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

User Guide

June 2016

Revision: 1.0 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

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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	Android M Dessert 64 bit (both user and kernel 64 bit)	Fedora /RedHat * Linux (Glibc 2.19, Kernel 3.18.20) 64bit
Intel® Flash Image Tool		X	X		X	X		X				
Intel® Flash Programming Tool	X		X	X			X	X	X	X	X	X
Intel® TXEManuf Tool	X		X	X			X	X	X	X	X	X
Intel® TXE Info Tool	X		X	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						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.

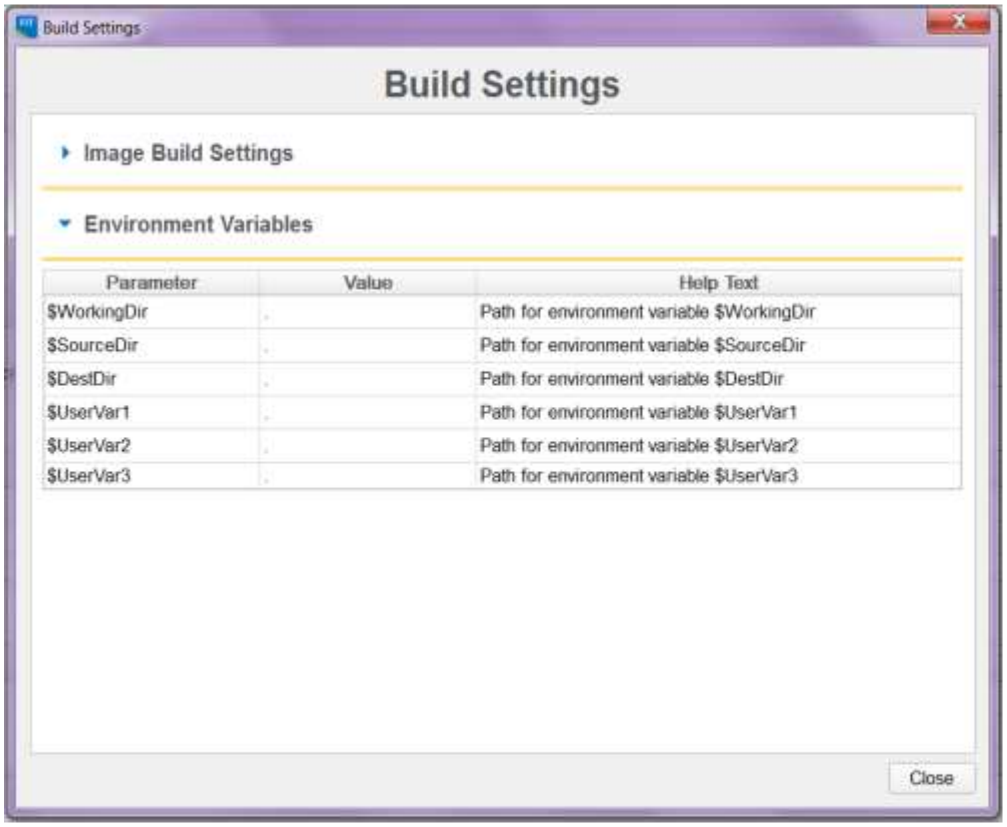
To modify the environment variables:

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.

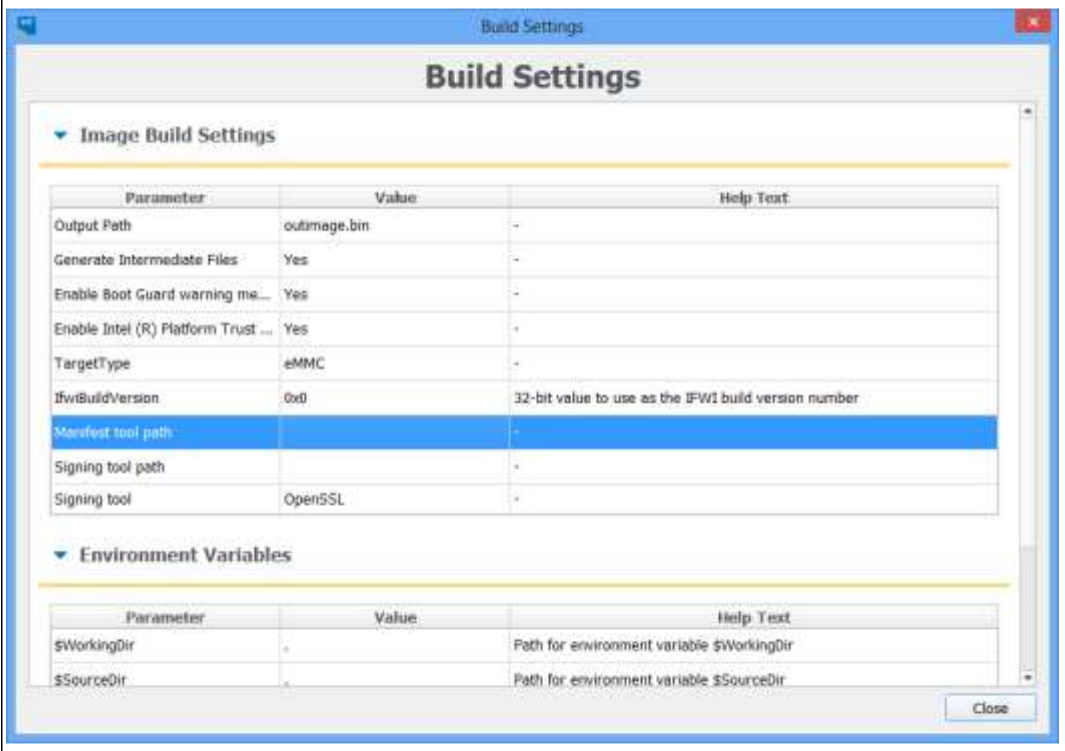
To modify the build setting:

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

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

Close

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.

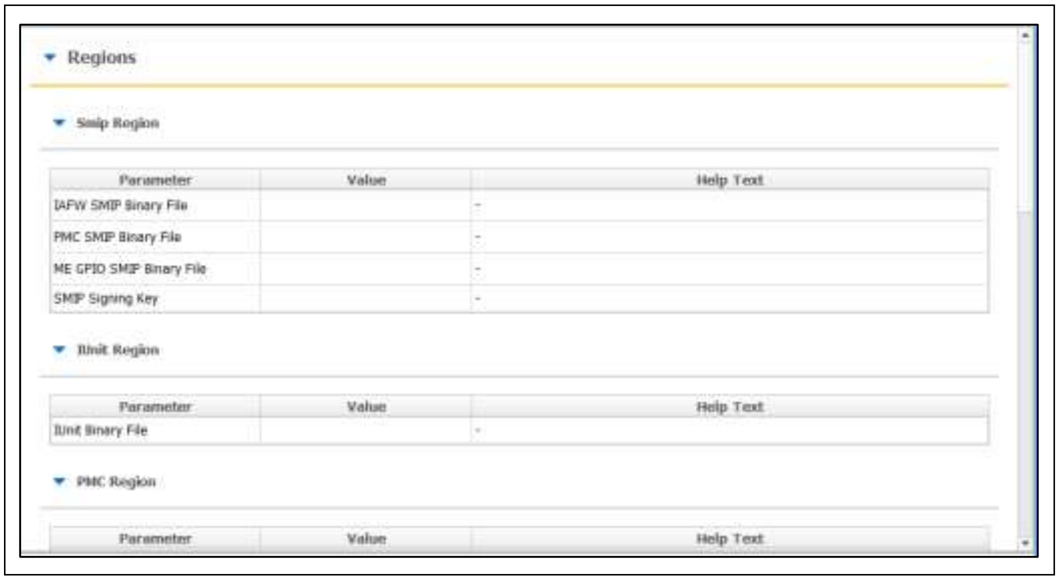
Table 3-4: Target Platform and Flash Options

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:

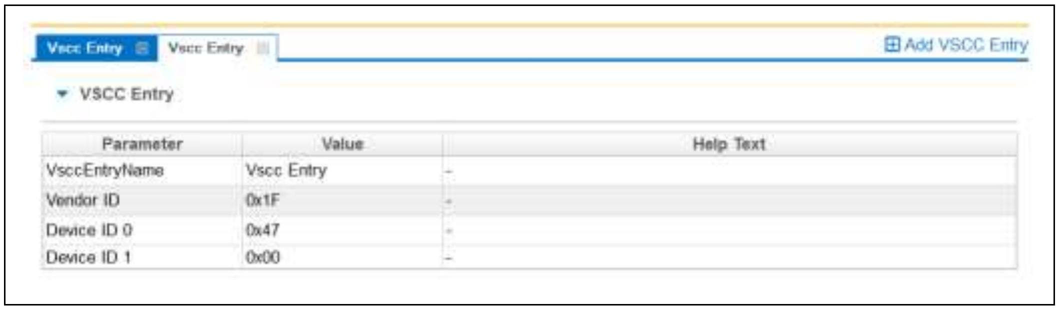
1. Select Flash Settings Tab on the left pan
2. Expand VSCC Entries on the right pan as shown in Figure 9 below:

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.

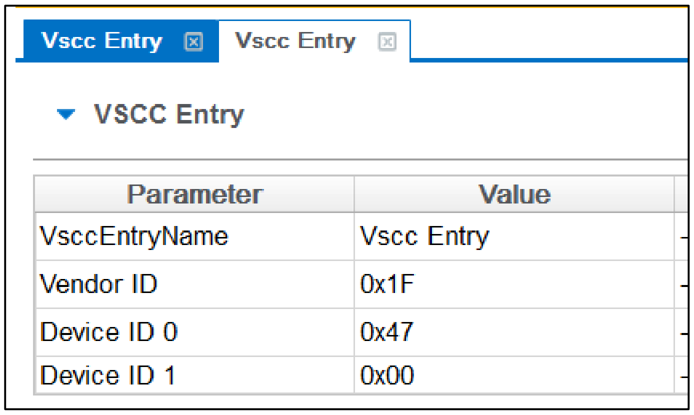
NOTES: If the descriptor region is being built manually the user will need to reference the VSCC table information for the parts being supported from the manufacturers' serial flash data sheet. The Apollo Lake SPI Programming Guide should be used to calculate the VSSC values.

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

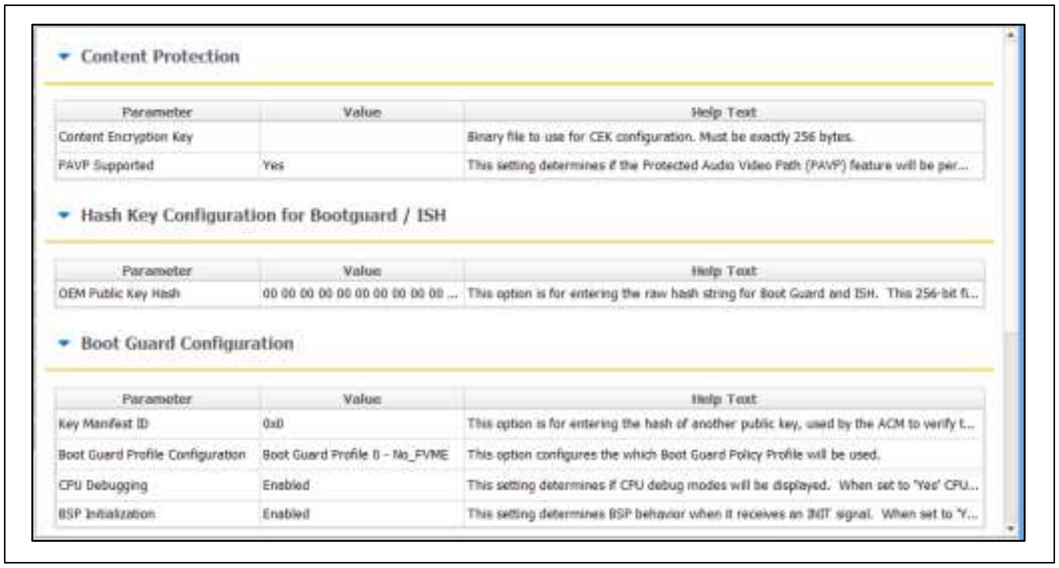
This tab includes many settings relating to the protection of the platform, and its integrity. In particular, it includes

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.

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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 is executed at the end of manufacturing phase. This option does the following: CloseMnf does the following: Commits all FPFs (if firmware is PV), even if CommitFPF was not called Does RPMB binding Sets SOC Config lock Sets all 'Return to Factory Defaults' to default values Creates eMMc/UFS data partitions Sets the Intel® TXE manufacturing mode done bit (Global Locked bit).

Option	Description
	Verifies that the Intel® TXE manufacturing mode done bit (Global Locked) is set. For SPI, sets the master region access permission in the Descriptor region to its Intel-recommended value, and verifies that flash regions are locked. 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 through the CF9GR mechanism. 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: In order to allow FPT to perform a global reset, BIOS should not lock CF9GR when Intel® TXE is in manufacturing mode. This step is highly recommended to the manufacturing process. Without doing proper end of manufacturing process would lead to ship platform with potential security/privacy risk. Important: Before using this option with Production MCP / FW verify that the values for the PTT and Anchor Cove are correct in your image. Once this setting is used it will permanently commit 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

Option	Description
-PAGE	Pauses the screen when a page of text has been reached. Hit any key to continue.
-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.

Option	Description
-ERRLIST <test name>	Return a list of available codes
-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
```

§ §

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.

§ §

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

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

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

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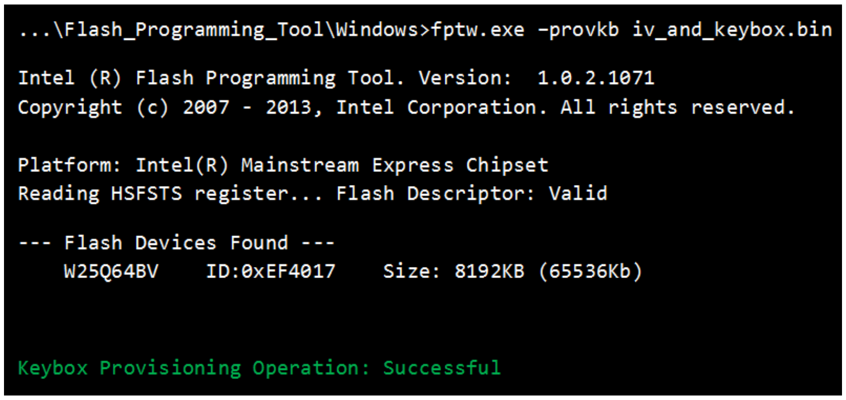
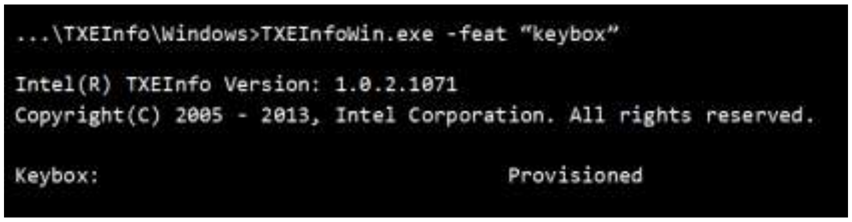
9 Widevine* KeyBox Provisioning Procedure

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>



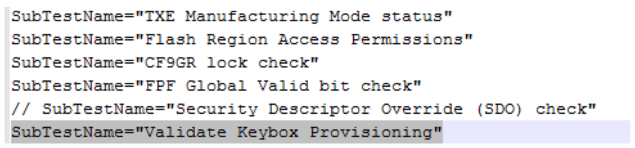
```
...\Flash_Programming_Tool\Windows>fptw.exe -provkb iv_and_keybox.bin

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"



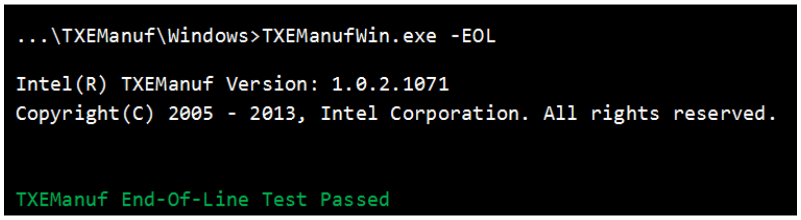
```
...\TXEInfo\Windows>TXEInfoWin.exe -feat "keybox"

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

Fixed Offset Name	FPT ID	Fixed Offset ID	Description	Data Length (in Bytes)	Expected Value	Secure	Reset Type
Non-Application Specific Fixed Offset Item Descriptions							
OEMSkuRule	7	0x000A	UINT32 (little endian) value. This controls what features are permanently disabled by OEM. **Notes:** **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.** 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.	4	Feature Capable: 1 Feature Permanently disabled: 0	**No**	**Global**

Bit	Description	Notes
31	Near Field Communication	1
30	Reserved	
29:22	Reserved	
21	TLS	
20	DAL	
19	Reserved	
18	Reserved	
17	Reserved	
16	Reserved	
15:13	Reserved	
12	PAVP	
11:6	Reserved	

Fixed Offset Name	FPT ID	Fixed Offset ID	Description	Data Length (in Bytes)	Expected Value	Secure	Reset Type
					<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>		
Feature Shipment Time State	8	0x000B	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 **Notes:** **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.**	4	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>	**No**	**Global**
OEM_TAG	34	0x000F	A human readable 32-bit number to describe the flash image represented by value	4	Readable 32 bit hex value identifying the image. Can be empty (Null).	**No**	**TXE**
Revenue Sharing Related CVAR Item Descriptions							
ODM_ID		0x5003	CVAR used for setting the ODM 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**

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 Common Error Code for All Tools

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

Error Code	Error Message	Response
0	Success	
1	Memory allocation error occurred	Make sure there is enough memory in the system
2	Invalid descriptor region	Check descriptor region
3	Region does not exist	Check region to be programmed
4	Failure. Unexpected error occurred	Contact Intel
5	Invalid data for Read ID command	Contact Intel
6	Error occurred while communicating with SPI device	Check SPI device
7	Hardware sequencing failed. Make sure that access permissions are correct for the target flash area	Check descriptor region access settings
8	Software sequencing failed. Make sure that access permissions are correct for the target flash area	Check descriptor region access settings
9	Unrecognized value in the HSFSTS register	Unrecognized value in the HSFSTS register
10	Hardware Timeout occurred in SPI device	Hardware Timeout occurred in SPI device
11	AEL is not equal to zero	AEL is not equal to zero
12	FCERR is not equal to zero	FCERR is not equal to zero
25	The host CPU does not have writes access to the target flash area. To enable write access for this operation the user needs to modify the descriptor settings to give host access to this region.	Check descriptor region access settings
26	The host CPU does not have read access to the target flash area. To enable read access for this operation the user needs to modify the descriptor settings to give host access to this region.	Check descriptor region access settings

Error Code	Error Message	Response
27	The host CPU does not have erase access to the target flash area. To enable erase access for this operation the user needs to modify the descriptor settings to give host access to this region.	Check descriptor region access settings
28	Protected Range Registers are currently set by BIOS, preventing flash access. 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. If Protected Range Registers (memory location: SPIBAR + 74h -> 8Fh) are still set, contact the target BIOS vendor.
50	General Erase failure	Attempt the command again. If it fails again, contact Intel.
51	An attempt was made to read beyond the end of flash memory	Check address
52	An attempt was made to write beyond the end of flash memory	Check address
53	An attempt was made to erase beyond the end of flash memory	Check address
54	The address <address> of the block to erase is not aligned correctly	Check address
55	Internal Error	Contact Intel
56	The supplied zero-based index of the SPI Device is out of range.	The supplied zero-based index of the SPI Device is out of range.
57	AEL or FCERR is not equal to zero for Software Sequencing	AEL or FCERR is not equal to zero for Software Sequencing
75	File not found	Check file location
76	Access was denied opening the file	Check file location
77	An unknown error occurred while opening the file	Verify the file is not corrupt
78	Failed to allocate memory for the flash part definition file	Check system memory Verify the file is not corrupt
79	Failed to read the entire file into memory	Check system memory Verify the file is not corrupt
80	Parsing of file failed	Check system memory Verify the file is not corrupt
100	This error can occur if both Software and Hardware sequencing are not available and the SPI Flash configuration registers are write protected by the Flash Configuration Lock-Down bit (FLOCKDN). Contact the BIOS vendor to unlock this bit or enable hardware sequencing in descriptor mode.	Check with BIOS vendor or SPI programming Guide

Error Code	Error Message	Response
101	No SPI flash device could be identified. Please verify if Fparts.txt has support for this part	Verify Fparts.txt contains device supported.
102	Failed to read the device ID from the SPI flash part	Verify Fparts.txt has correct values
103	There are no supported SPI flash devices installed. Check connectivity and orientation of SPI flash device	Verify Fparts.txt has correct values. Check SPI Device
104	The two SPI flash devices do not have compatible command sets	Verify both SPI devices on the system are compatible
105	An error occurred while writing to the write status register of the SPI flash device. This program will not be able to modify the SPI flash	Check SPI Device
202	Confirmation is not received from the user to perform operation.	
203	Flash is not blank	
204	Data verify mismatch found	
205	Unexpected failure occurred	
207	Invalid parameter value specified by user. The option specified cannot be run on a platform with Intel® TXE Ignition FW	
208	Intel® TXE is disabled	
209	Intel® TXE failed to reset	
210	Requesting Intel® TXE FW Reset failure.	
211	Communications error between FPT and the Intel® TXE.	
212	The request to disable the Intel® TXE failed.	
213	Intel® TXE disable is not required	
214	Intel® TXE is already disabled	
215	The attempt to commit the CVARs has failed.	
216	The Close Manufacturing process failed.	
217	Setting Global Reset Failed	
240	Access was denied opening the file	
241	Access was denied creating the file	
242	An unknown error occurred while opening the file	
243	An unknown error occurred while creating	
244	Not a valid file	
245	File not found error	
246	Failed to read the entire file into memory	
247	Failed to write the entire flash contents to file	

Error Code	Error Message	Response
248	File already exists	
249	The file is longer than the flash area to write.	
250	The file is smaller than the flash area to write.	
251	Length of image file extends past the flash area.	
252	Image file not found.	
253	File does not exist	
254	Not able to open the file	
255	Error occurred while reading the file	
256	Error occurred while writing to the file	
280	Failed to disable write protection for the BIOS space	
281	The Enable bit in the LPC RCBA register is not set. The value of this register cannot be used as the SPI BIOS base address.	
282	Failed to get information about the installed flash devices	
283	Unable to write data to flash.	
284	Fail to load driver (PCI access for Windows*). The tool needs to run with an administrator privilege account.	
320	FPT General failure error	
321	The address is outside the boundaries of the flash area.	
360	Invalid Block Erase Size value in	
361	Invalid Write Granularity value in	
362	Invalid Enable Write Status Register Command value	
363	Invalid Chip Erase Timeout value	
360	Invalid Block Erase Size value in	
361	Invalid Write Granularity value in	
362	Invalid Enable Write Status Register Command value	
363	Invalid Chip Erase Timeout value	
360	Invalid Block Erase Size value in	
361	Invalid Write Granularity value in	
362	Invalid Enable Write Status Register Command value	
363	Invalid Chip Erase Timeout value	
440	Invalid Fixed Offset variable name	

Error Code	Error Message	Response
441	CVAR invalid variable ID	
442	Param file is already opened	
443	CVAR exists already	
444	Invalid name or Id of CVAR	
445	Invalid length of CVAR value. Check CVAR configuration file for correct length	
446	Password does not match the criteria.	
447	Error occurred while reading CVAR configuration file	
448	Invalid hash certificate file	
449	Valid PID/PPS/Password records are not found in	
450	Invalid Intel® TXE Manufacturing Mode Done value entered	
451	Unable to get master base address from the descriptor.	
452	Verification of End Of Manufacturing settings failed	
453	End Of Manufacturing Operation failure - Verification failure on Intel® TXE Manufacturing Mode Done settings	
454	End Of Manufacturing Operation failure - Verification failure on Intel® TXE Manuf counter.	
455	End Of Manufacturing Operation failure - Verification failure on Descriptor Lock settings.	
456	Invalid hexadecimal value entered for the CVAR	
457	Parsing of file failed	
481	The setup file version is unsupported	
483	The given buffer length is invalid	
484	the record chunk count cannot contain all of the setup file record data	
485	the setup file header indicates that there are no valid records (RecordsConsumed >= RecordCount)	
486	the given buffer is invalid	
487	A record entry with an invalid Module ID was encountered.	
488	A record was encountered with an invalid record number.	
489	The setup file header contains an invalid module ID list.	

Error Code	Error Message	Response
490	The setup file header contains an invalid byte count.	
491	The setup file record id is not found	
492	The list of data record entries is invalid.	
495	The PID is invalid.	
496	The PPS is invalid.	
497	The PID checksum failed.	
498	The PPS checksum failed.	
501	The data record is missing a PID entry.	
502	The data record is missing a PPS entry.	
503	The header chunk count cannot contain all of the setup file header data.	
504	The requested index is invalid.	
505	Failed to write to the given file.	
506	Failed to read from the given file.	
507	Failed to create random numbers.	
508	The data record is missing a PKI DNS Suffix entry.	
509	The data record is missing a Config Server FQDN entry.	
511	The data record is missing a Pre-Installed Certificate enabled entry.	
512	The data record is missing a User defined certificate config entry.	
513	The data record is missing a User defined certificate Add entry.	
515	OEM Firmware Update Qualifier data missing in USB file.	
1000	Invalid command line option(s)	
1001	Unsupported OS	
8192	General error	
8193	Cannot locate Intel® TXE device	
8194	Memory access failure	
8195	Write register failure	
8196	OS failed to allocate memory	
8197	Circular buffer overflow	
8198	Not enough memory in circular buffer	
8199	Communication error between application and Intel® TXE <HECI command name>	Contact Intel

Error Code	Error Message	Response
8200	Unsupported HECI bus message protocol version	
8201	Unexpected interrupt reason	
8203	Unexpected result in command response <HECI command name>	Contact Intel
8204	Unsupported message type	
8205	Cannot find host client	
8206	Cannot find Intel® TXE client	
8207	Client already connected	
8208	No free connection available	
8209	Illegal parameter	
8210	Flow control error	
8211	No message	
8212	Requesting HECI receive buffer size is too large	
8213	Application or driver internal error	
8214	Circular buffer not empty	

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

Error Code	Error Message
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
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 Intel® TXEManuf Errors

Error Codes	Error Messages
9248	Intel® TXE internal communication error (BIST)
9249	Intel® TXE internal communication error (FW)
9250	Used by IBX, not used by CPT, TXE8

Error Codes	Error Messages
9251	Fail to create verbose log file %s. Where %s is the log file name user specified.
9252	Used by IBX, not used by CPT, TXE8
9254	Used by IBX, not used by CPT, TXE8
9255	Internal error
9256	Communication error between host application and Intel® TXE FW
9261	Hibernation isn't supported by the OS, Intel® TXE test cannot run
9262	Used by IBX, not used by CPT, TXE8
9263	Used by IBX, not used by CPT, TXE8
9264	Used by IBX, not used by CPT, TXE8
9265	Used by IBX, not used by CPT, TXE8
9266	Used by IBX, not used by CPT, TXE8
9267	Fail to establish a communication with SPI flash interface
9268	Fail to load vsccommn.bin
9269	Zero flash device found for VSCC check
9270	Fail to load driver (PCI access for Windows*) Tool needs to run with an administrator priviledge account.
9271	Flash ID 0x%06X Intel® TXE VSCC mismatch Programmed value of 0x%X doesn't match the recommended value of 0x%X See PCH SPI programming Guide for more details
9272	No recommended TXE VSCC value found for flash ID 0x%06X
9273	Intel® VE is disabled by PCH SoftStrap, not used by TXE8
9275	Used by IBX, not used by CPT
9276	Fail to read FW Status Register value 0x%X
9277	Intel® VE internal error, not used by TXE8
9278	Cannot locate hardware platform identification This program cannot be run on the current platform. Unknown or unsupported hardware platform or A %s hardware platform is detected This program cannot be run on the current platform. Unknown or unsupported hardware platform Where %s is the official name of the hardware platform
9279	SPI flash Intel® TXE region is not locked

Error Codes	Error Messages
9280	Intel® Gbe/TXE has read or write access to BIOS region
9281	SPI flash descriptor region is not locked
9282	BIOS has granted Intel® Gbe and/or Intel® TXE access to its region
9283	Region access permissions don't match Intel recommended values
9284	Read firmware flash master region permission failure
9285	Used by IBX, not used by CPT, TXE8
9286	Used by IBX, not used by CPT, TXE8
9287	Used by IBX, not used by CPT, TXE8
9288	Used by IBX, not used by CPT, TXE8
9289	Used by IBX, not used by CPT, TXE8
9290	Used by IBX, not used by CPT, TXE8
9291	Used by IBX, not used by CPT, TXE8
9295	Used by IBX, not used by CPT, TXE8
9296	TXEINFO Test Failed Or TXEINFO End-Of-Line Test Failed Or TXEINFO Operation Failed
9297	Intel® NAND needs to be enabled to perform the test, not used by TXE8
9298	Used by IBX, not used by CPT
9299	Single flash part found, Flash Partition Boundary Address must be zero
9300	Flash Partition Boundary Address should be in between flash parts
9301	The two flash parts on this platform require different BIOS VSCC values
9302	Intel® NAND module test failed (feature not enabled), not used by TXE8
9303	Memory allocation failed for checking variable "<Variable Name>"
9304	Variable "<Variable Name>" mismatch, actual value is - <Variable Value>
9305	Intel® TXE firmware version mismatch, actual value is - <Version String> Intel® Gbe version mismatch, actual value is - <Version String> BIOS version mismatch, actual value is - <Version String>
9307	Intel® Wired/Wireless LAN MAC address mismatch, feature is not supported Intel® Wired/Wireless LAN MAC address mismatch, actual value is - <MAC Address>
9308	Security Descriptor Override Strap (SDO) is enabled
9309	End-Of-Post message is not sent
9310	Unable to determine Intel® TXE Manufacturing Mode status Intel® TXE is still in Manufacturing Mode
9311	Intel® TXE test failed to start, error 0x%X returned

Error Codes	Error Messages
9312	Intel® TXE test timeout (exceeded 30 seconds)
9313	No Intel® TXE test result to retrieve, not used by TXE8
9314	Intel® TXE test result reports error(s), not used by TXE8
9315	Intel® TXE test is currently running, try again
9316	Intel® TXE cannot run Full BIST. Possible Causes: (1) Power package 2 not supported, (2) This is a mobile system with DC power
9317	No valid OEM ICC data programmed
9318	TXEINFO End-Of-Line Test config file generation failed
9319	CIRA service button is broken, not used by TXE8
9320	Internal error
9321	TXEINFO End-Of-Line Test Failed
9322	TXEINFO Operation Failed
9324	CM3 results are not available from SPI. Please run –test option to perform the BIST test
9325	Failed to delete CM3 results from SPI
9326	CM3 test failed
9327	CM3 test failed
9328	Internal error
9329	Internal error
9330	Internal error
9331	SMBus hardware is not ready
9332	Internal error
9333	SMBus encountered time-out
9334	Failed to retrieve password from SPI
9335	Internal error
9336	Internal error
9337	Internal error
9338	Failed to retrieve test result from SPI
9339	Failed to retrieve power rule from SPI
9340	Failed to retrieve power source
9341	Failed to retrieve PROC_MISSING_CVAR setting
9342	PROC_MISSING_CVAR setting is set incorrectly
9343	Internal error
9344	Failed to retrieve power package setting
9345	Failed to retrieve CM3 Power Rails Availability setting
9346	CM3 Power Rails Availability setting is set incorrectly

Error Codes	Error Messages
9347	Power source is not AC
9348	Internal error
9349	Internal error
9350	Internal error
9351	Length of OEM Customizable Certificate Friendly Name setting is set incorrectly
9352	OEM Customizable Certificate Stream setting is set incorrectly
9353	OEM Customizable Certificate Hash Algorithm setting is set incorrectly
9354	Length of OEM Customizable Certificate Stream is set incorrectly
9358	LAN power well setting is set incorrectly
9359	Power Pkg 2 Supported is set incorrectly
9360	USBr EHCI 1 Enabled and/or USBr EHCI 2 Enabled setting is set incorrectly
9362	Internal error
9363	Internal error
9364	The compressed data is incorrect
9365	Intel integrated LAN setting is set incorrectly
9366	Intel LAN connected Device (PHY) physical connectivity error with TXE
9367	Firmware is in recovery mode
9368	SMBus address is not configured correctly
9369	Could not register for SMBus alert
9370	Communication interference
9371	SMBUS connection failed. Check connection or SMBUS address
9372	GPIO connection failed. Check connection or GPIO configuration
9373	NFC Radio – Unknown error
9374	NFC RF Test – Error returned from radio
9375	NFC RF Test – Communication interference or bad response returned from radio
9376	NFC RF Test – Timeout

B.4 Intel® TXEINFO Errors

Error Code	Error Messages
9452	Communication error between application and Intel® TXE module (iCLS client)
9455	Failed to read FW Status Register value 0x%X
9457	Failed to create verbose log file %s: Where %s is the log file name user specified

Error Code	Error Messages
9458	Communication error between application and Intel® TXE module (FW Update client)
9459	Internal error (Could not determine FW features information)
9460	Cannot locate hardware platform identification This program cannot be run on the current platform. Unknown or unsupported hardware platform Or A %s hardware platform is detected This program cannot be run on the current platform. Unknown or unsupported hardware platform Where %s is the official name of the hardware platform
9461	Communication error between application and Intel® TXE module (HCI client)
9462	Communication error between application and Intel® TXE module (Kernel Client)
9467	Cannot use zero as SPI Flash ID index number
9468	Couldn't find a matching SPI Flash ID
9469	Access to SPI Flash device(s) failed
9470	Failed to load driver (PCI access for Windows*) Tool needs to run with an administrator privilege account.
9471	Invalid feature name XXXXX: Where XXXXX is the feature name
9472	XXXXX feature was not available: Where XXXXX is the feature name
9473	XXXXX actual value is – YYYYY: Where XXXXX is the feature name Where YYYY is the feature value
9474	Error reporting revenue share information – Invalid index used
9475	Error reporting revenue share information – Index already in use
9476	Error reporting revenue share information – Slot is empty

B.5 FPT Errors

Error Code	Error
Invalid Parameters	
200	Invalid parameter value specified by the user. Use -? Option to see help.
Invalid Verbose File	
254	Not able to open the file <FILENATXE>.
Unsupported Platform	

Error Code	Error
201	<EXENATXE> cannot be run on the current platform. Please contact your vendor.
Unsupported OS	
9254	Unsupported OS
Commit CVARs Operation	
517	Get CVAR - Read Failed
518	Get CVAR - Invalid CVAR specified
519	Get CVAR - Out of Memory
520	Get CVAR - Blob Integrity Failed
8193	Intel® TXE Interface : Cannot locate Intel® TXE device driver
8199	Intel® TXE Interface : Intel® TXE Device not ready for data transmission
8204	Intel® TXE Interface : Unsupported message type
8213	Intel® TXE Interface : Buffer too small
Compare CVAR(s) Operation	
518	Get CVAR - Invalid CVAR specified
519	Get CVAR - Out of Memory
520	Get CVAR - Blob Integrity Failed
8193	Intel® TXE Interface : Cannot locate Intel® TXE device driver
8199	Intel® TXE Interface : Intel® TXE Device not ready for data transmission
8204	Intel® TXE Interface : Unsupported message type
8213	Intel® TXE Interface : Buffer too small
Retrieve CVAR Operation	
518	Get CVAR - Invalid CVAR specified
519	Get CVAR - Out of Memory
520	Get CVAR - Blob Integrity Failed
8193	Intel® TXE Interface : Cannot locate Intel® TXE device driver
8199	Intel® TXE Interface : Intel® TXE Device not ready for data transmission
8204	Intel® TXE Interface : Unsupported message type
8213	Intel® TXE Interface : Buffer too small
Updating Parameters Operations	
506	Failed to read from the given file.
3003	Error occurred while opening image file
3004	Parsing of image file failed
3005	Heci communication failed
3006	File does not exist

Error Code	Error
3007	Operating system is not supported
3009	User defined certificate hash table is full
3010	Unable to start HECI
3011	Invalid input file name
3012	Chipset not supported by the tool
3013	PID value is NULL
3014	PPS value is NULL
3015	Configuration Server FQDN value is NULL
3016	PKI DNS Suffix value is NULL
3017	Host Name value is NULL
3018	Domain Name value is NULL
3054	Unable to create Logfile
3055	System failed to retrieve current firmware feature state.
3056	Unable to Save updated parameter as factory defaults on FW image.
3057	Unable to complete CVAR commit option.

B.6 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
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

Error Code	Error
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.

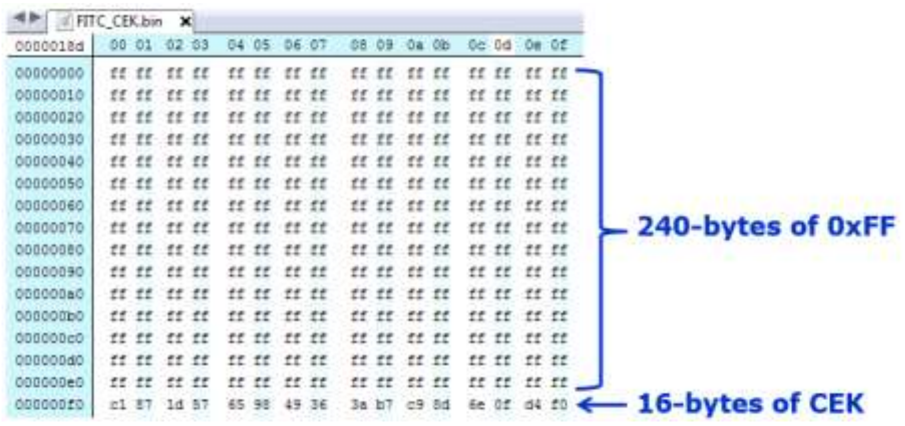
Note: The below key files are for demonstration purposes only and are not actual keys.

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



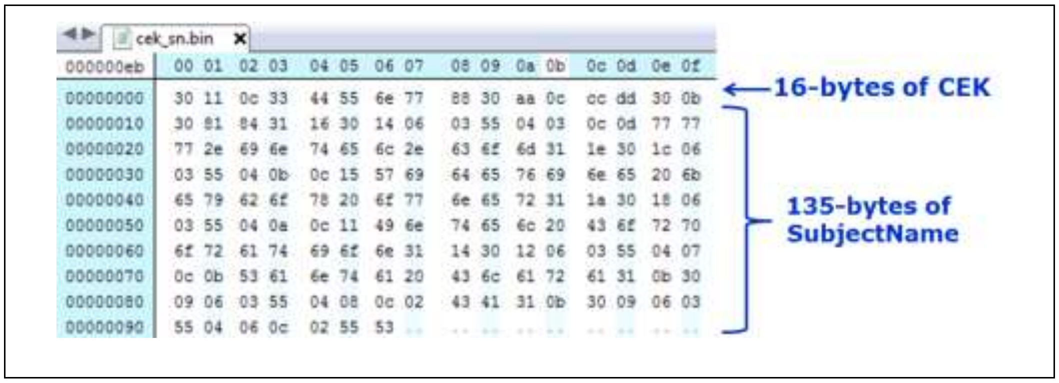
```
0000018d  00 01 02 03  04 05 06 07  08 09 0a 0b  0c 0d 0e 0f
00000000  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000010  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000020  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff ff ff
00000030  ff ff ff ff  ff ff ff ff  ff ff ff ff  ff ff 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
```

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

E.1.1.2 Ciphertext CEK

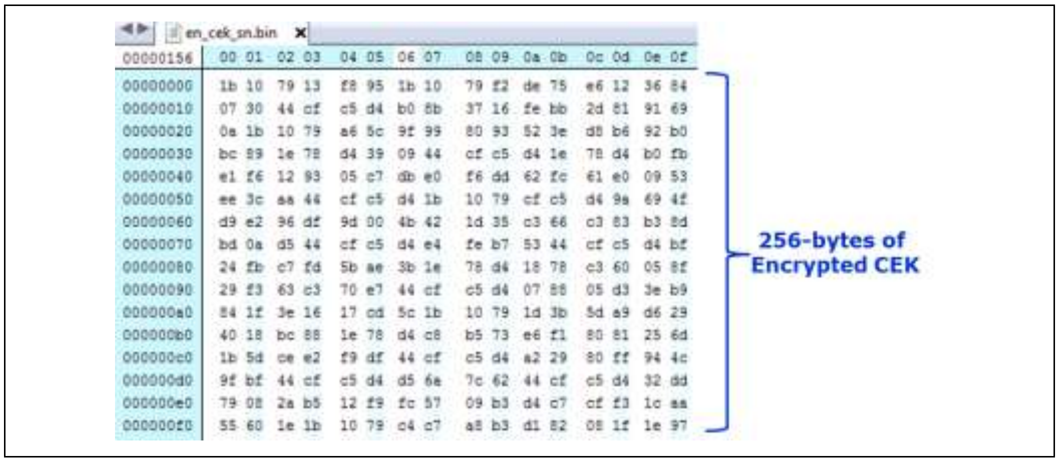
Note: Customer should scope relevant Google* documentation and decide on CEK insertion method. Intel recommended method is ciphertext

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



```
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



```
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 6e  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.

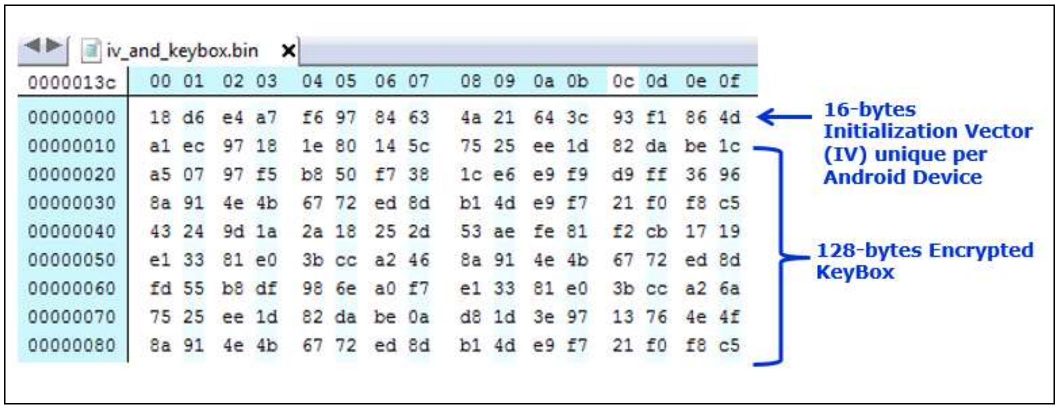
E.2.1 KeyBox Creation Procedure

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.
   <u>Example of encrypting KB with IV & CEK using AES-CBC</u>:

   ```
   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
```