiple other tabs of settings that can be configured. Each one should be opened, and the settings changed where relevant. In many cases, default values are provided which can be retained. Each field includes help text clarifying its meaning.

3.3.18 Building a Flash Image

The flash image can be built with the Intel FIT GUI interface.

To build a flash image with the currently loaded configuration:

- Choose **Build > Build Image**.

  – OR –

- Specify an XML file with the /b option in the command line.

Intel FIT uses an XML configuration file and the corresponding binary files to build the SPI flash image. The following is produced when an image is built:

- Binary file representing the image
- Text file detailing the various regions in the image
- Optional set of intermediate files (see Section 5).
- Multiple binary files containing the image broken up according to the flash component sizes (**Note**: These files are only created if two flash components are specified.)

The individual binary files can be used to manually program independent flash devices using a flash programmer. However, the user should select the single larger binary file when using Intel FPT.

3.3.19 Decomposing an Existing Flash Image

Intel FIT is capable of taking an existing flash image and decomposing it in order to create the corresponding configuration. This configuration can be edited in the GUI like any other configuration (see below). A new image can be built from this configuration that is almost identical to the original, except for the changes made to it.

To decompose an image:

1. Chose **File** > **Open.**
2. Change the file type filter to the appropriate file type.
3. Select the required file and click **Open**; the image is automatically decomposed, the GUI is updated to reflect the new configuration, and a folder is created with each of the components in a separate binary file.

Note: It is also possible to decompose an image by simply dragging and dropping the file into the main window. When decomposing an image, there are some CVARs which will not be able to be decomposed by Intel FIT. Intel FIT will use Intel default value instead. User might want to check the log file to find out which CVARs were not parsed.

Note: The TXE region binary contained in INT folder after image generation only contains the firmware default base settings for TXE region no Intel FIT customization is applied.

Note: Rebuilding an image requires access to some of the private keys used for SMIP signing in its initial creation.

3.3.20 Command Line Interface

Intel FIT supports command line options.

To view all of the supported options: Run the application with the -? option.

The command line syntax for Intel FIT is:

```
fit.exe [-exp] [-h|?] [-version|ver] [-b] [-o] [-f] [-me] [-bios]
[-pdr] [-bios_overlap] [-pmcp] [-ucode1] [-ucode2]
[-iunit] [-ufs_phy] [-sd_token] [-iafw_smip] [-pmc_smip]
[-smip_key] [-meu_path] [-st_path] [-st] [-w] [-s] [-d] [-u1] [-u2] [-u3]
[-i] [-flashcount] [-flashsize1] [-flashsize2] [-save]
```

Table 3-7. Intel FIT Command Line Options

Option	Description
-exp	Displays example usage of the tool
-H or -?	Displays the command line options.

Option	Description
-B	Automatically builds the flash image. The GUI does not appear if this flag is specified. This option causes the program to run in auto-build mode. If there is an error, a valid message is displayed and the image is not built. If a BIN file is included in the command line, this option decomposes it.
-O <file>	Path and filename where the image is saved. This command overrides the output file path in the XML file.
-f <file>	Specifies input file. XML, full image binary, or ME only binary.
-TXE <file>	Overrides the binary source file for the Intel® TXE Region with the specified binary file.
-BIOS <file>	Overrides the binary source file for the BIOS Region with the specified binary file.
-pdr	Overrides the binary source file for the PDR region
bios_overlap<true|false>	Overrides the Bios region overlap setting in the XML file.
-pmcp<file>	Overrides the binary source file for the PMCP region
-ucode1<file>	Overrides the binary source file for the uCode1 patch
-ucode2<file>	Overrides the binary source file for the uCode2 patch
-iunit<file>	Overrides the binary source file for the iUnit region
-ufs_phy<file>	Overrides the binary source file for the UFS PHY
-sd_token<file>	Overrides the binary source file for the Secure Debug Token
-iafw_smip<file>	Overrides the binary source file for the IAFW SMIP
-pmc_smip<file>	Overrides the binary source file for the PMC SMIP
-smip_key<file>	Overrides Key used to sign SMIP sub partition
-meu_path<path>	Overrides path to Manifest Extension Utility
-st_path<path>	Overrides path to Signing tool.
-st<OpenSSL | MobileSigningUtil>	Overrides signing tool setting
-W <path>	Overrides the working directory environment variable $WorkingDir. It is recommended that the user set these environmental variables first. (Suggested values can be found in the OEM Bringup Guide.)
-S <path>	Overrides the source file directory environment variable $SourceDir. It is recommended that the user set these environmental variables before starting a project.
-D <path>	Overrides the destination directory environment variable $DestDir. It is recommended that the user set these environmental variables before starting a project.
-U1 <value>	Overrides the $UserVar1 environment variable with the value specified. Can be any value required.
-U2 <value>	Overrides the $UserVar2 environment variable with the value specified. Can be any value required.

Option	Description
-U3 <value>	Overrides the $UserVar3 environment variable with the value specified. Can be any value required.
-I <enable|disable>	Enables or disables intermediate file generation.
-FLASHCOUNT <0, 1 or 2>	Overrides the number of flash components in the Descriptor Region. If this value is zero, only the Intel® TXE Region is built.
-FLASHSIZE1 <0, 1, 2, 3, 4, 5, 6 or 7>	Overrides the size of the first flash component with the size of the option selected as follows: 0 = 512KB 1 = 1MB 2 = 2MB 3 = 4MB 4 = 8MB 5 = 16MB 6 = 32MB 7 = 64MB
-FLASHSIZE2 <0, 1, 2, 3, 4, 5, 6 or 7>	Overrides the size of the first flash component with the size of the option selected as follows: 0 = 512KB 1 = 1MB 2 = 2MB 3 = 4MB 4 = 8MB 5 = 16MB 6 = 32MB 7 = 64MB
-Save <file>	Saves the XML file.

3.3.21 Example – Decomposing an Image and Extracting Parameters

The CVARS variables and the current value parameters of an image can be viewed by dragging and dropping the image into the main window, which then displays the current values of the image's parameters.

An image's parameters can also be extracted by entering the following commands into the command line:

```
fit.exe -f output.bin -save output.xml
```

This command would create a folder named "output". The folder contains the individual region binaries and the Map file.

The xml file contains the current Intel® TXE parameters.

The Map file contains the start, end, and length of each region.

Note: If using paths defined in the kit, be sure to put "" around the path as the spaces cause issues.

Note: The TXE override option changes the TXE base used on command line but still uses the values from the xml or binary passed in.

§ §

4 Flash Programming Tool

The FPT is used to program a complete SPI image into the SPI flash device(s).

On SPI flash only, FPT can program each region individually or it can program all of the regions with a single command. The user can also use FPT to perform various functions such as:

- View the contents of the flash on the screen.
- Write the contents of the flash to a log file.
- Perform a binary file to flash comparison.
- Write to a specific address block.

Note: For proper function in a Multi-SPI configuration the Block Erase, Block Erase Command and Chip Erase must all match.

On all flash types, the user can also use FPT to Program Named variables.

4.1 System Requirements

The EFI versions of FPT (**fpt.efi**) run on a 32-bit or 64-bit EFI environment. Ensure to take the respective binary from within the kit.

The Windows* versions (**fptw.exe and fptw64.exe**) run on a 32-bit or 64-bit EFI environment. The Windows* 64 bit version (fptw64.exe) is designed for running in native 64 bit OS environment which does not have 32 bit compatible mode available for example Windows*PE 64. Both versions require administrator privileges to run under Windows* OS. The user needs to use the **Run as Administrator** option to open the CLI.

FPT requires that the platform is bootable (i.e. working BIOS) and an operating system to run on. It is designed to deliver a custom image to a computer that is already able to boot and is not a means to get a blank system up and running. FPT must be run on the system with the flash memory to be programmed.

One possible workflow for using FPT is:

1. A pre-programmed flash with a bootable BIOS image is plugged into a new computer.
2. The computer boots.
3. FPT is run and a new IFWI image is written to flash.
4. The computer powers down.
5. The computer powers up, boots, and is able to access its Intel® TXE capabilities as well as any new custom BIOS features.

4.2 Microsoft Windows* Required Files

The Microsoft Windows* version of the FPT executable is **fptw.exe**. The following files must be in the same directory as **fptw.exe**:

- fparts.txt – contains a comma-separated list of attributes for supported flash devices. The text in the file explains each field. An additional entry may be required in this file to describe the flash part which is on the target system. Examine the target board before adding the appropriate attribute values. The supplied file is already populated with default values for SPI devices used with Intel CRBs.
- fptw.exe – the executable used to program the final image file into the flash.
- pmxdll.dll
- idrvdll.dll

In order for tools to work under the Windows* PE environment, you must manually load the driver with the .inf file in the Intel® TXE driver installation files. Once you locate the .inf file you must use the Windows* PE cmd `drvload HECI.inf` to load it into the running system each time Windows* PE reboots. Failure to do so causes errors for some features.

Table 4-1: FPT OS Requirements

FPT version	Target OS	Support Drivers
FPTw.EXE	Windows* 32 / 64 bit w/WOW64	idrvdll.dll, pmxdll.dll
FPTW64.EXE	Windows* Native 64 bit	idrvdll32e.dll, pmxdll32e.dll

Note: In the Windows* environment for operations involving global reset you should add a pause or delay when running FPTW using a batch or script file.

4.3 EFI Required Files

The EFI version of the FPT executable is **fpt.efi**. The following files must be in the same directory as **fpt.efi**:

- fparts.txt – contains a comma-separated list of attributes for supported flash devices. The text in the file explains each field. An additional entry may be required in this file to describe the flash part which is on the target system. Examine the target board before adding the appropriate attribute values. The supplied file is already populated with default values for SPI devices used with Intel CRBs.
- fpt.efi – the executable used to program the final image file into the flash. Before running fpt.efi, all the required files must be placed at root directory of the disk otherwise errors like "FPT is unable to find FPARTS.TXT "might be displayed.

4.4 Programming the Flash Device

Once the Intel® TXE is programmed, it runs at all times. Intel® TXE is capable of writing to the flash device at any time, even when the management mode is set to none and it may appear that no writing would occur.

4.5 Programming CVARS

FPT can program the CVARS and change the default values of the parameters. The modified parameters are used by the Intel® TXE FW after a global reset (Intel® TXE + HOST reset) or upon returning from a G3 state. CVARS can be programmed using getfile/setfile/CommitFiles APIs.

The variables can be modified individually or all at once via a text file.

Note: After setting CVARs, you need to call the –commit command to ensure they are committed. This is different to previous platforms.

Table 4-2. Named Variables Options

Option	Description
fpt.exe –CVARS	Displays a list of the supported manufacturing configurable named variables (CVARs).
fpt.exe –cfggen	Creates a list of blank CVARs in a text file that lets the user update multiple line configurable CVARS. The variables have the following format in the text file: CVAR name = value which will be used by setfile.
fpt.exe –U –N <CVAR name>	Accept the CVAR name
fpt.exe –IN <Text file>	Accepts cfggen file with values set and will use setfile to update

See Appendix A for a description of all the CVAR parameters.

4.6 Usage

The EFI and Windows* versions of the FPT can run with command line options.

To view all of the supported commands: Run the application with the -? option.

The commands in EFI and Windows* versions have the same syntax. The command line syntax for fpt.efi, fpt.exe and fptw.exe is:

```
FPT.exe [-H|?] [-VER] [-EXP] [-VERBOSE] [-Y] [-P] [-LIST] [-I] [-F]
[-ERASE] [-VERIFY][-NOVERIFY] [-D] [-DESC] [-BIOS] [-TXE] [-PDR]
[-B] [-E][REWRITE] [-ADDRESS|A] [-LENGTH|L]
[-CVARS] [-CFGGEN] [-U] [-O] [-IN] [-N][-V] [-CLOSEMNF] [-GRESET] [-PAGE]
[-SPIBAR] [-R] [-VARS] [-COMMIT] [-HASHED] [-FPFS] [-COMMITFPFS][-RPBIND]
[-GETPID]
```

Table 4-3. Command Line Options for fpt.efi, fpt.exe and fptw.exe

Option	Description
Help (-H, -?)	Displays the list of command line options supported by FPT tool.
-VER	Shows the version of the tools.
-EXP	Shows examples of how to use the tools.

Option	Description
-VERBOSE [<file>]	Displays the tool's debug information or stores it in a log file.
-Y	Bypasses Prompt. FPT does not prompt user for input. This confirmation will automatically be answered with "y".
-P <file>	Flash parts file. Specifies the alternate flash definition file which contains the flash parts description that FPT has to read. By default, FPT reads the flash parts definitions from fparts.txt.
-LIST	Supported Flash Parts. Displays all supported flash parts. This option reads the contents of the flash parts definition file and displays the contents on the screen.
-I	Info. Displays information about the image currently used in the flash.
-F <file> <NOVERIFY>	Flash. Programs a binary file into an SPI flash. The user needs to specify the binary file to be flashed. FPT reads the binary, and then programs the binary into the flash. After a successful flash, FPT verifies that the SPI flash matches the provided image. Without specify the length with –L option, FPT will use the total SPI size instead of an image size. The NOVERFY sub-option *must* follow the file name. This will allow flashing the SPI without verifying the programming was done correctly. The user will be prompted before proceeding unless '-y' is used.
-ERASE:	Block Erase. Erases all the blocks in a flash. This option does not use the chip erase command but instead erases the SPI flash block by block. This option can be used with a specific region argument to erase that region. This option cannot be used with the –f, -b, -c, -d or –verify options.
-VERIFY <file>:	Verify. Compares a binary to the SPI flash. The image file name has to be passed as a command line argument if this flag is specified.
-D <file> :	Dump. Reads the SPI flash and dumps the flash contents to a file or to the screen using the STDOUT option. The flash device must be written in 4KB sections. The total size of the flash device must also be in increments of 4KB.
-DESC:	Read/Write Descriptor region. Specifies that the Descriptor region is to be read, written, or verified. The start address is the beginning of the region.
-BIOS:	Read/Write BIOS region. Specifies that the BIOS region is to be read, written, or verified. Start address is the beginning of the region. Note that in APL platforms, the entire IFWI image resides in the BIOS region.
-TXE:	Read/Write Intel® TXE region. Specifies that the Intel® TXE region is to be read, written, or verified. The start address is the beginning of the region. Note that in APL platforms, the entire IFWI image resides in the BIOS region, and the TXE region in SPI is only used for TXE ROM Bypass code.

Option	Description
-PDR:	Read/Write PDR region. Specifies that the PDR region is to be read, written, or verified. The start address is the beginning of the region.
-B:	Blank Check. Checks whether the SPI flash is erased. If the SPI flash is not empty, the application halts as soon as contents are detected. The tool reports the address at which data was found.
-E:	Skip Erase. Does not erase blocks before writing. This option skips the erase operation before writing and should be used if the part being flashed is a blank SPI flash device.
-A<value>, -ADDRESS <value>	Write/Read Address. Specifies the start address at which a read, verify, or write operation must be performed. The user needs to provide an address. This option is not used when providing a region since the region dictates the start address.
-L <value>, LENGTH <value>	Write/Read Length. Specifies the length of data to be read, written, or verified. The user needs to provide the length. This option is not used when providing a region since the region/file length determines this.
-CVARS:	Lists all the current manufacturing line configurable variables.
-U:	Update. Updates the CVARs in the flash. The user can update the multiple FOVs by specifying their names and values in the parameter file. The parameter file must be in an INI file format (the same format generated by the –cfggen command). The -in <file> option is used to specify the input file.
-O <file>	Output File. The file used by FPT to output CVAR information.
-IN <file>	Input File. The file used by FPT for CVAR input. This option flag must be followed by a text file (i.e., fpt –u –in FPT.cfg). The tool updates the CVARs contained in the text file with the values provided in the input file. User can also use FPT –cfggen to generate this file.
-N <value>	Name. Specifies the name of the CVAR that the user wants to update in the image file or flash. The name flag must be used with Value (-v).
-V <value>	Value. Specifies the value for the CVAR variable. The name of variable is specified in the Name flag. The Value flag must follow the Name flag.
-CLOSEMNF <NO> <PDR>	End of Manufacturing. This option must be executed at the end of manufacturing. CloseMnf does the following: Commits all FPFs Sets SOC Config lock (SOC_Config_Lock FPF) Sets all 'Return to Factory Defaults' to default values Sets the Intel® TXE manufacturing mode done bit (Global Locked bit). For SPI, sets the master region access permission in the Descriptor region to its Intel-recommended value, and verifies that flash regions are locked.

Option	Description
	If the image was properly set before running this option, FPT skips all of the above and reports PASS. If anything was changed, FPT automatically forces a global reset. The user can use the no reset option to bypass the reset. If nothing was changed, based on the current setting, the tool reports PASS without any reset. The "NO" addition will prevent the system from doing a global reset following a successful update of the TXE Manufacturing Mode Done, the Region Access permissions, or both. The "PDR" addition will allow CPU\BIOS Read & Write access to the PDR region of flash. Note: This step is highly recommended to the manufacturing process. Not performing the proper end of manufacturing process would leave the platform with potential security/privacy risks. Important: Before using this option with Production MCP / FW verify that the values for PTT are correct in your image. Once this setting is used it will permanently commit the values into the Field Programmable Fuses and cannot be undone.
-GRESET <NO> :	Global Reset. FPT performs a global reset. On mobile platforms this includes driving GPIO30 low. Mobile platforms require a SUS Well power-down acknowledge-driven low before the global reset occurs or the platform may not boot up from the reset. The "NO" afterwards disables the driving of GPIO30 for mobile SKUs.
-CFGGEN	CVAR Input file generation option. This creates a file which can be used to update the line configurable CVARS.
-SPIBAR:	Display SPI BAR. FPT uses this option to display the SPI Base Address Register.
-R <name>	CVAR or FPF Read. FPT uses this option to retrieve value for a specific CVAR or FPF file name. The value of the variable is displayed. By default, all non- secure variables are displayed in clear-text and secure CVAR will be displayed in HASH. The -hashed option can be used to display the hash of a value instead of the clear-text value.
-VARS:	Display Supported Variables. FPT uses this option to display all variables supported for the -R and -COMPARE commands.
-COMMIT:	Commit. FPT uses this option to commit all setfile commands CVARs changes to CVAR and cause relevant reset accordingly If no pending variable changes are present, Intel® TXE does not reset and the tool displays the status of the commit operation.
-COMMITFPF	Commits CVAR values to FPF via firmware and prevents further modification of FPFs
-PAGE	Pauses the screen when a page of text has been reached. Hit any key to continue.

Option	Description
-HASHED:	Hash Variable Output. FPT uses this option to distinguish whether the displayed output is hashed by the FW. For variables that can only be returned in hashed form this option has no effect – the data displayed is hashed regardless.
-FPFS	Displays a list of the FPFs
-COMMITFPFS<name>	Commit the FPFs permanently into the MCP.
-REWRITE	Allows to rewrite the SPI with file data even if flash is identical.
-RPBIND	Bind RP
-GETPID	Retrieve the part id into a file

Table 4-4. FPT –closemnf Behavior

Condition before FPT -closemnf			Condition after FPT -closemnf			Other FPT Action	
Intel TXE Mfg Done bit set	Flash Access set to Intel rec values	Intel TXE Mfg Mode	Intel TXE Mfg Done bit set	Flash Access set to Intel rec values?	Intel TXE Mfg Mode	FPT return value **	Global Reset
No	No	Enabled	**Yes**	**Yes**	**Disabled**	0	Yes
No	Yes	Enabled	No	Yes	Enabled	1	No
Yes	No	Enabled	Yes	**Yes**	**Disabled**	0	Yes
Yes	Yes	Disabled	Yes	Yes	Disabled	0	No

** Return value 0 indicates successful completion. In the second case, FPT –closemnf returns 1 (= error) because it is unable to set the Intel TXE Mfg Done bit, because flash permissions are already set to Intel recommended values (host cannot access Intel TXE Region).

4.7 Fparts.txt File

The **fparts.txt** file contains a list of all SPI flash devices that are supported by FPT. The flash devices listed in this file must contain a 4KB erase block size. If the flash device is not listed, the user will receive the following error:

```
Intel (R) Flash Programming Tool. Version:  x.x.x.xxxx
Copyright (c) 2007-2014, Intel Corporation. All rights reserved.
Platform: Intel(R) Qxx Express Chipset
Error 75: ‘‘fparts.txt’’ file not found.
```

If the SPI flash device is not located in **fparts.txt**, the user is expected to provide information about the device, inserting the values into **fparts.txt** in same format as is used for the rest of the devices. Detailed information on how to derive the values in **fparts.txt** is found in the Apollo Lake SPI Programming Guide. The device must have a **4KB erase sector** and the total size of the SPI Flash device must be a multiple of 4KB. The values are listed in columns in the following order:

- Display name
- Device ID (2 or 3 bytes)

- Device Size (in bits)
- Block Erase Size (in bytes - 256, 4K, 64K)
- Block Erase Command
- Write Granularity (1 or 64)
- Unused

4.8 Examples

The following examples illustrate the usage of the EFI version of the tool (fpt.efi). The Windows* version of the tool (Fptw.exe) behaves in the same manner apart from running in a Windows* environment.

4.8.1 Complete SPI Flash Device Burn with Binary File

```
C:\ fpt.exe -f spi.bin

EFI:
>fpt.efi -f spi.bin or fs0:\>fpt.efi -f spi.bin
```

This command writes the data in the **spi.bin** file into a whole SPI flash from address 0x0

4.8.2 Dump full image

```
fpt.exe -d imagedump.bin
```

This command dumps the full image into the **imagedump.bin** file.

4.8.3 Display SPI Information

```
fptw.exe -I
```

This command displays information about the flash devices present in the computer. The base address refers to the start location of that region and the limit address refers to the end of the region. If the flash device is not specified in **fparts.txt**, FPT returns the error message "There is no supported SPI flash device installed".

4.8.4 Verify Image with Errors

```
fpt.exe -verify outimage.bin
```

This command compares the Intel® TXE region programmed on the flash with the specified FW image file **outimage.bin**. If the `-y` option is not used; the user is notified that the file is smaller than the binary image. This is due to extra padding that is added during the program process. The padding can be ignored when performing a comparison. The `-y` option proceeds with the comparison without warning.

4.8.5 Verify Image Successfully

```
fpt.exe -verify outimage.bin
```

This command compares **image.bin** with the contents of the flash. Comparing an image should be done immediately after programming the flash device. Verifying the contents of the flash device after a system reset results in a mismatch because Intel® TXE changes some data in the flash after a reset.

4.8.6 Get Intel® TXE settings

```
fpt.exe –r “Privacy/SecurityLevel”
```

Please note that only –r (get command) supports the –hashed optional command argument. When –hashed is used, variable value will be returned in hashed format, otherwise it will be returned in clear txt. There are a few exceptions in the case of variables PID and PPS, their value will be always returned in hashed format regardless –hashed is used or not. This is primarily because of security concern.

4.8.7 Compare Intel® TXE Settings

FPT –verbose –compare vars.txt compares variables with suggested values in vars.txt, and report result on the screen. Vars.txt can have the following data with verbose information: FPT –VARS can be used to get the VAR list for the platform and get the value/format from Intel FIT advanced mode. There are settings in the Intel® TXE which are stored encrypted. Users will not be able to compare them using clear text values. Please use FPT –R option to read the hash value of those settings and use them as baseline for the expected value.

4.8.8 CVAR Configuration File Generation (-cfggen)

It creates an input file which can be used to update CVARs. The file includes all the current CVAR. When creating the file, it extracts the fixed offset variables from flash. Note, the file generated will change every time the list of CVAR changes.

```
fpt.exe -cfggen [ -o <Output Text File> ][ options ]
```

```
        -o <Output File Name>    The desired name of the file
                                 generated.  If none is provided the
                                 default, fpt.cfg, will be used.
        -p < file name >         Alternate SPI Flash Parts list file.
        -page                    Pauses at screen / page / window
                                 boundaries.  Hit any key to continue.
        -Verbose [<file name>]   Displays more information.
        -y                       Will not pause to user input to
                                 continue
```

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5 Intel® TXEManuf and TXEManufWin

Intel® TXEManuf validates Intel® TXE functionality on the manufacturing line. It verifies that these components have been assembled together correctly.

The Windows* version of Intel® TXEManufWin (Intel® TXEManufWin) requires administrator privileges to run under Windows* OS. The user needs to use the **Run as Administrator** option to open the CLI.

Intel® TXEManuf validates all components and flows that need to be tested according to the FW installed on the platform in order to ensure the functionality of Intel® TXE applications: BIOS-FW, Flash, etc. This tool is meant to be run on the manufacturing line.

5.1 Windows* PE Requirements

In order for tools to work under the Windows* PE environment, you must manually load the driver with the .inf file in the Intel® TXEI driver installation files. Once you locate the .inf file you must use the Windows* PE cmd `drvload HECI.inf` to load it into the running system each time Windows* PE reboots. Failure to do so causes errors for some features.

5.2 How to Use Intel® TXEManuf

Intel® TXEManuf checks the FW SKU and runs the proper tests accordingly unless an option to select tests is specified.

Intel® TXEManuf is intelligent enough to know if it should run the test or report a result. If there is no test result available for an Intel® TXE enabled platform, TXEManuf calls the test. Otherwise, it reports the result or the failure message from the previous test.

Intel® TXEManuf tools report the result or cause a reboot. If there is a reboot, Intel® TXEManuf should be run again.

VSCCCOMMN.bin is required to verify the VSCC entry on the platform. This file must be in same folder as the TXEManuf executable or TXEManuf reports an error.

5.3 Usage

The DOS version of the tool can be operated using the same syntax as the Windows* version. The Windows* version of the tool can be executed by:

```
TXEManuf [-EXP] [-H|?] [-VER] [-TEST] [-S0]
         [-BISTRESULT] [-EOL] [-CFGGEN] [-F] [-VERBOSE] [-PAGE]
         [-ERRLIST] [-ALL][-NOISH] [-ISH]
```

Table 5-1: Options for the Tool

Option	Description
No option	Test result will be reported back right after the test is done and cleared. If BIST test result isn't displayed after BIST test is done, the tool needs to be run again (with or without any BIST related argument combinations) to retrieve the result, once test result is displayed, it will be cleared. Tool is capable of remembering whether/what tests (including host based tests) have been run from previous invocation. Host based tests will be run for all cases (whether it's retrieving test result or run the actual BIST).
-EXP	Shows examples of how to use the tools.
-H or -?	Displays the help screen.
-VER	Shows the version of the tools.
-TEST	Run full test
-S0	Run BIST test that does not require power cycle
-BISTRESULT	Returns last BIST results
-EOL <Var|Config> -F <filename>	This option runs several checks for the use of OEMs to ensure that all settings and configurations have been made according to Intel requirements before the system leaves the manufacturing process. The check can be configured by the customer to select which test items to run and their expected value (only applicable for Variable Values, FW Version, BIOS Version). The sub option config or var is optional. Using -EOL without a sub option is equivalent to the –EOL config. When –f flag is used along with a file name, the tool will load the file as the configuration file, instead of using TXEManuf.cfg.
-CFGGEN <filename>	Use this option along with a filename to generate a default configuration file. This file (with or without modification) can be used for the -EOL option. Rename it TXEManuf.cfg before using it. It is highly recommended to use this option to generate a new TXEManuf.cfg with an up-to-date variable names list before using the Intel® TXEManuf End-Of-Line check feature.
-F <filename>	Load customer defined .cfg file
-VERBOSE <file>	Displays the debug information of the tool or stores it in a log file.
–PAGE	When it takes more than one screen to display all the information, this option lets the user pause the display and then press any key to continue on to the next screen.
-ERRLIST <test name>	Return a list of available codes

Option	Description
-NOISH	This option will skip ISH tests
-ISH	This option will force ISH tests

5.3.1 Host-based Tests

1. TXE/BIOS VSCC validation, Intel® TXEManuf verifies that flash SPI ID on the system is described in VSCC table. If found, VSCC entry for relevant SPI part should match the known good values that pre-populated in the file.
2. Intel® TXE state check, Intel® TXEManuf verifies Intel® TXE is in normal state. This is done by checking the value of 4 fields (initialization state, mode of operation, current operation state, and error state) in FW status register1. If any of these fields indicates Intel® TXE is in abnormal state, Intel® TXEManuf will report error without running BIST test.

5.4 Intel® TXEManuf –EOL Check

TXEManuf `-EOL` check is used to give customers the ability to check Intel® TXE-related configuration before shipping. There are two sets of tests that can be run: variable check and configuration check. Variable check is very similar as FPT –compare option. Please refer that section.

5.4.1 TXEManuf.cfg File

The TXEManuf**.cfg** file includes all the test configurations for `TXEManuf -EOL` check. It needs to be at the same folder that TXEManuf is run. If there is no TXEManuf**.cfg** file on that folder, TXEManuf `-EOL config` runs the Intel recommended default check only.

The default xml configuration file can be created by running the –CFGGEN command.

Lines which start with // are comments. They are also used to inform users of the available test group names and the names of specific checks that are included in each test that Intel® TXEManuf recognizes.

To select which test items to run: Create a line that begins with SubTestName="<specific sub test name>".

5.4.2 TXEManuf –EOL Variable Check

TXEManuf `-EOL variable` check is designed to check the Intel® TXE settings on the platform before shipping. To minimize the security risk in exposing this in an end-user environment, this test is only available in Intel® TXE manufacturing mode or No EOP Message Sent.

NOTES: `–EOL Variable` check. The system must be in Intel® TXE manufacturing mode when `–EOL Variable` check is run or No EOP Message Sent.

5.4.3 TXEManuf –EOL Config Check

TXEManuf `-EOL Config` check is designed to check the Intel® TXE-related configuration before shipping. Running Intel-recommended tests before shipping is highly recommended.

Table 5-2: TXEManuf - EOL Config Tests

Test	Expected Configuration
EOP status check	Enabled
Intel® TXE VSCC check	Set according to the Intel-recommended value
BIOS VSCC check	Set according to the Intel-recommended value
Intel® TXE Manufacturing Mode status	Disabled
Flash Region Access Permissions	Set according to the Intel-recommended value

Note: `-EOL Config` check. If the system is in Intel® TXE manufacturing mode when

`-EOL Config` check is run there will be an error report or No EOP Message Sent.

5.4.4 Output/Result

The following test results can be displayed at the end-of-line checking:

- Pass – all tests passed
- Pass with warning – all tests passed except the tests that were modified by the customer to give a warning on failure. (This modification does not apply to Intel-recommended tests
- Fail with warning - all tests passed except some Intel-recommended tests that were modified by the customer to give a warning on failure.
- Fail - any customer-defined error occurred in the test.

5.5 Examples

5.5.1 Example for Consumer Intel® TXE FW SKU

```
TXEManuf -verbose


   Intel(R) TXEManuf Version: 3.0.0.1044
   Copyright(C) 2005 - 2015, Intel Corporation. All rights reserved.

   FW Status Register1: 0x82000255
   FW Status Register2: 0x80100000
   FW Status Register3: 0x30550607
   FW Status Register4: 0x00080000
   FW Status Register5: 0x80018001
   FW Status Register6: 0x00000000
```

```
  CurrentState:                         Normal
  ManufacturingMode:                    Enabled
  FlashPartition:                       Valid
  OperationalState:                     CM0 with UMA
  InitComplete:                         Complete
  BUPLoadState:                         Success
  ErrorCode:                            No Error
  ModeOfOperation:                      Normal
  SPI Flash Log:                        Not Present
  Phase:                                Maestro
  TXE File System Corrupted:            No
  FPF and TXE Config Status:            Not committed

FW Capabilities value is 0xFBA200
Feature enablement is 0xFBA200
Platform type is 0x2000441
Feature enablement is 0x71101840
TXE initialization state valid
TXE operation mode valid
Current operation state valid
TXE error state valid
MFS is not corrupted
PCH SKU Emulation is correct

Request Intel(R) TXE BIST status command... done

Get Intel(R) TXE test data command... done

Get Intel(R) TXE test data command... done
Total of 7 Intel(R) TXE test result retrieved


Policy Kernel - Boot Guard : Self Test - Passed
Policy Kernel - Embedded Controller : Power source type - Passed
MCA - MCA Tests : Blob - Passed
MCA - MCA Tests : MCA Manuf - Passed
VDM - General : VDM engine - Passed
Policy Kernel - ME Password : Validate MEBx password - Passed

Clear Intel(R) TXE test data command... done




TXEManuf Operation Passed
```

6 Intel® TXEInfo

TXEInfoWin and Intel® TXEInfo provide a simple test to check whether the Intel® TXE FW is alive. Both tools perform the same test; query the Intel® TXE FW– and retrieve data.

Table 18 contains a list of the data that each tool returns.

The Windows* version of TXEInfo (TXEInfoWin) requires administrator privileges to run under Windows* OS. The user needs to use the Run as Administrator option to open the CLI.

6.1 Windows* PE Requirements

In order for tools to work under the Windows* PE environment, you must manually load the driver with the .inf file in the Intel® TXEI driver installation files. Once you locate the .inf file you must use the Windows* PE cmd `drvload HECI.inf` to load it into the running system each time Windows* PE reboots. Failure to do so causes errors for some features.

6.2 Usage

The executable can be invoked by:

```
TXEInfo.exe [-EXP] [-H|?] [-VER] [-FITVER] [-FEAT]
            [-VALUE] [-FWSTS] [-VERBOSE] [-PAGE] [-NOISH] [-ISH]
```

Table 6-1. Intel® TXEInfo Command Line Options

Option	Description
-FEAT < name> -VALUE <value>	Compares the value of the given feature name with the value in the command line. If the feature name or value is more than one word, the entire name or value must be enclosed in quotation marks. If the values are identical, a message indicating success appears. If the values are not identical, the actual value of the feature is returned. Only one feature may be requested in a command line.
-FITVER	Displays Intel FIT version information
-FEAT <name>	Retrieves the current value for the specified feature. If the feature name is more than one word, the entire feature name must be enclosed in quotation marks. The feature name entered must be the same as the feature name displayed by Intel® TXEINFO. Intel® TXEINFO can retrieve all of the information detailed below. However, depending on the SKU selected, some information may not appear. **Note:** For the EFI shell version you need to add additional "^" to enclose the text string in order for it to be properly parsed. **Example:** TXEINFO.efi –feat "^"BIOS boot state"^"

Option	Description
–FWSTS	Decodes the Intel® TXE FW status register value field and breaks it down into the following bit definitions for easy readability: FW Status Register1: 0x1E000255 FW Status Register2: 0x69000006 CurrentState: Normal ManufacturingMode: Enabled FlashPartition: Valid OperationalState: CM0 with UMA InitComplete: Complete BUPLoadState: Success ErrorCode: No Error ModeOfOperation: Normal
-VERBOSE <filename>	Turns on additional information about the operation for debugging purposes. This option has to be used together with the above mentioned option(s). Failure to do so generates the error: "Error 9254: Invalid command line option". This option works with no option and `–feat`.
-H or -?:	Displays the list of command line options supported by the Intel® TXEINFO tool.
-VER	Shows the version of the tools.
- PAGE	When it takes more than one screen to display all the information, this option lets the user pause the display and then press any key to continue on to the next screen.
-EXP	Shows examples about how to use the tools.
-ISH	This shows ISH information Using the combination flags –ISH –fwstat you can retrieve the ISH firmware status
-NOISH	Do not display any information related to ISH
No option:	If the tool is invoked without parameters, it reports information for all components listed in Table 6-2 below for full SKU FW.

Table 6-2. List of Components that Intel® TXEINFO Displays

Feature Name	Feature Data Source (Intel® TXE Kernel/SW/ Other)	Specific Feature Dependency	Field Value
Tools Version	SW (Intel® TXEInfo)	N/A	Version string Example: 11.x.y.ZZZZ; where x=minor, y = HF/MR, ZZZZ = Build Number.
VendorID	Intel® TXE Kernel	N/A	A number (in Hex)
PCH Version	Intel® TXE Kernel	N/A	A version string

Feature Name	Feature Data Source (Intel® TXE Kernel/SW/ Other)	Specific Feature Dependency	Field Value
FW Version	Intel® TXE Kernel	N/A	Version string 11.x.y.ZZZZ; where x=minor, y = HF/MR, ZZZZ = Build Number.
Intel® TXE Driver version*	Other (Reading Windows* registry entries	Only when Windows* Intel® TXE driver is installed	A version string
IFWI Module Version	Intel® TXE Kernel	N/A	A version string
Number of IFWI Modules	Intel® TXE Kernel	N/A	A number
IFWI Module Name	Intel® TXE Kernel	N/A	A string
FW Capabilities	Intel® TXE Kernel	N/A	Combination of feature name list breakdown (with a Hexadecimal value) *This is a display of the Feature State for the Intel® TXE. Is enabled / disabled on the system. Each bit in the value represents a feature state.
Last Intel® TXE Reset Reason	Intel® TXE Kernel	N/A	Power up/ Firmware reset/ Global system reset/ Unknown
BIOS Lock	Other (Directly reading from SPI)	N/A	Enabled/Disabled/ Unknown If shown as enabled, both FLOCKDN for BIOS are set. If shown as disabled, either/all FLOCKDN for BIOS are not set.
Host Read Access to Intel® TXE	Other (Directly reading from SPI)	N/A	Enabled/Disabled/ Unknown
Host Write Access to Intel® TXE	Other (Directly reading from SPI)	N/A	Enabled/Disabled/ Unknown
SPI Flash ID	Other (Directly reading from SPI)	Only when there are SPI flash parts HW installed	A JEDEC ID number (in Hex)
TXE/BIOS VSCC register values	Other (Directly reading from SPI)	Only when there are flash parts HW installed	A 32bit VSCC number (in Hex)

Feature Name	Feature Data Source (Intel® TXE Kernel/SW/ Other)	Specific Feature Dependency	Field Value
BIOS Boot State	Intel® TXE Kernel	N/A	Pre Boot/ In Boot/ Post Boot
Capability Licensing Service	Intel® TXE Kernel	Not shown unless Fw feature capability supports it	Enabled/Disabled
OEM Tag	Intel® TXE Kernel	N/A	A 32bit Hexadecimal number
Report on Revenue Sharing ID Fields	Intel® TXE Kernel Firmware Host Interface	N/A	3 slot of 32-bit integer values (in Hex)
FWSTS	Intel® TXE Kernel	N/A	Two 32bit Hexadecimal numbers and their bit definition breakdown
OEM Public Key Hash FPF	Intel® TXE Kernel	BIOS	Yes / No
OEM Public Key Hash TXE	Intel® TXE Kernel	BIOS	SHA-256bit Hash entry
ACM SVN FPF	Intel® TXE Kernel	BIOS	
KM SVN FPF	Intel® TXE Kernel	BIOS	
BSMM SVN FPF	Intel® TXE Kernel	BIOS	
GuC Encryption Key TXE	Intel® TXE Kernel	BIOS	256-bit string
Protect BIOS Environment	Intel® TXE Kernel	BIOS	Yes / No
CPU Debugging	Intel® TXE Kernel	BIOS	Enabled / Disabled
BSP Initialization	Intel® TXE Kernel	BIOS	Enabled / Disabled
Measured Boot	Intel® TXE Kernel	BIOS	Yes / No
Verified Boot	Intel® TXE Kernel	BIOS	Yes / No
Key Manifest ID	Intel® TXE Kernel	BIOS	Hash of Public Key to verify Boot Policy Manifest
PTT	Intel® TXE Kernel	BIOS	Enabled / Disabled
EK Revoke	Intel® TXE Kernel	BIOS	Revoked / Not Revoked
Integrated Sensor Solution FW State	ISH	ISH Firmware	Responding / Not Responding
FW Status	ISH	ISH Firmware	Sensors Apps Responding / Sensor Apps Not Responding

Feature Name	Feature Data Source (Intel® TXE Kernel/SW/ Other)	Specific Feature Dependency	Field Value
Integrated Sensor Solution FW Version	ISH	ISH Firmware	Version string
Module Status	ISH	ISH Firmware	Module x Status: Loaded / Not Loaded
Extended Modules FW Status	ISH	ISH Firmware	Version string
Extended Modules FW Versions	ISH	ISH Firmware	Version string
HECI Driver Version	ISH	ISH Firmware	Version string
PCI Bus Driver Version	ISH	ISH Firmware	Version string
Integrated Sensor Solution Driver Version	ISH	ISH Firmware	Version string
Sensors Information	ISH	ISH Firmware	Information on the various Sensors configured on the platform.

6.3 Examples

This is a simple test that indicates whether the FW is alive. If the FW is alive, the test returns device-specific parameters. The output is from the Windows* version.

6.3.1 Intel® TXE FW SKU

```
TXEINFOWIN.exe


Intel(R) TXEInfo Version: 3.0.0.1044
Copyright(C) 2005 - 2015, Intel Corporation. All rights reserved.



Intel(R) TXE code versions:

BIOS Version                                 APLK_IFWI_X64_R_2015_39_4_00
Vendor ID                                    8086
PCH Version                                  3
FW Version                                   3.0.0.1044 Unknown
TXEI Driver Version                          3.0.0.1044
IFWI Module Version                          3.0.0.1044
Number of IFWI Modules                       0
IFWI Module Name

FW Capabilities                              0x71101840

    Intel(R) Capability Licensing Service - PRESENT/ENABLED
    Protect Audio Video Path - PRESENT/ENABLED
    Intel(R) Dynamic Application Loader - PRESENT/ENABLED
    Service Advertisement & Discovery - PRESENT/ENABLED
    Intel(R) Platform Trust Technology - PRESENT/ENABLED

TLS                                          Disabled
Last TXE reset reason                        Power up
BIOS Config Lock                             Disabled
Host Read Access to TXE                      Enabled
Host Write Access to TXE                     Enabled
Host Read Access to EC                       Disabled
Host Write Access to EC                      Disabled
SPI Flash ID 1                               EF6018
SPI Flash ID 2                               Unknown
BIOS boot State                              Post Boot
Capability Licensing Service                 Enabled
OEM Tag                                      0x00000000
Slot 1 Board Manufacturer                    0x00000000
Slot 2 System Assembler                      0x00000000
Slot 3 Reserved                              0x00000000
M3 Autotest                                  Disabled
EPID Group ID                                0x4DC
Replay Protection                            Not Supported
Replay Protection Counters                   0
Storage Device Type                          SPI
OEM Public Key Hash FPF                      Not set
OEM Public Key Hash TXE                      Not set
ACM SVN FPF                                  Not set
KM SVN FPF                                   Not set
BSMM SVN FPF                                 Not set
GuC Encryption Key FPF                       Not set
GuC Encryption Key TXE                       Not set

                                             FPF            TXE
                                             ---            --
Protect BIOS Environment                     Not set        Not set
CPU Debugging                                Not set        Not set
BSP Initialization                           Not set        Not set
Measured Boot                                Not set        Not set
Verified Boot                                Not set        Not set
Key Manifest ID                              Not set        Not set
Enforcement Policy                           Not set        Not set
PTT                                          Not set        Not set
EK Revoke State                              Not set
```

6.3.2 Retrieve the Current Value of the Flash Version

```
C:\ TXEINFO.exe -feat "BIOS boot state"
Intel(R) TXEInfo Version: 3.0.0.1044
Copyright(C) 2005 - 2015, Intel Corporation. All rights reserved.

BIOS boot State: Post Boot
```

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7 Intel® Platform Flash Tool

The Platform Flash Tool is included with a dedicated installer in the firmware kit. It includes its own documentation, covering usage of DnX to flash firmware on eMMC and UFS flash devices, as well as secure token creation.

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8 Intel® Manifest Extension Utility (MEU)

8.1 Introduction

This chapter covers in detail the usage of the Intel Manifest Extension Utility (MEU).

Intel MEU is a tool used to generate various binaries containing manifests which will be validated by the TXE FW. Intel MEU can call an external signing tool, such as OpenSSL, to sign the manifests in the final binary.

Depending on the binary type being generated, the contents may be stitched into an IFWI image using the Intel Flash Image Tool (Intel FIT), or the contents may be passed to the TXE FW at runtime by a driver. Intel FIT may also call Intel MEU to add a signed manifest to a binary it is generating.

The usage flow of the Intel MEU to add manifests, sign binaries, and build images for the Apollo Lake platforms is explained in the Apollo Lake Signing and Manifesting Guide.

8.2 Intel MEU XML

When generating a binary, Intel MEU consumes two XML files. One is for tool configuration, the other is used to configure the binary being generated.

This section describes the requirements associated with these XML files.

Each XML file has a root node which tells the tool what type of XML file this is. For example, the Intel MEU configuration XML contains **MeuConfig** as the root node:

```
<?xml version="1.0" encoding="utf-8"?>

<MeuConfig version="2.3">

    ...

</MeuConfig>
```

The root node also contains a **version** attribute. Intel MEU will use the value to detect if the XML was generated with an older and incompatible version of MEU.

Underneath the root node, there will be config nodes, these may be grouped into sections, for example:

```
<VersionExtraction>
```

```
    <Enabled value="false" value_list="true,,false" help_text="If 
enabled, the version details will be extracted from the InputFile 
binary at the offsets specified. If disabled, the version must be 
specified manually.">

    <InputFile value="" help_text="Binary file from which to 
extract the version details.">

    ...

</VersionExtraction>
```

The config nodes may have multiple attributes, in general only the **value** attribute is looked at by the tool, while the other attributes are for the user's information:

- **value** - Used to configure a value for the given setting. If the setting is an enum, the value must match one of the values in value_list. If the setting is a number the value may be entered in decimal (256) or by hex using a 0x prefix (0x100).
- **value_list** - Contains a double-comma separated list of valid values.
- **help_text** - Contains details for the user regarding how to configure the setting.

8.3 Intel MEU Configuration

Intel MEU uses XML configuration file that is used to configure the signing and compression utilities as well as some user variables. The config file is not visible upon installation, but needs to be generated by the user. The config file template, meu_config.xml, can be generated by the tool with the following command:

```
C:\meu\meu.exe -gen meu_config
```

By default, the tool will look for meu_config.xml in the same folder as the meu.exe executable, but this can be overridden using a command line option.

8.3.1 Signing Tool Configuration

The following XML block is used in the meu_config.xml to configure the signing utility:

```
<SigningConfig>

    <SigningTool value="OpenSSL" 
value_list="Disabled,,OpenSSL,,MobileSigningUtil">

    <SigningToolPath value="$UserVar1/openssl/openssl.exe">

    <PrivateKeyPath value="$SourceDir/keys/dbg_priv_key.pem">

    <SigningToolXmlPath value="">

    <SigningToolExecPath value="">

</SigningConfig>
```

- **SigningTool** - Select the tool to use for signing. Currently, Intel MEU only supports OpenSSL.
- **SigningToolPath** - The path to the signing tool binary file.
- **PrivateKeyPath** - The path to the private key file (in PEM format) to use for signing.
- **SigningToolXmlPath** Leave blank.
- **SigningToolExecPath** Configures the path to execute the signing tool from. If left blank, the current working directory will be used. This can be useful if relative paths are used in the Signing Tool XML file.

Intel MEU does not come with the OpenSSL command line utility, and it must be installed separately. One source for OpenSSL binaries is Shining Light Productions, the "Light" version is sufficient.

8.3.2 LZMA Compression Tool

TXE FW supports handling of compressed modules. This functionality is currently available for the Integrated Sensor Hub Code Partition (ISH). The manifest tool must be configured with the path to the compression utility, which is usually distributed with the tool. If LZMA compression is not needed, this path can be left blank.

```
<CompressionConfig label="Compression Configuration">

    <LzmaToolPath value="$UserVar1/ftool/lzma.exe" label="LZMA
Tool Path">

</CompressionConfig>
```

8.3.3 User Path Variables

Intel MEU allows the use of User Path Variables to allow the XML to be more flexible. These variables can be configured in the meu_config.xml or by using command line options.

```
<PathVars label="Path Variables">

    <WorkingDir value="./" label="$WorkingDir" help_text="Path
for environment variable $WorkingDir">

    <SourceDir value="./" label="$SourceDir" help_text="Path for
environment variable $SourceDir">

    <DestDir value="./" label="$DestDir" help_text="Path for
environment variable $DestDir">

    <UserVar1 value="./" label="$UserVar1" help_text="Path for
environment variable $UserVar1">

    <UserVar2 value="./" label="$UserVar2" help_text="Path for
environment variable $UserVar2">
```

```
    <UserVar3 value="./" label="$UserVar3" help_text="Path for environment variable $UserVar3">

</PathVars>
```

These variables can be substituted in a configuration xml node's value and will be replaced by the variable's value at build time. For example when configuring the OpenSSL path, we can use $UserVar1:

```
<SigningToolPath value="$UserVar1\openssl.exe">
```

And, then if the tool is run with the -u1 switch:

```
C:\meu\meu.exe -f <input xml> -u1 "c:\openssl\bin"
```

Intel MEU will look for OpenSSL at the path "c:\openssl\bin\openssl.exe".

Although some of these variables are named (i.e. SourceDir), the tool will not actually search in this path, for a given source/input file, unless "$SourceDir" is contained in the corresponding xml configuration xml node's value.

8.4 Supported Binary Formats

This section describes the binary formats supported by Intel MEU.

8.4.1 Binary Types

Intel MEU generates template XML configuration files for each binary format. To get a complete list of templates Intel MEU can generate, use the following command:

```
C:\meu\meu.exe -binlist
```

To generate an XML template use the following command:

```
C:\meu\meu.exe -gen <Binary Type> -o <output.xml>
```

This is the table of supported binaries for OEM usage:

Binary Type	Usage
CodePartition	ISH
CodePartitionMeta	iUnit, Audio (aDSP)
Bios	IAFW (BIOS) Image
OEMKeyManifest	OEM Key Manifest Extension
DnxRecoveryImage	DnX IFWI Image
OEMUnlockToken	OEM Unlock Token

8.4.2 Example: OEM Key Manifest Creation

To Generate the OEM Key Manifest XML template, run the following command:

```
    C:\meu>meu -gen OEMKeyManifest -o OEMKeyManifest.xml
```

```
=================================================================

Intel(R) Manifest Extension Utility. Version: 3.0.0.1029

Copyright (c) 2013 - 2015, Intel Corporation. All rights
reserved.

8/12/2015 - 3:58:35 pm

=================================================================

Command Line: meu -gen OEMKeyManifest -o OEMKeyManifest.xml

Saving XML ...

XML file written to OEMKeyManifest.xml
```

To build the OEM Key manifest, edit the XML configuration file generated in the previous step to ensure all of its fields include correct data

```
    C:\meu\meu.exe -f M:/fw/build/meu/OEMKeyManifest.xml \

                         -o M:/fw/bin /OEMKeyManifest.bin \

                         -s M:/fw/build  \

                         -mnver 3.0.0.7005 \

                         -u1 M:/fw/tools
```

8.5 Creating a Public Key Hash:

Intel MEU supports creation of a public key hash, which is a binary file containing the hash of the public key’s modulus and exponent in little endian format, in one of 3 different ways:

1. Extraction from an already signed binary:

```
# meu.exe -keyhash <output hashfile> -f <input.bin>
```

2. Extraction from a public or private key in PEM format

```
# meu.exe -keyhash <output hashfile> -key <inputkey.pem>
```

3. Creation when building or signing a binary

```
# meu.exe -keyhash <output hashfile> -f <input.xml> -o <output.bin>
```

The public key hash is a readable string, and can be copied and pasted from the text file as needed.

8.5.1 Example: Key Hash Generation

To generate a public key hash from a signed binary:

```
# meu.exe -keyhash temp/hash -f iunp.bin

=========================================================================

Intel(R) Manifest Extension Utility. Version: 3.0.0.1048

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10/29/2015 - 10:10:24 am

=========================================================================


Command Line: meu -keyhash temp/hash -f iunp.bin

Log file written to meu.log

Loading XML file: C:/Users/meu_config.xml

Public Key Hash Value:

  14 05 A8 A4 EB 1C 8A C2 51 19 7D 85 96 14 09 FF 15 FD CD 23 D3 25 CC DD
88 D2 17 5C DE 3B 27 36


Public Key Hash Saved to:

  temp\hash.bin

  temp\hash.txt

Program terminated.
```

8.6 Decomposing a Binary

Intel® MEU is able to decompose a manifested and signed binary, to return it to the original state it was in before Intel MEU added a manifest and/or signature, together with an xml detailing the decomposition. This xml can later be used as input to Intel®

MEU to recreate the full binary with manifest and signature. The –decomp command also requires the binary type as its first parameter. So, for example, to decompose a BIOS binary, you can call:

```
# meu -decomp BIOS -f <input.bin> –save <decomp.xml>
```

8.7 Resigning a Binary

Intel® MEU is able to resign a binary that has already been signed. This is very useful when changing the signing keys – the relevant binary files just need to be resigned.

```
# meu.exe -resign -f <input.bin> -o <output.bin> -key <privatekey.pem>
```

It is only necessary to override the private key for signing (as in the example) if the key is different to that defined in the default Intel® MEU configuration xml.

Some binaries – such as full IFWI images, include multiple manifests. When calling the –resign option on such binaries, you need to include the index of the manifest to be resigned, or 'all' if all are to be resigned (using the new key). If the index, or 'all' is not included, Intel® MEU will show a full list of the manifests included in the binary:

```
More than one manifest was found in this file. Please provide a comma-
separated list of the manifest indices you want to resign. (ex. -resign
"0,3,5") or specify "all" (ex. -resign all)

The following manifests were detected:

  Index | Offset      | Size        | Name (if available)

  ----------------------------------------------

      0 | 0x000002058 | 0x000000378 | SMIP.man

      1 | 0x000006058 | 0x000000378 | RBEP.man

      2 | 0x00000E088 | 0x0000003E0 | PMCP.man

      3 | 0x00001C130 | 0x000000D6C | FTPR.man

      4 | 0x00006F000 | 0x0000002EC | rot.key

      5 | 0x000072CD0 | 0x0000003B8 | oem.key

      6 | 0x000077070 | 0x0000002EC | IBBP.man

      7 | 0x0000D1058 | 0x000000378 | ISHC.man

      8 | 0x0001116E8 | 0x0000011B0 | NFTP.man

      9 | 0x0005C2070 | 0x000000378 | IUNP.man
```

The Intel® MEU can then be called again, including the index desired. Following the above example, if the SMIP is to be resigned, call:

```
# meu.exe –resign 0 -f <input.bin> –o <output.bin> -key <privatekey.pem>
```

8.8 Exporting a Manifest

Intel® supports exporting the manifest(s) from a binary. This can be useful if a user wishes to sign them using a different application (i.e. not OpenSSL), or send them to a signing server to be signed.

Use the MEU –export function to export the manifest. The manifest is exported to a directory.

```
# meu -export -f <binary.bin> -o <directory_containing_manifests>
```

If the binary includes multiple manifests, you need to give the index of the desired manifest, e.g.

```
# meu -export 0 -f <binary.bin> -o <directory_containing_manifests>
```

If you do not supply an index, or include all with the –export flag, Intel® will output a list of all the manifests, including their indices:

```
More than one manifest was found in this file. Please provide a comma-
separated list of the manifest indices you want to export. (ex. -export
"0,3,5") or specify "all" (ex. -export "all")

The following manifests were detected:

  Index | Offset      | Size        | Name (if available)

  ----------------------------------------------

      0 | 0x000001130 | 0x000000D9C | FTPR.man

      1 | 0x000053000 | 0x000000330 | rot.key

      2 | 0x000094058 | 0x000000378 | RBEP.man

      3 | 0x0000A1748 | 0x000001280 | NFTP.man

      4 | 0x0001A2058 | 0x000000378 | DNXP.man

Error 26: Failed to export manifest(s). Missing manifest indices list.
```

8.9 Importing a Manifest

Use the MEU –import function to import the signed manifest back into the binary. The signed manifest must be in a separate directory, which is passed as an input parameter. If the binary supports multiple manifests (e.g. a full IFWI binary), and the folder has multiple manifests, the command will be able to import them all back into the binary.

```
# meu.exe -import <directory_containing_manifests> -f <input_binary.bin>
-o <output_binary.bin>
```

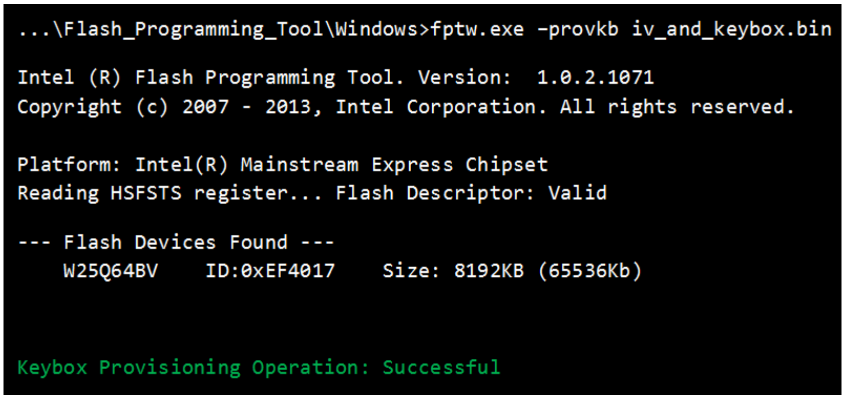
8.10 Command Line Options

Command Line Option	Description
exp	Display example usage of this tool.
h | ?	Display help screen.
version | ver	Display version of the tool.
verbose | v	Log verbose messages.
binlist	Displays a list of supported binary types
o	Overrides the output file path.
f	Specifies input file. XML, full image binary, or ME only binary.
gen	Specifies the type of XML template to generate.
cfg	Overrides the path to the tool config XML file.
decomp	Specifies the binary type to use for decomposition.
save	Overrides the output XML path
w	Overrides the $WorkingDir environment variable.
s	Overrides the $SourceDir environment variable.
d	Overrides the $DestDir environment variable.
u1	Overrides the $UserVar1 environment variable.
u2	Overrides the $UserVar2 environment variable.
u3	Overrides the $UserVar3 environment variable.
mnver	Overrides the version of the output binary.
mndebug	Overrides the debug flag in the output binary's manifest(s)
st	Overrides SigningTool in the tool config XML file
stp	Overrides SigningToolPath in the tool config XML file
key	Overrides the signing key in the XML file.
noverify	Skips verification of generated manifest signature
keyhash	Exports the public key hash to a directory
resign	Resigns manifest(s) in a binary
export	Exports manifest(s) from a binary
import	Imports manifest(s) into a binary

§ §

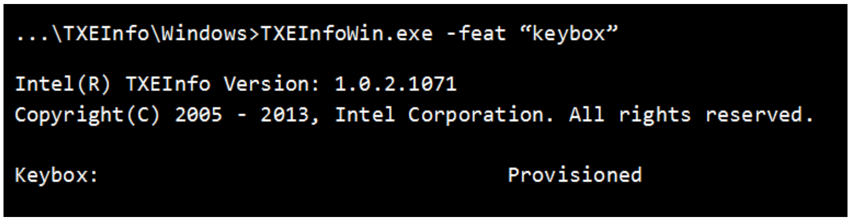
9 Widevine* KeyBox Provisioning Procedure

1. Provision Widevine using IV (Initialization Vector) and encrypted KeyBox file (refer to Chapter 8 - **Error! Reference source not found.**, for files creation procedure)
   - Run FPT –provkb <iv_and_keybox.bin>



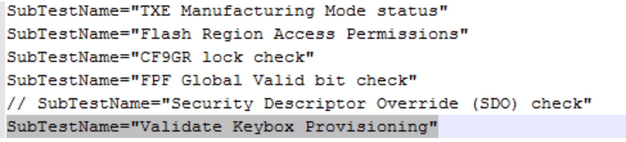
```
...\Flash_Programming_Tool\Windows>fptw.exe -provkb iv_and_keybox.bin

Intel (R) Flash Programming Tool. Version:  1.0.2.1071
Copyright (c) 2007 - 2013, Intel Corporation. All rights reserved.

Platform: Intel(R) Mainstream Express Chipset
Reading HSFSTS register... Flash Descriptor: Valid

--- Flash Devices Found ---
    W25Q64BV     ID:0xEF4017     Size: 8192KB (65536Kb)


Keybox Provisioning Operation: Successful
```

2. Optional: Verify that the Widevine device has been properly provisioned
   - Run: TXEInfo –feat "keybox"



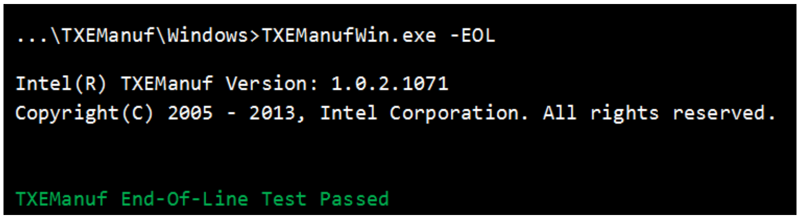
```
...\TXEInfo\Windows>TXEInfoWin.exe -feat "keybox"

Intel(R) TXEInfo Version: 1.0.2.1071
Copyright(C) 2005 - 2013, Intel Corporation. All rights reserved.

Keybox:                                    Provisioned
```

3. After properly closing manufacturing (using FPT-closemnf), run TXEManuf EOL Testing.
   Edit TXEManuf.cfg file in EOL section
   - Uncomment "SubTestName "Validate Keybox Provisioning"" test in order to include WV Provisioning Test check



```
SubTestName="TXE Manufacturing Mode status"
SubTestName="Flash Region Access Permissions"
SubTestName="CF9GR lock check"
SubTestName="FPF Global Valid bit check"
// SubTestName="Security Descriptor Override (SDO) check"
SubTestName="Validate Keybox Provisioning"
```

   - Run TXEManuf –EOL



```
...\TXEManuf\Windows>TXEManufWin.exe -EOL

Intel(R) TXEManuf Version: 1.0.2.1071
Copyright(C) 2005 - 2013, Intel Corporation. All rights reserved.


TXEManuf End-Of-Line Test Passed
```

Appendix A Intel® TXE CVARs

This appendix only covers fixed offset variables that are directly available to FPT and FPTW. A complete list of CVARs can be found in the *Firmware Variable Structures for Intel® Management Engine*. All of the fixed offset variables have an ID and a name. The `-CVAR` option displays a list of the IDs and their respective names. The variable name must be entered exactly as displayed below.

This table is for reference use only and will be updated later.

Table 20: CVARs Descriptions

<table>
<tr><th>Fixed Offset Name</th><th>FPT ID</th><th>Fixed Offset ID</th><th>Description</th><th>Data Length (in Bytes)</th><th>Expected Value</th><th>Secure</th><th>Reset Type</th></tr>
<tr><td colspan="8"><b>Non-Application Specific Fixed Offset Item Descriptions</b></td></tr>
<tr><td>OEMSkuRule</td><td>7</td><td>0x000A</td><td>UINT32 (little endian) value. This controls what features are permanently disabled by OEM.
<b>Notes:</b>
<b>There are reserved bits that the must not be changed for proper platform operation. The user should only modify the bit(s) for the feature(s) they wish to change. There is NO ability to change features one at a time. This CVAR sets OEM Permanent Disable for ALL features. In addition prior updating or changing any of available settings it is highly recommended that the user first retrieves the current OEM Sku Rule and toggling only the desired bits, and then resave them.</b>
This will not enable functionality that is not capable of working in the target hardware SKU. Please see the respective Firmware Bring-up Guide for a list of what features are capable with what firmware bundle and Hardware SKU of Intel 9 Series Chipset.</td><td>4</td><td>Feature Capable: 1
Feature Permanently disabled: 0
<table>
<tr><th>Bit</th><th>Description</th><th>Notes</th></tr>
<tr><td>31</td><td>Near Field Communication</td><td>1</td></tr>
<tr><td>30</td><td>Reserved</td><td></td></tr>
<tr><td>29:22</td><td>Reserved</td><td></td></tr>
<tr><td>21</td><td>TLS</td><td></td></tr>
<tr><td>20</td><td>DAL</td><td></td></tr>
<tr><td>19</td><td>Reserved</td><td></td></tr>
<tr><td>18</td><td>Reserved</td><td></td></tr>
<tr><td>17</td><td>Reserved</td><td></td></tr>
<tr><td>16</td><td>Reserved</td><td></td></tr>
<tr><td>15:13</td><td>Reserved</td><td></td></tr>
<tr><td>12</td><td>PAVP</td><td></td></tr>
<tr><td>11:6</td><td>Reserved</td><td></td></tr>
</table></td><td><b>No</b></td><td><b>Global</b></td></tr>
</table>

<table>
<tr><th>Fixed Offset Name</th><th>FPT ID</th><th>Fixed Offset ID</th><th>Description</th><th>Data Length (in Bytes)</th><th>Expected Value</th><th>Secure</th><th>Reset Type</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td><table><tr><td>5</td><td>Reserved</td><td></td></tr><tr><td>4:3</td><td>Reserved</td><td></td></tr><tr><td>2</td><td>Security Application</td><td></td></tr><tr><td>1</td><td>Reserved</td><td></td></tr><tr><td>0</td><td>Reserved</td><td></td></tr></table></td><td></td><td></td></tr>
<tr><td>Feature Shipment Time State</td><td>8</td><td>0x000B</td><td>UINT32 (little endian) value. This controls what features are enabled or disabled. This setting is only relevant for features NOT permanently disabled by the OEM Permanent Disable.
This will not enable functionality that is not capable of working in the target hardware SKU. Please see the respective Firmware Bring-up Guide for a list of what features are capable with what firmware bundle and Hardware SKU
<b>Notes:</b>
<b>There are reserved bits that the must not be changed for proper platform operation. The user should only modify the bit(s) for the feature(s) they wish to change. There is NO ability to change features one at a time. This CVAR sets OEM Permanent Disable for ALL features. In addition prior updating or changing any of available settings it is highly recommended that the user first retrieves the current Feature Shipment Time State and toggling only the desired bits, and then resave them.</b></td><td>4</td><td>Feature Enabled: 1
Feature Disabled: 0<table><tr><th>Bit</th><th>Description</th><th>Notes</th></tr><tr><td>31:30</td><td>Reserved</td><td></td></tr><tr><td>29</td><td>Reserved</td><td></td></tr><tr><td>28:3</td><td>Reserved</td><td></td></tr><tr><td>2</td><td>Reserved</td><td></td></tr><tr><td>1:0</td><td>Reserved</td><td></td></tr></table></td><td><b>No</b></td><td><b>Global</b></td></tr>
<tr><td>OEM_TAG</td><td>34</td><td>0x000F</td><td>A human readable 32-bit number to describe the flash image represented by value</td><td>4</td><td>Readable 32 bit hex value identifying the image. Can be empty (Null).</td><td><b>No</b></td><td><b>TXE</b></td></tr>
<tr><td colspan="8"><b>Revenue Sharing Related CVAR Item Descriptions</b></td></tr>
<tr><td>ODM_ID</td><td></td><td>0x5003</td><td>CVAR used for setting the ODM ID Used by Intel ® Services
<b>Note: This value can only be programmed into FW once.</b></td><td>4</td><td>32-bit value
Value 0x00000000 < n < 0xFFFFFFFF</td><td><b>Yes</b></td><td><b>TXE</b></td></tr>
</table>

Fixed Offset Name	FPT ID	Fixed Offset ID	Description	Data Length (in Bytes)	Expected Value	Secure	Reset Type
SystemIntegratorID		0x5004	Used for setting the System Integrator ID used by Intel ® Services **Note: This value can only be programmed into FW once.**	4	32-bit value Value 0x00000000 < n < 0xFFFFFFFF	**Yes**	**TXE**
ReservedID		0x5005	Used for setting the "Reserved" ID used by Intel ® Services **Note: This value can only be programmed into FW once.**	4	32-bit value Value 0x00000000 < n < 0xFFFFFFFF	**Yes**	**TXE**
Field Programmable Fuses							
PTT Enable		0x7001	Enables / Disables the fTPM / PTT FPFs	1	0 = Disabled 1 = Enabled **Note:** Setting the value to '0' will permanently disable Intel® PTT in the chipset.	**No**	**TXE**

FPT CVAR Retrieve command:
fpt.exe –r <name> | all [-f <file>] [options]

Required Parameters

<name> Name of CVAR OR All retrieves all the CVARs

Manufacturing Configurable CVARs
Named Variables (CVARs)
OEMSkuRule
FeatureShipState
OEM_TAG
ODM ID used by Intel (R) Services
System Integrator ID used by Intel (R) Services
Reserved ID used by Intel (R) Services

Manufacturing Configurable CVARs
Named Variables (CVARs)
Flash Protection Override Policy Hard
Flash Protection Override Policy Soft

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Appendix B Tool Detail Error Codes

B.1 Line Tool Error Codes

Note that FIT and MEU have different error codes, as mentioned in section 2.7.

Code	Message	Response
0		
1		
2	Failure. Unexpected error occurred	Contact Intel
3	Internal Error. Unexpected error occurred	Contact Intel
4	Unsupported OS	
5	Memory allocation error occurred	Make sure there is enough memory in the system
6	Error accessing the function "GetSystemFirmwareTable" from "kernel32.dll"	
7	The function "GetSystemFirmwareTable" failed with Windows Error Code: %d	
8	Error accessing the "kernel32.dll"	
9	Error log is not created because tool is likely running on a read-only media	
10	Error occurred while reading the file "%s"	
11	Error getting current working directory path:	
12	Error getting current working directory permissions:	
13	An unknown error occurred while opening the file	
14	An unknown error occured while working with the file "%s".	
15	Error occurred while writing to the file "%s"	
16	NVAR not found	
21	General error	
22	Cannot locate TXE device	
23	Memory access failure	
24	Write register failure	
25	OS failed to allocate memory	
26	Circular buffer overflow	
27	Not enough memory in circular buffer	
28	Communication error between application and Intel(R) TXE module	
29	Unsupported HECI bus message protocol version	

Code	Message	Response
31	AMT device unavailable	
32	Unexpected result in command response	Contact Intel
33	Unsupported message type	
34	Cannot find host client	
35	Cannot find TXE client	
36	Failure occurred during TXE disconnect	
37	Client already connected	
38	No free connection available	
39	Illegal parameter	
40	Flow control error	
41	No message	
42	Requesting Intel(R) TXEI recieve buffer size is too large	
43	Application or driver internal error	
45	Command is not supported	
46	Invalid command line option(s)	
47	The following Parameter is not a valid option: %s	
48	Internal Error (PCH is not supported)	
49	Internal Error (Safe function wrapper error: Invalid size)	
50	Internal Error (Safe function wrapper error: compose string from list)	
51	Internal Error (Safe function wrapper error: compose string)	
52	Internal Error (Safe function wrapper error: memncpy)	
53	Internal Error (Safe function wrapper error: strncpy)	
54	Internal Error (Safe function wrapper error: strncat)	
55	Internal Error (Safe function wrapper error: strtok)	
57	Failed getting variable "%s" value	
58	You cannot do a compare on a complex structure such as "%s".	
59	Unable to find matching LOCL	
60	Intel(R) Gbe was not found	
61	Interal Error (Plat info general failure)	
62	Could not access PCI device	
63	Operation is not supported	
64	Internal Error (OS interace: Illegal Param)	
65	Unexpected Failure.	
66	Unable to load library	
67	Unable to change permission	
68	Unable to perform request due to permission failure	
70	Unable to perform CreateFile	
71	The FPF compare failed	
72	Retrieving the FPF Data failed	

Code	Message	Response
73	The FPF requested, "%s", is not valid for this operation. Valid FPFs include:	
74	This FPF cannot be retrieved until it has been committed	
75	The FPF is not currently supported by the TXE	
76	Communication error between application and Intel(R) TXE module (AMT client)	
77	Communication error between application and Intel(R) AMT module (PTHI client)	
78	Communication error between application and Intel(R) TXE module (ICLS client)	
79	Fail to read FW Status Register value	
80	Fail to create verbose log file %s	
81	Internal error (Could not determine FW features information)	
82	Unknown or unsupported hardware platform	
83	Communication error between application and Intel(R) TXE module (HCI client)	
84	Communication error between application and Intel(R) TXE module (FPF client)	
85	Communication error between application and Intel(R) TXE module (NFC client)	
86	Communication error between application and Intel(R) TXE module (FWU client)	
88	Fail to load driver (PCI access for Windows). Tool needs to run with an administrator priviledge account.	
89	%s feature was not found.	
90	%s feature was not available.	
91	%s actual value is - %s.	
92	Error reporting revenue share information - Invalid index used	
93	Error reporting revenue share information - Index already in use	
94	This slot is unused	
95	%s feature was not available because TXE is not in manufacturing mode.	
96	Failed to locate DATA manifest marker	
97	Failed to locate PID module entry	
98	End of file encountered when reading first record	
99	Invalid PID Section Data Marker	
100	This PID cannot be used since the PID matches the known PID for Pre-Production PCHs	
101	Non-Intel chipset found in first record	
102	No PID list marker found	
105	Internal Error (Failed to initialize platinfo)	
106	Error occurred while communicating with SPI device	Check SPI device
107	Failed to create dependency list for features	
108	Fail to load driver (PCI access for Windows). Tool needs to run with an administrator priviledge account.	
109	Unsupported TXE Firmware Version	

Code	Message	Response
110	Failed to retrieve feature	
111	Received Status from TXE: FPF File Invalid	
112	Internal Error (Failed to check eligility)	
113	Internal Error (Unexpected error occured)	
114	Failed to retrieve Intel(R) FIT version	
115	Unknown or unsupported hardware platform	
116	Unsupported TXE Firmware Version %i.%i.%i.%i %s	
117	TXEManuf Operation Failed	
119	Fail to load driver (PCI access for Windows). Tool needs to run with an administrator priviledge account.	
120	Communication error between application and Intel(R) TXE module (BIST client)	
121	Communication error between application and Intel(R) TXE module (AMT client)	
122	Fail to read FW Status Register value	
124	Fail to retrieve error list	
125	Internal error (Could not determine FW features information)	
126	Access to SPI Flash device(s) failed	
127	Failed to create dependency list for features	
128	Intel(R) test failed to start, error 0x%X returned	
129	Intel(R) test timeout (exceeded 30 seconds)	
130	Intel(R) TXE test is currently running, try again later	
131	TXEManuf End-Of-Line Test config file generation failed	
132	M3 results are not available from SPI. Please run -test option to perform the BIST test	
133	Could not read M3 results from SPI	
136	Internal Error	
137	Internal error - Invalid Parameters	
138	SMBus hardware is not ready	
139	Internal error - SMBus Read Byte PEC failure	
140	SMBus encountered time-out	
141	Internal Error. FW returns status %d	
142	Power source is not AC	
143	Failed to retrieve power source	
144	Internal error - Failed to enum PP	
145	Internal error - Failed to match	
146	Internal error - Out of memory	
147	Internal error - Unabled to get current PP	
148	Failed to retrieve test result from SPI	
149	Failed to retrieve power package setting	
150	Failed to retrieve power rule from SPI	
151	WLAN power well setting is set incorrectly	

Code	Message	Response
152	Failed to retrieve test result from SPI	
153	Internal error - Failed to retrieve Platform Attribute	
154	Failed to retrieve PROC_MISSING NVAR setting	
155	PROC_MISSING NVAR setting is set incorrectly	
156	Failed to retrieve test result from SPI	
157	Failed to retrieve power package setting	
158	Failed to retrieve M3 Power Rails Availablitiy setting	
159	M3 Power Rails Availablitiy setting is set incorrectly	
160	Failed to retrieve password from SPI	
161	Internal error - Password length is incorrect	
162	Internal error - Modified local password	
163	Internal error - Invalid password	
164	Firmware is in recovery mode	
165	Boot Guard Self Test Failed	
166	Intel integrated LAN setting is set incorrectly	
167	Intel LAN Connected Device (PHY) physical connectivity error with TXE	
168	Internal error - Illegal data length	
169	Internal error - Illegal data value	
170	EHBC State Test Failed - Error while reading data from flash	
171	EHBC State Test Failed - Contradiction with current Privacy Level	
172	Current WLAN does not match micro-code, please update WLAN micro-code in FW	
173	Communication with WLAN device failed	
174	Length of OEM Customizable Certificate Friendly Name setting is set incorrectly	
175	OEM Customizable Certificate Stream setting is set incorrectly	
176	OEM Customizable Certificate Hash Algorithm setting is set incorrectly	
177	Length of OEM Customizable Certificate Stream is set incorrectly	
178	Internal error - Unable to compress	
179	The compressed data is incorrect	
180	USBr EHCI 1 Enabled and/or USBr EHCI 2 Enabled setting is set incorrectly	
181	KVM device is already in use by other components	
182	Internal error	
183	Failed to retrieve power source	
184	Power source is not AC	
185	I2C address or alert pin is not configured correctly	
186	Internal error - alert pin	
187	Cannot communicate with NFC module. Check physical connection of I2C, I2C address configuration and reset pin	

Code	Message	Response
188	Internal error - self-test	
189	I2C communications failed. Check physical connection and I2C address	
190	Alert pin failed. Check physical connection and alert pin configuration	
191	NFC RF - error returned from module	
192	NFC RF - communication interference or bad response from module	
193	NFC RF - timed out	
194	NFC RF - module is in the wrong state	
195	NFC RF - antenna not present or blocked	
196	NFC RF - internal error	
197	NFC reset pin failure. Check physical reset pin connection.	
198	LAN power well setting is set incorrectly	
199	WLAN power well setting is set incorrectly	
200	M3 Power Rail Supported is set incorrectly	
201	Intel(R) TXE firmware version mismatch, actual value is - %s	
202	Intel(R) Gbe version mismatch, actual value is - %s	
203	BIOS version mismatch, actual value is - %s	
204	System UUID mismatch, actual value is - %s	
205	System UUID mismatch, feature is not supported	
206	System UUID actual value is all 0x00	
207	System UUID actual value is all 0xFF	
208	Intel(R) Wired LAN MAC address mismatch, actual value is - %s	
209	Intel(R) Wireless LAN MAC address mismatch, actual value is - %s	
210	Security Descriptor Override Strap (SDO) is enabled	
211	End-Of-Post message is not sent	
212	Unable to determine Intel(R) TXE Manufacturing Mode status	
213	Intel(R) TXE is still in Manufacturing Mode	
214	CF9GR is not locked	
215	Region access permissions don't match Intel recommended values	
216	BIOS has granted Intel(R) TXE access to its region	
217	SPI flash descriptor region is not locked	
218	Intel(R) TXE has read or write access to BIOS region	
219	SPI flash Intel(R) TXE region is not locked	
229	Wireless LAN micro-code mismatch, actual value is - %s	
230	%s have not been set	
231	%s mismatch, actual value is - %s	
232	Variable %s mismatch, actual value is - %s	
233	Memory allocation failed for checking variable	

Code	Message	Response
234	Invalid test name -	
235	Internal error	
236	Cannot run the command since Intel(R) AMT is not available	
237	No valid OEM ICC data programmed	
238	MFS is corrupted	
239	Using wrong PCH SKU Emulation via Intel (R) FIT vs whats the actual HW Type	
240	FPFs are not committed	
241	FPFs and TXE Config mismatch	
242	Internal error	
243	Cannot perform hibernation. Please manually reboot the system	
244	TXEManuf Test Failed	
245	No Intel(R) TXE test result to retrieve	
246	TXEManuf Operation Passed (with warnings)	
247	Test is enabled by the user but is unknown by the platform -	
248	Some Intel(R) recommended checks have been skipped:	
251	Attempting to add sibling to XML root node	
252	File size is zero	
253	XML parsing failed	
254	XML parsing encountered data overflow	
255	Invalid XML error code conversion	
256	XML parser - out of memory error	
296	Failed to retrieve list of BIST tests to run from FW	
297	Unexpected failure when retrieving BIST results	
298	Test is enabled by the user but is not supported by the current sku -	
299		
300	Retrieving the EOL Config list of tests failed.	
301	Retrieving the EOL Var list of tests failed.	
302	No name attribute specified for test:	
303	Failed to parse configuration file provided.	
304	No output file path specified to write configuration file.	
305	No data to write to configuration file.	
306	Invalid ErrAction specified:	
307	Invalid node name.	
308	The 2 SPI flash devices do not have compatible command sets.	
309	No SPI flash device could be identified. Please verify if Fparts.txt has support	Verify that the device is listed in Fparts.txt.
310	"%s" file not found.	Check file location
311	Access was denied opening the file "%s"	Check file location

Code	Message	Response
312	An unknown error occurred while opening the file "%s"	Verify the file is not corrupt
313	Failed to allocate memory for the flash part definition file "%s"	Check system memory Verify the file is not corrupt
314	Failed to read the entire file "%s" into memory.	Check system memory Verify the file is not corrupt
315	Parsing of file "%s" failed.	Check system memory Verify the file is not corrupt
316	Protected Range Registers are currently set by BIOS, preventing flash access. Please contact the target system BIOS vendor for an option to disable Protected Range Registers.	Assert Flash Descriptor Override Strap (GPIO33) to Low, Power Cycle, and Retry.
317	Hardware sequencing failed. Make sure that you have access to target flash area!	If Protected Range Registers (memory location: SPIBAR + 74h -> 8Fh) are still set, contact the target BIOS vendor.
318	The host CPU does not have read access to the target flash area. To enable read access for this operation you must modify the descriptor settings to give host access to this region.	Check descriptor region access settings
319	An attempt was made to read beyond the end of flash memory	Check address
320	Software sequencing failed. Make sure that you have access to target flash area!	Software sequencing failed
321	Invalid Block Erase Size value in "%s".	
322	Invalid Write Granularity value in "%s".	
323	Invalid Enable Write Status Register Command value in "%s".	
325	Internal Error.	
326	The supplied zero-based index of the SPI Device is out of range.	
328	Invalid descriptor region.	Check descriptor region
329	Region does not exist.	Check region to be programmed
330	An attempt was made to write beyond the end of flash memory	Check address
331	An attempt was made to erase beyond the end of flash memory	Check address
332	General Erase failure.	Attempt the command again. If it fails again, contact Intel.
333	The address 0x%08X of the block to erase is not aligned correctly.	Check address

Code	Message	Response
334	The host CPU does not have erase access to the target flash area. To enable erase access for this operation you must modify the descriptor settings to give host access to this region.	Check descriptor region access settings
335	Error occurred while communicating with SPI device.	Check SPI device
337	Hardware timeout occurred in SPI device.	
338	There are no supported SPI flash devices installed. Please check connectivity	Verify Fparts.txt has correct values. Check SPI Device
339	Unrecognized value in the HSFSTS register.	
340	AEL is not equal to zero.	
341	FCERR is not equal to zero.	
344	Checking variable "%s" failed.	
347	Invalid Manufacturing Line Configurable variable name "%s".	
349	"%s" file already exists.	
350	"%s" file does not exist.	
353	End Of Manufacturing Operation failure - Verification failure on Descriptor Lock settings.	
354	Unable to get master base address from the descriptor.	
355	Password does not match the criteria.	
356	Invalid length of Manufacturing Line Configurable value. Check configuration file for correct length.	
357	Invalid hexadecimal value entered for the Manufacturing Line Configurable.	
358	Invalid hash certificate file "%s".	
359	An unknown error occurred while opening the file "%s".	
360	End Of Manufacturing Operation failure - Verification failure on TXE Manufacturing Mode Done settings.	
361	The Global Lock Bit has already been set.	
362	Not able to open the file "%s".	
365	Invalid parameter value specified by user. Use -? option to see help.	
366	Fail to load driver (PCI access for Windows). Tool needs to run with an administrator priviledge account.	
367	[%s] cannot be run on the current platform. Please contact your vendor.	
368	Failed to disable write protection for the BIOS space.	
369	TXE disabled	
370	Failed to get information about the installed flash devices!	
371	An error occurred reading the flash descriptor signature.	
372	Flash descriptor does not have correct signature.	
375	"%s" is not a valid file name.	
376	Image file "%s" not found.	
377	Access was denied opening the file "%s".	
378	Failed to read the entire file into memory. File: %s	Check system memory Verify the file is not corrupt

Code	Message	Response
379	The address is outside the boundaries of the flash area.	
380	Unable to write data to flash. Address 0x%x.	
381	Data verify mismatch found.	
382	Access was denied creating the file "%s".	
383	An unknown error occurred while creating %s.	
384	Failed to write the entire flash contents to file.	
385	General Read failure.	
386	An error occurred reading the flash mapping data.	
387	System booted in Non-Descriptor mode, but the flash appears to contain a valid signature.	
388	An error occurred reading the flash components data.	
389	An error occurred reading the flash region base/limit data.	
390	An error occurred reading the flash master access data.	
391	Flash is not blank.	
392	The Close Manufacturing process failed.	
393	Setting Global Reset Failed	
394	TXE disable not needed	
395	TXE already disabled	
396	The request to disable the TXE failed.	
397	There was a communications error between FPT and the TXE.	
398	There is a problem with the GbE binary which prevents saving the data.	
400	Param file "%s" is already opened.	
401	Requesting ME FW Reset failure.	
402	Fail to load driver (PCI access for Windows)	
403	No FPF Name provided.	
404	No value to compare against.	
405	A required parameter is missing.	
437	Invalid keybox API version in provisioning response.	
438	Invalid keybox command id in provisioning response.	
439	Invalid keybox buffer length in provisioning response.	
440	CEK is invalid.	
441	CEK is not available.	
442	Cannot provision after EOM.	
443	Unknown error for provisioning status.	
444	Bad CRC.	
445	Bad Magic.	
446	Invalid keybox status in provisioning response.	
447	Invalid keybox API version in provisioning response.	
448	Invalid keybox command id in provisioning response.	
449	Invalid keybox buffer length in provisioning response.	

Code	Message	Response
450	Keybox is not provisioned.	
451	The host CPU does not have write access to the target flash area. To enable write access for this operation you must modify the descriptor settings to give host access to this region.	Check descriptor region access settings
453	User elected to cancel the operation.	
454	Confirmation is not received from the user to perform operation.	
455	User response was invalid. Please select from the correct responses.	
456	Open Process Token error %d	
457	Adjust Token Privileges error %d	
458	Initiate System Shutdown error %d	
459	Graceful Exit of Windows has failed.	
460	Error determining possible system states.	
462	Cannot locate MEI driver	
463	A test returned from FW does not match known test by the tool: App(%d) Comp(%d) Test(%d)	
464	FW update pin failed. Check physical FW update pin connection.	
465	The test was not run	
467	MCA Internal Error	
468	Folder does not exist	
469	Folder is not empty	
470	Blob Internal Error	
471	Write Error	
472	Read Error	
473	Remove Error	
474	Invalid "State" found for test -	
475	ISH Internal Error	
476	IUP Not Found	
477	Attempt to communicate to ISH library failed	
478	ISH error. Library status: 0x%08X	
479	ISH error. Unexpected Failure. Please make sure to use correct DLL version.	
480	ISH error. Invalid level selected.	
481	ISH Test failed	
482	Error retrieving ISH configuration	
483	Communication error between application and Intel(R) TXE module (Intel(R) Precise Technology client).	
484	Cannot locate HID device.	
485	Incorrect Report ID received.	
486	MCTP SMBUS test failed	
487		
488	Invalid config file. "State" was not found for test -	

Code	Message	Response
489	Invalid config file. "RequiredValue" was not found for test -	
490	Invalid config file. "ErrAction" was not found for test -	
492	Unable to validate address range	
493	Memory window not set or device is not armed for operation	
494	Sensor could not be found. Either no sensor is connected, the sensor has not yet initialized, or the system is improperly configured.	
495	Not enough memory/storage for requested operation	
496	Unexpected error occurred	
497	Used in TOUCH_SENSOR_HID_READY_FOR_DATA_RSP to indicate sensor has been disabled or reset and must be reinitialized.	
498	Used to indicate compatibility revision check between sensor and ME failed, or protocol ver between TXE/HID/Kernels failed.	
499	Indicates sensor went through an unexpected reset	
500	Requested sensor reset failed to complete	
501	Operation timed out	
502	Test mode pattern did not match expected values	
503	Indicates sensor reported fatal error during reset sequence. Further progress is not possible.	
504	Indicates sensor reported non-fatal error during reset sequence. HID/BIOS logs error and attempts to continue.	
505	Indicates sensor reported invalid capabilities, such as not supporting required minimum frequency or I/O mode.	
506	Indicates that command cannot be complete until ongoing Quiesce I/O flow has completed.	
507	Touch - Vendor ID mismatch, actual value is - %s	
508	Cannot access the NVAR file.	
509	Cannot find the NVAR file; the system maybe in EOM.	
511	Cannot read the NVAR file.	
513	Cannot access the NVAR file attributes.	
514	Cannot access the CVAR file; No CVAR files to commit.	
515	Cannot modify the NVAR file.	
516	Cannot access the CVAR file; file is not allowed to be changed after EOM.	
517	Used an invalid input parameter to access the NVAR file.	
528	No Permission to access the NVAR file; the system maybe in EOM.	
529	NVAR access in the system caused a general error.	
530	Some platform eligible tests have been skipped:	
531	HDCP file invalid.	
535	Failure. Unexpected error occurred.	
536	Can not provision after EOM.	
537	Certificate verification failed.	
538	HDCP Rx is not provisioned.	

Code	Message	Response
540	Invalid string value entered for the Manufacturing Line Configurable.	
542	Fail to read FW Status Register value	
543	Detected TXE in recovery mode.	
546	FW returned status: Erase token failure.	
548	Detected invalid data size.	
549	Detected invalid hex value.	
550	Integrated Sensor Solution Test Returned Warning.	
551	Invalid data	
552	Invalid size	
553	Failed to read DnXP Partition	
554	does not contain region	
555	IFWI Prepare to Update failed	
558	Command size does not match expected value	
559	EOM prevents IFWI Prepare to Update from completing	
560	Command not supported	
561	System Audit Log Error	
562	CSE is in some special security sensitive state	
563	Undefined Error not expected, BIOS may continue with update	
564	Variable "%s" is not available on this platform.	
565	An error occurred while opening the file "%s".	
566	Unexpected size found in the file "%s". Expected: 0x%X. Received: 0x%X.	
567	Keybox is not provisioned.	
568	Unexpected keybox failure.	
569	Unable to execute command in this Firmware State. Please reboot.	
570	Unable to enable the feature "Persistent PRTC Backup Power" through FPT by setting the CVAR to 00.	
571	File "%s" contains GPIO pin assignments that are not multiples of the GPIO pin data structure.	
572	DnX Enumeration Timeout mismatch, actual value is - %s.	
573	Mismatch on FPF file %s - UEP: %s, FPF HW: %s.	
574	Valid bit FPF is not set on file %s.	
575	FPFs are not committed to HW.	
576	RPMB data migration done FPF is not set.	
577	RPMB is not bound.	
578	Failed to read provisioning status.	
579	Failed to read FPF HW.	
580	SOC Config Lock is not set.	
581	Lock bit FPF is not set on file %s.	
582	Failed to read FPF in UEP.	

Code	Message	Response
583	Failed to retrieve Intel (R) Internal Build Version	
584	Attestation KeyBox NVAR is empty	
585	Attkb file size invalid.	

B.2 Firmware Update Errors

Error Code	Error Message
0	Success
8193	Intel® TXE Interface : Cannot locate Intel® TXE device driver
8704	Firmware update operation not initiated due to a SKU mismatch
8705	Firmware update not initiated due to version mismatch
8706	Firmware update not initiated due to integrity failure or invalid FW image
8707	Firmware update failed due to an internal error
8708	Firmware Update operation not initiated because a firmware update is already in progress
8710	Firmware update tool failed due to insufficient memory
8713	Firmware update not initiated due to an invalid FW image header
8714	Firmware update not initiated due to file open or read failure
8716	Invalid usage
8718	Update operation timed-out; cannot determine if the operation succeeded
8719	Firmware update cannot be initiated because Local Firmware update is disabled
8722	Intel® TXE Interface : Unsupported message type
8723	No Firmware update is happening
8724	Platform did not respond to update request.
8725	Failed to receive last update status from the firmware
8727	Firmware update tool failed to get the firmware parameters
8728	This version of the Intel I® FW Update Tool is not compatible with the current platform.
8741	FW Update Failed.
8743	Unknown or unsupported Platform.
8744	OEM ID verification failed.
8745	Firmware update cannot be initiated because the OEM ID provided is incorrect

Error Code	Error Message
8746	Firmware update not initiated due to invalid image length
8747	Firmware update not initiated due to an unavailable global buffer
8748	Firmware update not initiated due to invalid firmware parameters
8754	Encountered error writing to file.
8757	Display FW Version failed.
8758	The image provided is not supported by the platform.
8759	Internal Error.
8760	Update downgrade vetoed.
8761	Firmware write file failure.
8762	Firmware read file failure.
8763	Firmware delete file failure.
8764	Partition layout NOT compatible.
8765	Downgrade NOT allowed, data mismatched.
8766	Password did not match.
8768	Password Not provided when required.
8769	Polling for FW Update Failed.
8772	Invalid usage, -allowsv switch required to update the same version firmware
8778	Unable to read FW version from file. Please verify the update image used.
8787	Password exceeded maximum number of retries.

B.3 MEU Errors

Error Code	Error
1	Failed to initialize tool
2	Failed to process input XML
3	Invalid command line options
4	Failed to build
5	Failed to save XML
6	File not found
7	Unknown root node found in XML
8	Invalid XML template option specified
9	Invalid Manifest Version specified on CLI
10	Unable to load tool config xml
11	Unsupported signing tool specified

Error Code	Error
12	Invalid signing tool configuration
13	Error setting the log file
14	Invalid decomp binary type specified
15	Invalid input file type
16	File is not a valid XML file
17	Invalid manifest index value
18	Error finding manifests in file
19	Failed to write file
20	Path provided is not a valid directory
21	Unable to find files
22	Unable to read file
23	Failed to import manifest(s)
24	Failed to resign manifest(s)
25	Failed to generate public key hash
26	Failed to export manifest(s)
27	Failed to decompose

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Appendix C Tool Option Dependency on BIOS/Intel® TXE Status

Tools' Options	Intel® TXE End-of-Manufacturing CVAR		End of post	
	Set	Not Set	Yes	No
FPT -Greset	Not related	Not related	Not related	N/A Not related
FPT –R	Depends on End of post status	Work	Depends on Intel® TXE manufacturing mode done bit status	Work
Intel® TXEINFO – EOL config	Depends on End of post status	Work	Depends on Intel® TXE manufacturing mode done bit status	Work

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Appendix D: Using Local Android* Intel® TXE System Tools

D.1 Using Android* System Tools

In order to use Intel® TXE System tools locally on SUT, you must push the tools using ADB (Android Debug Bridge) to a directory that can be accessed using Terminal Emulator OR using ABD itself.

D.2 Setup & Install ADB and Fastboot

Obtain ADB and Fastboot tool (comes as part of the Phone Flash Tool installation, which is part of the Intel TXE FW Kit). There are Linux* and Windows versions of the tool. Usage of this tool will be the same with respect to Intel TXE System tools.

D.3 Using Fastboot

To use Fastboot:

1. Connect a MicroUSB OTG cable between the platform USB OTG port and the host System
2. From the host system, navigate to the Fastboot path, and open CMD/Shell
3. Run Fastboot –devices
    - The output should be the device name on the devices list
4. For more information about Fastboot commands run: Fastboot -?

D.4 How to Push & Use the Intel® TXE System Tools

1. Connecting SUT to console can be done in two ways:
    - Connect a MicroUSB OTG cable between the platform USB OTG port and the host system
    - Or using network connection:
        1. Place both SUT & Console on same IP network
        2. Use "ADB Connect <IP_Address_Of_SUT>"
2. Push the Intel TXE FW tools & their components, example below:
    -
      ```
      \platform-tools>adb.exe push FPT /data/local
                1862 KB/s (357043 bytes in 0.187s)
      ```
    -
      ```
      \platform-tools>adb.exe push TXEInfo /data/local
                1986 KB/s (222110 bytes in 0.109s)
      ```

- \platform-tools>adb.exe push TXEManuf /data/local

  1914 KB/s (305893 bytes in 0.156s)
- \platform-tools>adb.exe push TXEManuf.cfg /data/local

  377 KB/s (6023 bytes in 0.015s)
- \platform-tools>adb.exe push fparts.txt /data/local

  7 KB/s (8057 bytes in 1.000s)
- \platform-tools>adb.exe push vsccommn.bin /data/local

  133 KB/s (2132 bytes in 0.015s)
- \platform-tools>adb.exe push FpfConfigFile.txt /data/local

  26 KB/s (431 bytes in 0.015s)

3. Run the Intel® TXE System tools using ADB or local Terminal Emulator
   - Using ABD Example:
     - \platform-tools>adb.exe shell
     - root@android:/ # su
     - 127|root@android:/ # cd data/local
     - root@android:/data/local # chmod 777 FPT TXEInfo TXEManuf
     - Verify execution rights have been given via "ls -l"
     - While in "data/local" directory run: "./TXEInfo" / "./FPT" "./TXEManuf"
4. Running local Terminal Emulator or Serial connection will be the same usage of the Intel® TXE System tools. For Serial connection:
   - Connect microUSB to Console COM port.
   - Using Terminal client (e.g. PuTTY) configure connection to be serial with speed of 115200.
   - When connection is successful, change to Android directory where tools have been pushed (i.e. /data/local per above example).

Appendix E : Google* Widevine for Intel® TXE

E.1 Creating Widevine* CEK (Customer Encryption Key)

The CEK is responsible for encrypting Widevine Keybox in Android devices and not accessible by the host. The CEK is a global key used among the same models of devices for a single Customer.

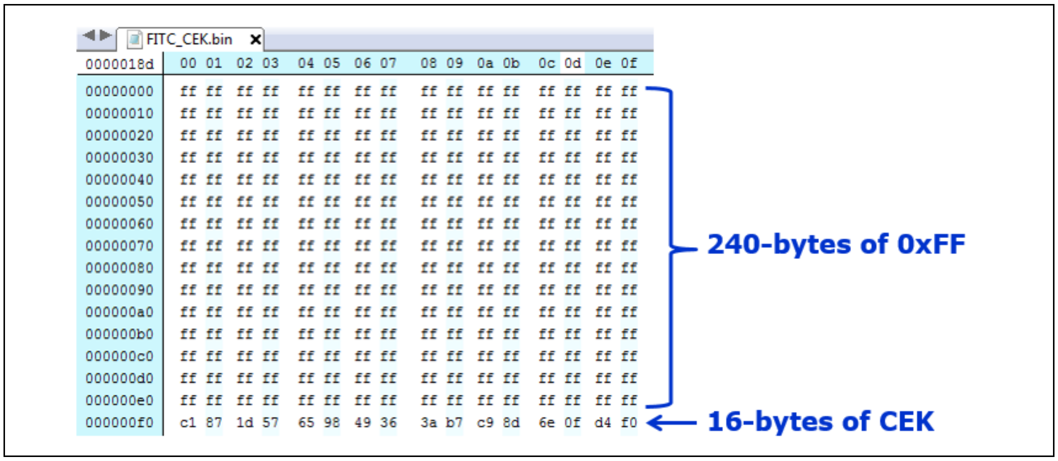
Note: The below key files are for demonstration purposes only and are not actual keys.

E.1.1 FITC CEK File Creation Procedure

E.1.1.1 Cleartext CEK

1. Generate a 16-byte Hex random number (unique per OEM) which is called CEK.
2. Combine 240 bytes of 0xFF (upper) with 16-byte CEK (lower) into 256 bytes FITC_CEK.bin
3. Insert FITC_CEK.bin into flash image with FITC tool (refer to section **Error! Reference source not found.**, steps 2-5).

FITC CEK File Map Example



```
0000018d  00 01 02 03  04 05 06 07  08 09 0a 0b  0c 0d 0e 0f
00000000  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000010  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000020  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000030  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000040  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000050  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000060  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000070  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000080  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000090  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
000000a0  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
000000b0  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
000000c0  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
000000d0  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
000000e0  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
000000f0  c1 87 1d 57  65 98 49 36  3a b7 c9 8d  6e 0f d4 f0
```

240-bytes of 0xFF

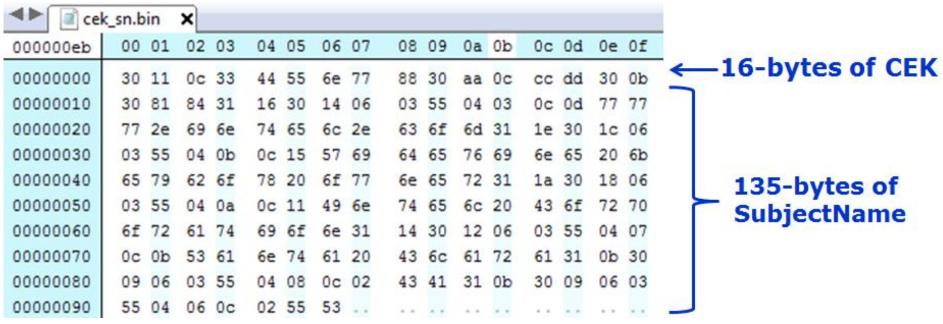
16-bytes of CEK

When building the image, add FITC_CEK.bin file (Flash Image -> TXE Region -> Configuration -> TXE -> CEK Configuration)

E.1.1.2 Ciphertext CEK

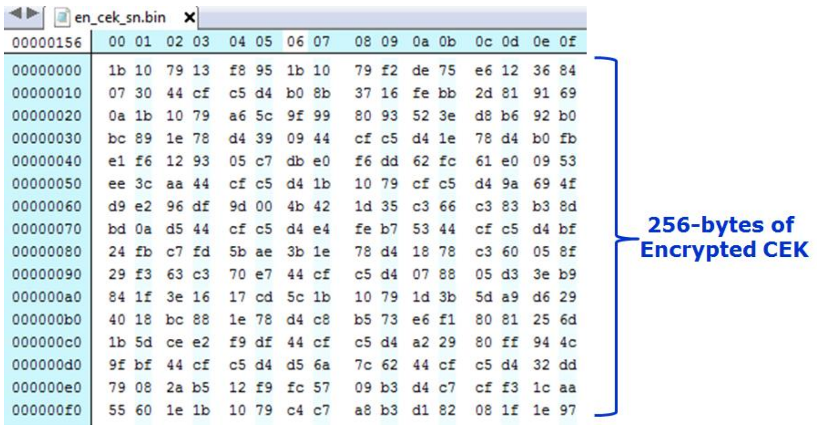
Note: Customer should scope relevant Google* documentation and decide on CEK insertion method. Intel recommended method is ciphertext

1. Generate a 16-byte Hex random number (unique per OEM) which is called CEK.
2. Create concatenated CEK||subjectname into one file (cek_sn.bin)
   a. SubjectName can be found under \\System Tools\Certificates\TXE1SubjectName.bin



```
cek_sn.bin
000000eb   00 01  02 03   04 05  06 07   08 09  0a 0b   0c 0d  0e 0f
00000000   30 11  0c 33   44 55  6e 77   88 30  aa 0c   cc dd  30 0b
00000010   30 81  84 31   16 30  14 06   03 55  04 03   0c 0d  77 77
00000020   77 2e  69 6e   74 65  6c 2e   63 6f  6d 31   1e 30  1c 06
00000030   03 55  04 0b   0c 15  57 69   64 65  76 69   6e 65  20 6b
00000040   65 79  62 6f   78 20  6f 77   6e 65  72 31   1a 30  18 06
00000050   03 55  04 0a   0c 11  49 6e   74 65  6c 20   43 6f  72 70
00000060   6f 72  61 74   69 6f  6e 31   14 30  12 06   03 55  04 07
00000070   0c 0b  53 61   6e 74  61 20   43 6c  61 72   61 31  0b 30
00000080   09 06  03 55   04 08  0c 02   43 41  31 0b   30 09  06 03
00000090   55 04  06 0c   02 55  53 ..   .. ..  .. ..   .. ..  .. ..
```

3. Use openssl tool (open source tool) to convert the CEK certificate to *.pem format
   a. CEK certificate can be found under \\System Tools\Certificates\ TXE1DrmCekKeyProvPreProduction.cer
   b. Run openssl.exe x509 -inTXE1DrmCekKeyProvPreProduction.cer -inform DER -out <TXE1DrmCekKeyProvPreProduction_CEK.pem> -outform PEM
4. Encrypt CEK:
   a. Run: openssl.exe rsautl -encrypt -inkey <TXE1DrmCekKeyProvPreProduction_CEK.pem> -certin -pkcs -in cek_sn.bin -out en_cek_sn.bin



```
en_cek_sn.bin
00000156   00 01  02 03   04 05  06 07   08 09  0a 0b   0c 0d  0e 0f
00000000   1b 10  79 13   f8 95  1b 10   79 f2  de 75   e6 12  36 84
00000010   07 30  44 cf   c5 d4  b0 8b   37 16  fe bb   2d 81  91 69
00000020   0a 1b  10 79   a6 5c  9f 99   80 93  52 3e   d8 b6  92 b0
00000030   bc 89  1e 78   d4 39  09 44   cf c5  d4 1e   78 d4  b0 fb
00000040   e1 f6  12 93   05 c7  db e0   f6 dd  62 fc   61 e0  09 53
00000050   ee 3c  aa 44   cf c5  d4 1b   10 79  cf c5   d4 9a  69 4f
00000060   d9 e2  96 df   9d 00  4b 42   1d 35  c3 66   c3 83  b3 8d
00000070   bd 0a  d5 44   cf c5  d4 e4   fe b7  53 44   cf c5  d4 bf
00000080   24 fb  c7 fd   5b ae  3b 1e   78 d4  18 78   c3 60  05 8f
00000090   29 f3  63 c3   70 e7  44 cf   c5 d4  07 88   05 d3  3e b9
000000a0   84 1f  3e 16   17 cd  5c 1b   10 79  1d 3b   5d a9  d6 29
000000b0   40 18  bc 88   1e 78  d4 c8   b5 73  e6 f1   80 81  25 6d
000000c0   1b 5d  ce e2   f9 df  44 cf   c5 d4  a2 29   80 ff  94 4c
000000d0   9f bf  44 cf   c5 d4  d5 6a   7c 62  44 cf   c5 d4  32 dd
000000e0   79 08  2a b5   12 f9  fc 57   09 b3  d4 c7   cf f3  1c aa
000000f0   55 60  1e 1b   10 79  c4 c7   a8 b3  d1 82   08 1f  1e 97
```

5. Insert en_cek_sn.bin into flash image with FITC tool (refer to section **Error! Reference source not found.**, steps 2-5)

E.2 Constructing Widevine* Provisioning KeyBox File

To support **Security Level 1** playback of protected content on Android devices, Widevine Keybox must be provisioned by Customer in factory. This keybox contains a device ID that is **unique** for each Android device and is the license that establishes a root of trust between Widevine DRM servers and the Android device.

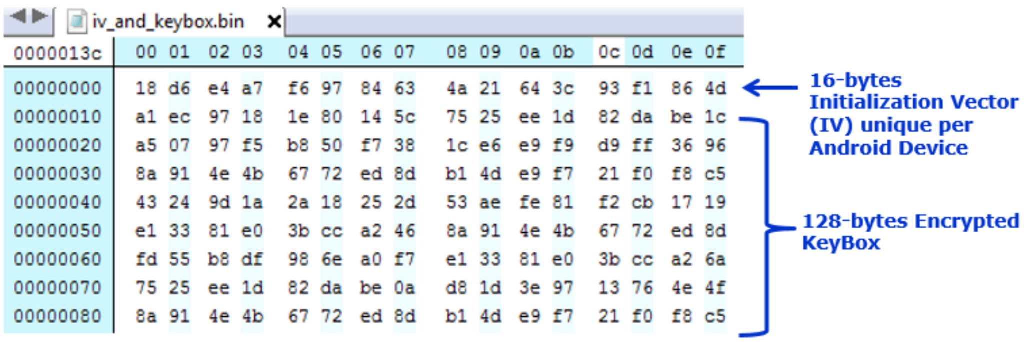
E.2.1 KeyBox Creation Procedure

1. Request KeyBox directly from Google.
2. Create appropriate unique 16-byte IV (Initialization Vector) for respective Android device.
3. Encrypt keybox by global CEK and IV via AES-CBC encryption.
   Example of encrypting KB with IV & CEK using AES-CBC:

   ```
   openssl aes-128-cbc -nopad -K <16-byte-CEK> -iv <16-byte-IV> -in
   GoogleKeyBox.bin -out EncryptedKB.bin
   ```

4. Write 16 bytes of IV, 128 bytes of encrypted keybox using FPT (refer to Widevine* KeyBox Provisioning Procedure, Chapter 7)

FPT KeyBox Provisioning File Map Example


iv_and_keybox.bin
16-bytes Initialization Vector (IV) unique per Android Device
128-bytes Encrypted KeyBox

```
0000013c   00 01 02 03  04 05 06 07  08 09 0a 0b  0c 0d 0e 0f
00000000   18 d6 e4 a7  f6 97 84 63  4a 21 64 3c  93 f1 86 4d
00000010   a1 ec 97 18  1e 80 14 5c  75 25 ee 1d  82 da be 1c
00000020   a5 07 97 f5  b8 50 f7 38  1c e6 e9 f9  d9 ff 36 96
00000030   8a 91 4e 4b  67 72 ed 8d  b1 4d e9 f7  21 f0 f8 c5
00000040   43 24 9d 1a  2a 18 25 2d  53 ae fe 81  f2 cb 17 19
00000050   e1 33 81 e0  3b cc a2 46  8a 91 4e 4b  67 72 ed 8d
00000060   fd 55 b8 df  98 6e a0 f7  e1 33 81 e0  3b cc a2 6a
00000070   75 25 ee 1d  82 da be 0a  d8 1d 3e 97  13 76 4e 4f
00000080   8a 91 4e 4b  67 72 ed 8d  b1 4d e9 f7  21 f0 f8 c5
```