

## Document information

Information	Content
Keywords	eIQ, Media, Media Processing, Processing Pipeline, Library
Abstract	This document describes the Media Processing Pipeline software library for MCUs. The library is used for constructing media-handling components graphs for Vision-specific applications.

## 1 MCU Media Processing Pipeline

This document describes the MCU Media Processing Pipeline API.

### 1.1 Features overview

The Media Processing Pipeline for MCUs is a software library for constructing graphs of media-handling components for Vision-specific applications.

This is a clean and simple API which makes it easy to build and prototype vision-based applications.

#### 1.1.1 Concept

The concept behind the API is to create a Media Processing Pipeline (MPP) based on processing elements. The basic pipeline structure - the *mpp* in the API context - has a chain/queue structure which begins with a **source element**:

- Camera
- Static image

The pipeline continues with multiple **processing elements** having a single input and a single output:

- Image format conversion
- Labeled rectangle drawing
- Machine learning inference with two frameworks:
  - Tensorflow Lite Micro
  - GLOW

The pipeline can be closed by adding a **sink element**:

- Display panel
- Null sink

Also, multiple basic *mpps* can be **joined** into a new one to which further elements can be added. An *mpp* can also be **split** when the same media stream must follow different processing paths. With these join/split operations, more complex pipelines can be constructed.

Compatibility of elements and supplied parameters are checked at each step and only compatible elements can be added in an unequivocal way.

After the construction is complete, each *mpp* must be started for all hardware, and software required to run the pipeline to initialize. Pipeline processing begins as soon as the the last start call is flagged.

Each pipeline branch can be stopped individually. The process involves stopping the execution and the hardware peripherals of the branch. After being stopped, each branch can be started again. To stop the whole pipeline, you must stop each of its branches separately.

At runtime, the application receives events from the pipeline processing and may use these events to update the elements parameters. For example, in object detection when the label of a bounding box must be updated whenever a new object is detected.

Summarizing, the application controls:

- Creation of the pipeline
- Instantiation of processing elements
- Connection of elements to each other
- Reception of callbacks based on specific events
- Updating specific elements (not all elements can be updated)
- Stopping the pipeline (includes shut down of the hardware peripherals)

Application does not control:

- Memory management
- Data structures management

The order in which an element is added to the pipeline defines its position within this pipeline, and therefore the order is important.

## 1.2 Example and references

See the examples/reference documentation for practical examples using the MPP API.

## 2 Deployment

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The eIQ Media Processing Pipeline is part of the eIQ machine learning software package, which is an optional middleware component of MCUXpresso SDK.

The eIQ component is integrated into the MCUXpresso SDK Builder delivery system available on [mcuxpresso.nxp.com](https://mcuxpresso.nxp.com).

To include eIQ Media Processing Pipeline into the MCUXpresso SDK package, select both “eIQ” and “FreeRTOS” in the software component selector on the SDK Builder page.

For details, see, [Figure 1](#).

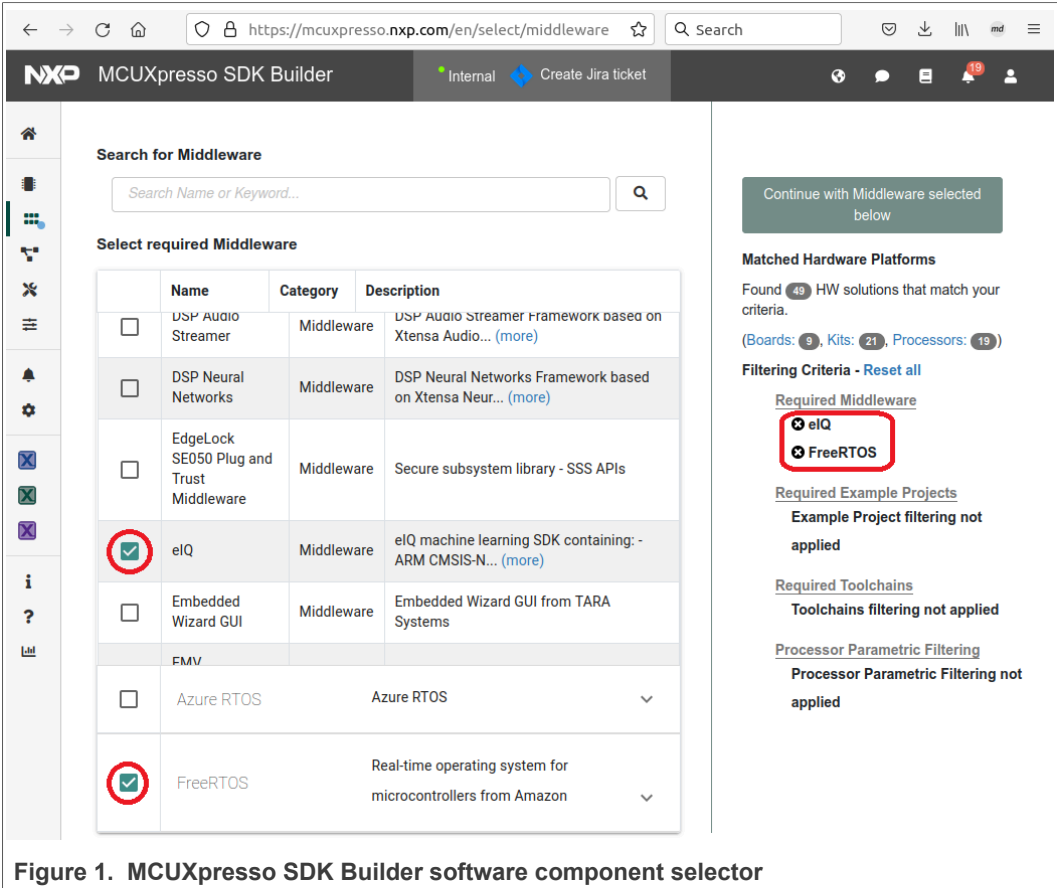


Figure 1. MCUXpresso SDK Builder software component selector

Once the MCUXpresso SDK package is downloaded, it can be extracted on a local machine or imported into the MCUXpresso IDE. For more information on the MCUXpresso SDK folder structure, see the Getting Started with MCUXpresso SDK User's Guide (document: [MCUXSDKGSUG](#)). The package directory structure is similar to [Figure 2](#) and [Figure 3](#). The eIQ Media Processing Pipeline directories are highlighted in red.

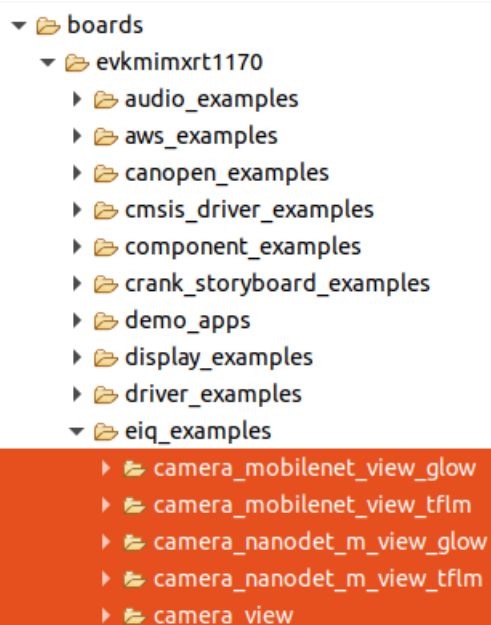
- 
- ```
▼ boards
  ▼ evkmimxrt1170
    ▶ audio_examples
    ▶ aws_examples
    ▶ canopen_examples
    ▶ cmsis_driver_examples
    ▶ component_examples
    ▶ crank_storyboard_examples
    ▶ demo_apps
    ▶ display_examples
    ▶ driver_examples
    ▼ eiq_examples
      ▶ camera_mobilenet_view_glow
      ▶ camera_mobilenet_view_tflm
      ▶ camera_nanodet_m_view_glow
      ▶ camera_nanodet_m_view_tflm
      ▶ camera_view
```
- The image shows a directory tree for the MCUXpresso SDK. The 'boards' directory is expanded, showing the 'evkmimxrt1170' sub-directory. Inside 'evkmimxrt1170', there are several example directories: 'audio\_examples', 'aws\_examples', 'canopen\_examples', 'cmsis\_driver\_examples', 'component\_examples', 'crank\_storyboard\_examples', 'demo\_apps', 'display\_examples', 'driver\_examples', and 'eiq\_examples'. The 'eiq\_examples' directory is further expanded, showing five sub-directories: 'camera\_mobilenet\_view\_glow', 'camera\_mobilenet\_view\_tflm', 'camera\_nanodet\_m\_view\_glow', 'camera\_nanodet\_m\_view\_tflm', and 'camera\_view'. The 'eiq\_examples' directory and its contents are highlighted with an orange background.

Figure 2. MCUXpresso SDK directory structure for examples

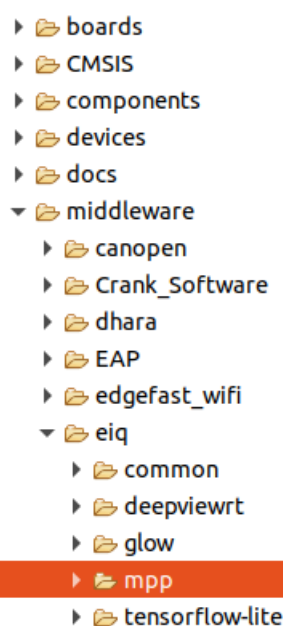
- 
- ```
▶ boards
▶ CMSIS
▶ components
▶ devices
▶ docs
▼ middleware
  ▶ canopen
  ▶ Crank_Software
  ▶ dhara
  ▶ EAP
  ▶ edgefast_wifi
  ▼ eiq
    ▶ common
    ▶ deepviewrt
    ▶ glow
    ▶ mpp
    ▶ tensorflow-lite
```
- The image shows a directory tree for the MCUXpresso SDK. The 'middleware' directory is expanded, showing several sub-directories: 'canopen', 'Crank\_Software', 'dhara', 'EAP', 'edgefast\_wifi', and 'eiq'. The 'eiq' directory is further expanded, showing five sub-directories: 'common', 'deepviewrt', 'glow', 'mpp', and 'tensorflow-lite'. The 'mpp' directory is highlighted with an orange background.

Figure 3. MCUXpresso SDK directory structure for mpp

The *boards* directory contains example application projects for supported toolchains. For the list of supported toolchains, see the *MCUXpresso SDK Release Notes*. The *middleware* directory contains the eIQ library source code and example application source code and data.

### 3 Example applications

The eIQ Media Processing Pipeline is provided with a set of example applications. For details, see [Table 1](#). The applications demonstrate the usage of the API in several use cases.

**Table 1. Example applications**

Name	Description	Availability
camera_view	This basic example shows how to use the library to create two simple pipelines: <ul style="list-style-type: none"><li>• camera preview</li><li>• image view</li></ul>	EVK-MIMXRT1170
camera_mobilenet_view_tflm	This example shows how to use the library to create two image classification use-cases: <ul style="list-style-type: none"><li>• image classification using camera as source</li><li>• image classification using a file as source</li></ul> The machine learning framework used is TensorFlow Lite Micro. The image classification model used is quantized Mobilenet convolution neural network model that classifies the input image into one of 1000 output classes.	EVK-MIMXRT1170
camera_mobilenet_view_glow	This example shows how to use the library to create two image classification use-cases: <ul style="list-style-type: none"><li>• image classification using camera as source</li><li>• image classification using a file as source</li></ul> The machine learning framework used is GLOW. The image classification model used is quantized Mobilenet convolution neural network model that classifies the input image into one of 1000 output classes.	EVK-MIMXRT1170
camera_nanodet_m_view_tflm	This example shows how to use the library to create two object detection use-cases: <ul style="list-style-type: none"><li>• object detection using camera as source</li><li>• object detection using a file as source</li></ul> The machine learning framework is TensorFlow Lite Micro. The object detection model used is quantized nanodet m with two output tensors. The model performs multiple objects detection among 80 classes. The application also performs IOU and NMS to pick the best box for each detected object.	EVK-MIMXRT1170

Table 1. Example applications...continued

Name	Description	Availability
camera_nanodet_m_view_glow	<p>This example shows how to use the library to create two object detection use-cases:</p> <ul style="list-style-type: none"> <li>object detection using camera as source</li> <li>object detection using a file as source</li> </ul> <p>The machine learning framework is GLOW. The object detection model used is quantized nanodet m with two output tensors. The model performs multiple objects detection among 80 classes. The application also performs IOU and NMS to pick the best box for each detected object.</p>	EVK-MIMXRT1170

For details on how to build and run the example applications with supported toolchains, see *Getting Started with MCUXpresso SDK User's Guide* (document: MCUXSDKGSUG).

When using MCUXpresso IDE, the example applications can be imported through the SDK Import Wizard as shown in [Figure 4](#).

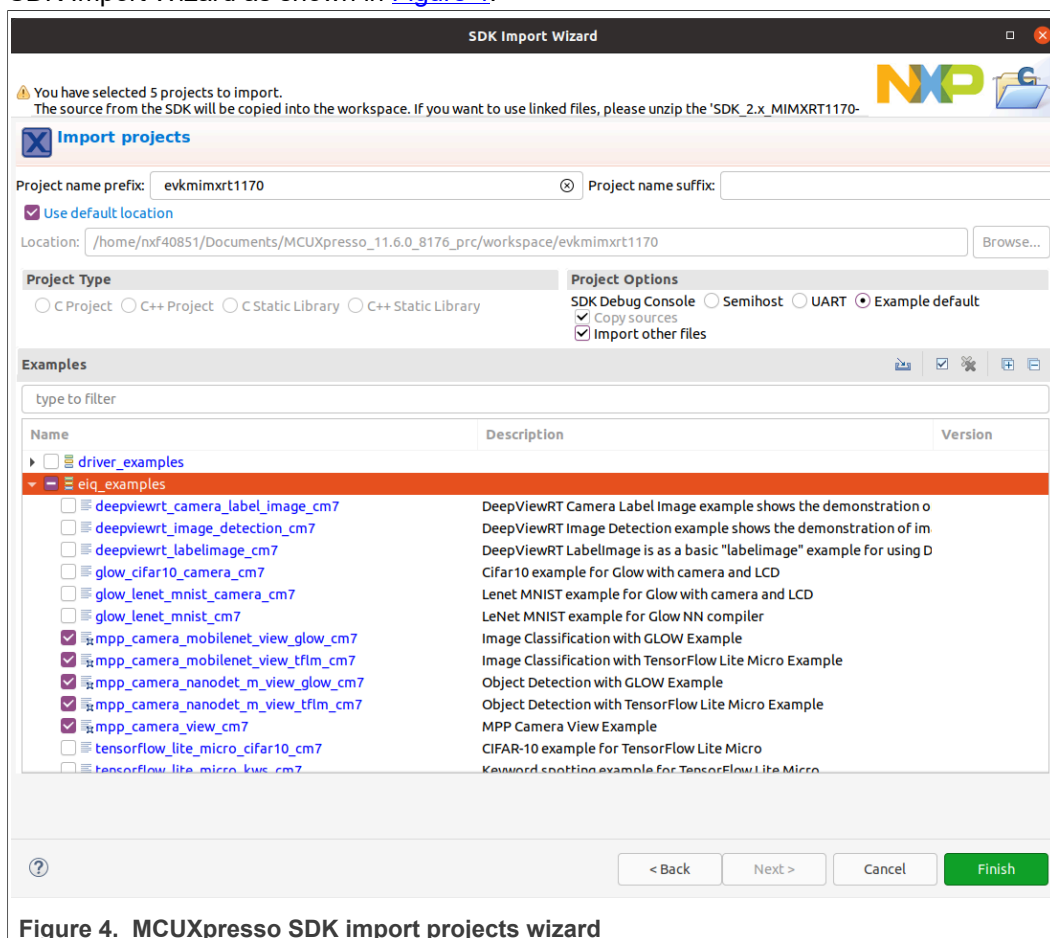


Figure 4. MCUXpresso SDK import projects wizard

After building the example application and downloading it to the target, the execution stops in the *main* function. When the execution resumes, an output message displays on the connected terminal. For example, [Figure 5](#) shows the output of the

camera\_mobilenet\_view\_tflm example application printed to the MCUXpresso IDE Console window when semihosting debug console is selected in the SDK Import Wizard.

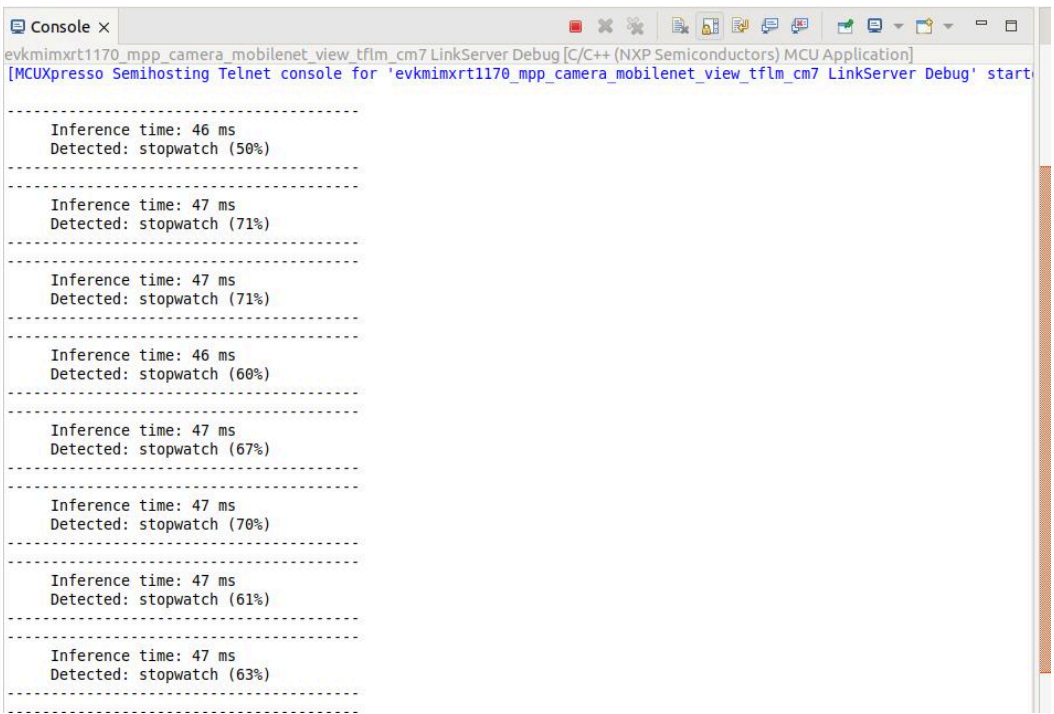


Figure 5. PuTTY console window

When building applications with armgcc, the build scripts for debug target should be edited to call `make` using more than one process.

```
make -jX
```

Where, X>1

The build scripts for armgcc are located under the directory as shown in [Figure 6](#).

























- ▼  boards
  - ▼  evkmimxrt1170
    - >  audio\_examples
    - >  aws\_examples
    - >  canopen\_examples
    - >  cmsis\_driver\_examples
    - >  component\_examples
    - >  crank\_storyboard\_examples
    - >  demo\_apps
    - >  display\_examples
    - >  driver\_examples
  - ▼  eiq\_examples
    - ▼  camera\_mobilenet\_view\_glow
      -  armgcc
    - ▼  camera\_mobilenet\_view\_tflm
      -  armgcc
    - ▼  camera\_nanodet\_m\_view\_glow
      -  armgcc
    - ▼  camera\_nanodet\_m\_view\_tflm
      -  armgcc
    - ▼  camera\_view
      -  armgcc

Figure 6. armgcc build scripts location

## 4 API references

### 4.1 Module documentation

This section provides information on:

- [MPP API](#)
- [MPP types](#)
- [Return codes](#)

#### 4.1.1 MPP API

##### 4.1.1.1 Functions

- int [mpp\\_api\\_init](#) (void)
- [mpp\\_tmpp\\_create](#) ([mpp\\_params\\_t](#) params, int ret)
- int [mpp\\_camera\\_add](#) ([mpp\\_t](#) mpp, const char name, [mpp\\_camera\\_params\\_t](#) params, \_Bool defconfig)
- int [mpp\\_static\\_img\\_add](#) ([mpp\\_t](#) mpp, [mpp\\_img\\_params\\_t](#) params, void addr)
- int [mpp\\_display\\_add](#) ([mpp\\_t](#) mpp, const char name, [mpp\\_display\\_params\\_t](#) params)
- int [mpp\\_nullsink\\_add](#) ([mpp\\_t](#) mpp)
- int [mpp\\_element\\_add](#) ([mpp\\_t](#) mpp, [mpp\\_element\\_id\\_t](#) id, [mpp\\_element\\_params\\_t](#) params, [mpp\\_elem\\_handle\\_t](#) elem\_h)
- int [mpp\\_split](#) ([mpp\\_t](#) mpp, unsigned int num, [mpp\\_exec\\_flag\\_t](#) flag, [mpp\\_t](#) out\_list)
- int [mpp\\_element\\_split](#) ([mpp\\_t](#) mpp, [mpp\\_element\\_id\\_t](#) id, [mpp\\_element\\_params\\_t](#) params, [mpp\\_t](#) out\_list, unsigned int num)
- int [mpp\\_element\\_join](#) ([mpp\\_t](#) in\_list, unsigned int num, [mpp\\_element\\_id\\_t](#) id, [mpp\\_element\\_params\\_t](#) params, [mpp\\_t](#) out)
- int [mpp\\_element\\_update](#) ([mpp\\_t](#) mpp, [mpp\\_elem\\_handle\\_t](#) elem\_h, [mpp\\_element\\_params\\_t](#) params)
- int [mpp\\_start](#) ([mpp\\_t](#) mpp, int last)
- int [mpp\\_stop](#) ([mpp\\_t](#) mpp)
- char\* [mpp\\_get\\_version](#) (void)

##### 4.1.1.2 Detailed Description

This section provides the detailed documentation for the MCU Media Processing Pipeline API.

##### 4.1.1.3 Function Documentation

###### 4.1.1.3.1 mpp\_api\_init()

```
int mpp_api_init (void)
```

Pipeline initialization.

This function initializes the library and its data structures.

It must be called before any other function of the API is called.

### Returns

[Return\\_codes](#)

#### 4.1.1.3.2 mpp\_create()

```
mpp_t mpp_create (mpp_params_t * params, int * ret)
```

Basic pipeline creation.

This function returns a handle to the pipeline.

### Parameters

in	<i>params</i>	pipeline parameters
out	<i>ret</i>	return code (0 - success, non-zero - error)

### Returns

A handle to the pipeline if success. NULL, if there is an error.

#### 4.1.1.3.3 mpp\_camera\_add()

```
int mpp_camera_add (mpp_t mpp, const char name, mpp_camera_params_t *  
params, _Bool defconfig)
```

Camera addition.

This function adds a camera to the pipeline.

in	<i>mpp</i>	input pipeline
in	<i>name</i>	camera driver name
in	<i>params</i>	parameters to be configured on the camera
in	<i>defconfig</i>	if set, default camera params are returned into the params structure

### Returns

[Return\\_codes](#)

#### 4.1.1.3.4 mpp\_static\_img\_add()

```
int mpp_static_img_add (mpp_t mpp, mpp_img_params_t params, void addr)
```

Static image addition.

### Parameters

in	<i>mpp</i>	input pipeline
in	<i>params</i>	static image parameters
in	<i>addr</i>	image buffer

**Returns**[Return\\_codes](#)**Preconditions**

Image buffer allocation/free is the responsibility of the user.

## 4.1.1.3.5 mpp\_display\_add()

```
int mpp_display_add (mpp_t mpp, const
char name, mpp_display_params_t params)
```

Display addition.

This function adds a display to the pipeline.

in	<i>mpp</i>	input pipeline
in	<i>name</i>	display driver name
in	<i>params</i>	parameters that are configured on the display

**Returns**[Return\\_codes](#)

## 4.1.1.3.6 mpp\_nullsink\_add()

```
int mpp_nullsink_add (mpp_t mpp)
```

Null sink addition.

This function adds a null-type sink to the pipeline.

After this call pipeline is closed and no further elements can be added. Input frames are discarded.

in	<i>mpp</i>	input pipeline
----	------------	----------------

**Returns**[Return\\_codes](#)

## 4.1.1.3.7 mpp\_element\_add()

```
int mpp_element_add
(mpp_t mpp, mpp_element_id_t id, mpp_element_params_t params,
mpp_elem_handle_t elem_h)
```

Add processing element (single input, single output). This function adds an element to the pipeline.

Available elements are:

- 2D image processing
- ML inference engine
- Labeled rectangle
- Compositor

in	<i>mpp</i>	input pipeline
in	<i>id</i>	element id
in	<i>params</i>	element parameters
out	<i>elem_h</i>	element handle in pipeline

**Returns**[Return\\_codes](#)

## 4.1.1.3.8 mpp\_split()

```
int mpp_split (mpp_t mpp, unsigned int num, mpp_exec_flag_t flag,
              mpp_t out_list)
```

Pipeline multiplication.

**Parameters**

in	<i>mpp</i>	input pipeline
in	<i>num</i>	number of output pipeline
in	<i>flags</i>	selecting the execution type
out	<i>out_list</i>	list of output pipelines

**Returns**[Return\\_codes](#)**Preconditions***out\_list* array must contain at least *num* elements.

## 4.1.1.3.9 mpp\_element\_split()

```
int mpp_element_split
(mpp_t mpp, mpp_element_id_t id, mpp_element_params_t params,
 mpp_t out_list, unsigned int num)
```

Branching through an element.

**Warning**

NOT TESTED

**Parameters**

in	<i>mpp</i>	input pipeline
in	<i>id</i>	element id
in	<i>params</i>	element parameters
out	<i>out_list</i>	output pipelines
in	<i>num</i>	number of output pipelines

**Returns**[Return\\_codes](#)

## 4.1.1.3.10 mpp\_element\_join()

```
int mpp_element_join (mpp_t in_list, unsigned
int num, mpp_element_id_t id, mpp_element_params_t params, mpp_t out)
```

Join multiple pipelines through an element.

The element becomes a source for output pipeline.

**Warning**

NOT TESTED

**Parameters**

in	<i>in_list</i>	list of joined pipelines
in	<i>num</i>	number of pipelines in the list
in	<i>id</i>	element id
in	<i>params</i>	element params
out	<i>out</i>	output pipeline

**Returns**

[Return\\_codes](#)

## 4.1.1.3.11 mpp\_element\_update()

```
int mpp_element_update
(mpp_t mpp, mpp_elem_handle_t elem_h, mpp_element_params_t params)
```

Update element parameters.

**Parameters**

in	<i>mpp</i>	input pipeline
in	<i>elem_h</i>	element handle in the pipeline.
in	<i>params</i>	new element parameters

**Returns**

[Return\\_codes](#)

## 4.1.1.3.12 mpp\_start()

```
int mpp_start (mpp_t mpp, int last)
```

Start pipeline.

When called with last=0, this function prepares the branch of the pipeline specified with mpp. When called with last!=0, this function starts the data flow of the pipeline.

Data flow should start after all the branches of the pipeline have been prepared.

**Parameters**

in	<i>mpp</i>	pipeline branch handle to start/prepare
----	------------	---

in	last	if non-zero start pipeline processing. No further start call is possible thereafter.
----	------	--

**Returns**[Return\\_codes](#)

## 4.1.1.3.13 mpp\_stop()

```
int mpp_stop (mpp_t mpp)
```

Stop a branch of the pipeline.

This function stops the data processing and peripherals of a pipeline branch.

**Parameters**

in	mpp	pipeline branch to stop
----	-----	-------------------------

**Returns**[Return\\_codes](#)

## 4.1.1.3.14 mpp\_get\_version()

```
char mpp_get_version (void)
```

Get MPP version.

**Returns**

Pointer to the MPP version string.

**4.1.2 MPP types****4.1.2.1 Data Structures**

- struct [mpp\\_params\\_t](#)
- struct [mpp\\_camera\\_params\\_t](#)
- struct [mpp\\_img\\_params\\_t](#)
- struct [mpp\\_display\\_params\\_t](#)
- struct [mpp\\_tensor\\_dims\\_t](#)
- struct [mpp\\_inference\\_out\\_tensor\\_param\\_t](#)
- struct [mpp\\_inference\\_cb\\_param\\_t](#)
- union [mpp\\_color\\_t](#)
- struct [mpp\\_color\\_t.rgb](#)
- struct [mpp\\_labeled\\_rect\\_t](#)
- struct [mpp\\_area\\_t](#)
- struct [mpp\\_inference\\_params\\_t](#)
- union [mpp\\_element\\_params\\_t](#)
- struct [mpp\\_element\\_params\\_t.compose](#)
- struct [mpp\\_element\\_params\\_t.labels](#)
- struct [mpp\\_element\\_params\\_t.convert](#)
- struct [mpp\\_element\\_params\\_t.resize](#)

- struct [mpp\\_element\\_params\\_t.color\\_conv](#)
- struct [mpp\\_element\\_params\\_t.rotate](#)
- struct [mpp\\_element\\_params\\_t.test](#)
- struct [mpp\\_element\\_params\\_t.ml\\_inference](#)

#### 4.1.2.2 Macros

- #define [MPP\\_INFERENCE\\_MAX\\_OUTPUTS](#)
- #define [MPP\\_INFERENCE\\_MAX\\_INPUTS](#)
- #define [MPP\\_INVALID](#)
- #define [MPP\\_EVENT\\_ALL](#)
- #define [MAX\\_TENSOR\\_DIMS](#)

#### 4.1.2.3 Typedefs

- typedef void \* [mpp\\_t](#)
- typedef uintptr\_t [mpp\\_elem\\_handle\\_t](#)
- typedef unsigned int [mpp\\_evt\\_mask\\_t](#)
- typedef typedef int(\* [inference\\_entry\\_point\\_t](#)) (uint8\_t \*, uint8\_t \*, uint8\_t \*)

#### 4.1.2.4 Enumerations

- enum [mpp\\_evt\\_t](#) { [MPP\\_EVENT\\_INVALID](#),  
[MPP\\_EVENT\\_INFERENCE\\_OUTPUT\\_READY](#), [MPP\\_EVENT\\_NUM](#) }
- enum [mpp\\_exec\\_flag\\_t](#) { [MPP\\_EXEC\\_INHERIT](#), [MPP\\_EXEC\\_RC](#),  
[MPP\\_EXEC\\_PREEMPT](#) }
- enum [mpp\\_rotate\\_degree\\_t](#) { [ROTATE\\_0](#),  
[ROTATE\\_90](#), [ROTATE\\_180](#), [ROTATE\\_270](#) }
- enum [mpp\\_flip\\_mode\\_t](#) { [FLIP\\_NONE](#), [FLIP\\_HORIZONTAL](#), [FLIP\\_VERTICAL](#),  
[FLIP\\_BOTH](#) }
- enum [mpp\\_convert\\_ops\\_t](#) { [MPP\\_CONVERT\\_NONE](#), [MPP\\_CONVERT\\_ROTATE](#),  
[MPP\\_CONVERT\\_SCALE](#), [MPP\\_CONVERT\\_COLOR](#), [MPP\\_CONVERT\\_CROP](#) }
- enum [mpp\\_pixel\\_format\\_t](#) { [MPP\\_PIXEL\\_ARGB](#), [MPP\\_PIXEL\\_RGB](#),  
[MPP\\_PIXEL\\_RGB565](#), [MPP\\_PIXEL\\_BGR](#), [MPP\\_PIXEL\\_GRAY888](#),  
[MPP\\_PIXEL\\_GRAY888X](#), [MPP\\_PIXEL\\_GRAY](#), [MPP\\_PIXEL\\_GRAY16](#),  
[MPP\\_PIXEL\\_YUV1P444](#), [MPP\\_PIXEL\\_VYUY1P422](#), [MPP\\_PIXEL\\_UYVY1P422](#),  
[MPP\\_PIXEL\\_YUYV](#), [MPP\\_PIXEL\\_DEPTH16](#), [MPP\\_PIXEL\\_DEPTH8](#),  
[MPP\\_PIXEL\\_YUV420P](#), [MPP\\_PIXEL\\_INVALID](#) }
- enum [mpp\\_element\\_id\\_t](#) { [MPP\\_ELEMENT\\_INVALID](#), [MPP\\_ELEMENT\\_COMPOSE](#),  
[MPP\\_ELEMENT\\_LABELED\\_RECTANGLE](#), [MPP\\_ELEMENT\\_TEST](#),  
[MPP\\_ELEMENT\\_INFERENCE](#), [MPP\\_ELEMENT\\_CONVERT](#), [MPP\\_ELEMENT\\_NUM](#) }
- enum [mpp\\_tensor\\_type\\_t](#) { [MPP\\_TENSOR\\_TYPE\\_FLOAT32](#),  
[MPP\\_TENSOR\\_TYPE\\_UINT8](#), [MPP\\_TENSOR\\_TYPE\\_INT8](#) }
- enum [mpp\\_tensor\\_order\\_t](#) { [MPP\\_TENSOR\\_ORDER\\_UNKNOWN](#),  
[MPP\\_TENSOR\\_ORDER\\_NHWC](#), [MPP\\_TENSOR\\_ORDER\\_NCHW](#) }
- enum [mpp\\_inference\\_type\\_t](#) { [MPP\\_INFERENCE\\_TYPE\\_TFLITE](#),  
[MPP\\_INFERENCE\\_TYPE\\_DEEVIEWRT](#), [MPP\\_INFERENCE\\_TYPE\\_GLOW](#) }



#### 4.1.2.5 Detailed Description

This section provides the detailed documentation for the MCU Media Processing Pipeline types.

#### 4.1.2.6 Data Structure Documentation

##### 4.1.2.6.1 struct mpp\_params\_t

Pipeline creation parameters.

##### Data Fields

- int(\* **evt\_callback\_f**)([mpp\\_t](#) mpp, [mpp\\_evt\\_t](#) evt, void evt\_data, void \*user\_data)
- [mpp\\_evt\\_mask\\_t](#) mask
- [mpp\\_exec\\_flag\\_t](#) exec\_flag
- void **cb\_userdata**

##### 4.1.2.6.2 struct mpp\_camera\_params\_t

Camera parameters.

##### Data Fields

int	height	buffer height
int	width	buffer width
<a href="#">mpp_pixel_format_t</a>	format	pixel format
int	fps	frames per second

##### 4.1.2.6.3 struct mpp\_img\_params\_t

Static image parameters.

##### Data Fields

int	height	
int	width	
<a href="#">mpp_pixel_format_t</a>	format	

##### 4.1.2.6.4 struct mpp\_display\_params\_t

Display parameters.

##### Data Fields

int	height	buffer resolution: setting to 0 will default to panel physical resolution
int	width	buffer resolution: setting to 0 will default to panel physical resolution
int	pitch	buffer resolution: setting to 0 will default to panel physical resolution
int	left	active rect: setting to 0 will default to fullscreen
int	top	active rect: setting to 0 will default to fullscreen
int	right	active rect: setting to 0 will default to fullscreen

int	bottom	active rect: setting to 0 will default to fullscreen
<a href="#">mpp_rotate_degree_t</a>	rotate	rotate degree
<a href="#">mpp_pixel_format_t</a>	format	pixel format

## 4.1.2.6.5 struct mpp\_tensor\_dims\_t

Inference tensor dimensions.

**Data Fields**

uint32_t	size
uint32_t	data[MAX_TENSOR_DIMS]

## 4.1.2.6.6 struct mpp\_inference\_out\_tensor\_param\_t

Tensor parameters.

**Data Fields**

const uint8_t *	data	output data
<a href="#">mpp_tensor_dims_t</a>	dims	tensor data dimensions
<a href="#">mpp_tensor_type_t</a>	type	tensor data type

## 4.1.2.6.7 struct mpp\_inference\_cb\_param\_t

Inference callback parameters.

**Data Fields**

void *	user_data	callback will pass this pointer
<a href="#">mpp_inference_out_tensor_params_t</a> *	out_tensors [ <a href="#">MPP_INFERENCE_MAX_OUTPUTS</a> ]	output tensors parameters
int	inference_time_ms	inference run time measurement - output to user

## 4.1.2.6.8 union mpp\_color\_t

MPP color encoding.

**Data Fields**

uint32_t	raw	Raw color.
struct <a href="#">mpp_color_t</a>	rgb	rgb color values RGB color

## 4.1.2.6.9 struct mpp\_color\_t.rgb

RGB color values.

**Data Fields**

uint8_t	R	Red byte.
---------	---	-----------

uint8_t	G	Green byte.
uint8_t	B	Blue byte.
uint8_t	pad	padding byte

## 4.1.2.6.10 struct mpp\_labeled\_rect\_t

MPP labeled rectangle element structure.

**Data Fields**

uint8_t	label[64]	label to print
uint16_t	clear	clear rectangle
uint16_t	line_width	rectangle line thickness
<a href="#">mpp_color_t</a>	line_color	rectangle line color
uint16_t	top	rectangle top position
uint16_t	left	rectangle left position
uint16_t	bottom	rectangle bottom position
uint16_t	right	rectangle right position
uint16_t	tag	labeled rectangle tag
uint16_t	reserved	pad for 32 bits alignment

## 4.1.2.6.11 struct mpp\_area\_t

Image area coordinates.

**Data Fields**

int	top	
int	left	
int	bottom	
int	right	

## 4.1.2.6.12 struct mpp\_inference\_param\_t

Processing element parameters.

**Data Fields**

uint64_t	constant_weight_MemSize	model constant weights memory size
uint64_t	mutable_weight_MemSize	Defines the amount of memory required both input & output data buffers.
uint64_t	activations_MemSize	Size of scratch memory used for intermediate computations needed by the model.
int	num_inputs	model's number of inputs
int	num_outputs	model's number of outputs

uint64_t	inputs_offsets[MPP_INFERENCE_MAX_INTPUTS]	offset of each input
uint64_t	outputs_offsets[MPP_INFERENCE_MAX_OUTPUTS]	offset of each output
<a href="#">inference_entry_point_t</a>	model_entry_point	function called to perform the inference
<a href="#">mpp_tensor_type_t</a>	model_input_tensors_type	type of input buffer

## 4.1.2.6.13 union mpp\_element\_params\_t

Processing element parameters.

**Data Fields**

struct <a href="#">mpp_element_params_t</a>	compose	Compose element's parameters - NOT IMPLEMENTED YET.
struct <a href="#">mpp_element_params_t</a>	labels	Labeled Rectangle element's parameters.
struct <a href="#">mpp_element_params_t</a>	convert	Convert element's parameters.
struct <a href="#">mpp_element_params_t</a>	resize	Resize element's parameters.
struct <a href="#">mpp_element_params_t</a>	color_conv	Color convert element's parameters.
struct <a href="#">mpp_element_params_t</a>	rotate	Rotate element's parameters.
struct <a href="#">mpp_element_params_t</a>	test	Test element's parameters.
struct <a href="#">mpp_element_params_t</a>	ml_inference	ML inference element's parameters.

## 4.1.2.6.14 struct mpp\_element\_params\_t.compose

Compose element's parameters. NOT IMPLEMENTED YET.

**Data Fields**

float	a	
float	b	

## 4.1.2.6.15 struct mpp\_element\_params\_t.labels

Labeled rectangle element's parameters.

**Data Fields**

uint32_t	max_count	maximum number of rectangles
uint32_t	detected_count	detected rectangles
<a href="#">mpp_labeled_rect_t</a> *	rectangles	array of rectangle data

## 4.1.2.6.16 struct mpp\_element\_params\_t.convert

Convert element's parameters.

**Data Fields**

unsigned int	width	output image width
unsigned int	height	output image height
<a href="#">mpp_pixel_format_t</a>	pixel_format	new pixel format
<a href="#">mpp_rotate_degree_t</a>	angle	rotation angle
<a href="#">mpp_area_t</a>	crop	input crop area
<a href="#">mpp_area_t</a>	out_area	output window area
<a href="#">mpp_convert_ops_t</a>	ops	operation selector mask

## 4.1.2.6.17 struct mpp\_element\_params\_t.resize

Resize element's parameters.

**Data Fields**

unsigned int	width	
unsigned int	height	

## 4.1.2.6.18 struct mpp\_element\_params\_t.color\_conv

Color convert element's parameters.

**Data Fields**

<a href="#">mpp_pixel_format_t</a>	pixel_format	
------------------------------------	--------------	--

## 4.1.2.6.19 struct mpp\_element\_params\_t.rotate

Rotate element's parameters.

**Data Fields**

<a href="#">mpp_rotate_degree_t</a>	angle	
-------------------------------------	-------	--

## 4.1.2.6.20 struct mpp\_element\_params\_t.test

Test element's parameters.

**Data Fields**

_Bool	inp	
unsigned int	width	
unsigned int	height	
<a href="#">mpp_pixel_format_t</a>	format	

## 4.1.2.6.21 struct mpp\_element\_params\_t.ml\_inference

ML inference element's parameters.

**Data Fields**

const void *	model_data	pointer to model binary
<a href="#">mpp_inference_type_t</a>	type	inference type
int	model_size	model binary size
float	model_input_mean	model 'mean' of input values, used for normalization
float	model_input_std	model 'standard deviation' of input values, used for normalization
<a href="#">mpp_tensor_order_t</a>	tensor_order	
<a href="#">mpp_int_params_t</a>	inference_params	model specific parameters used by the inference

#### 4.1.2.7 Macro Definition Documentation

##### 4.1.2.7.1 MPP\_INFERENCE\_MAX\_OUTPUTS

```
#define MPP_INFERENCE_MAX_OUTPUTS
```

Maximum number of inference inputs and outputs.

Maximum number of outputs supported by the pipeline.

##### 4.1.2.7.2 MPP\_INFERENCE\_MAX\_INPUTS

```
#define MPP_INFERENCE_MAX_INPUTS
```

Maximum number of inputs supported by the pipeline.

##### 4.1.2.7.3 MPP\_INVALID

```
#define MPP_INVALID
```

Invalid pipeline handle.

#### 4.1.2.8 Typedef Documentation

##### 4.1.2.8.1 mpp\_t

```
typedef void mpp\_t
```

Pipeline handle type.

##### 4.1.2.8.2 mpp\_elem\_handle\_t

```
typedef uintptr_t mpp\_elem\_handle\_t
```

Element handle type.

##### 4.1.2.8.3 mpp\_evt\_mask\_t

```
typedef unsigned int mpp\_evt\_mask\_t
```

Event mask for pipeline creation.

#### 4.1.2.8.4 inference\_entry\_point\_t

```
typedef int(* inference_entry_point_t) (uint8_t *, uint8_t *,
uint8_t *)
```

Bundle inference function type.

### 4.1.2.9 Enumeration Type Documentation

#### 4.1.2.9.1 mpp\_evt\_t

enum [mpp\\_evt\\_t](#)

Pipeline generated events.

##### Enumerator

MPP_EVENT_INVALID	invalid event
MPP_EVENT_INFERENCE_OUTPUT_READY	inference out is ready
MPP_EVENT_NUM	DO NOT USE.

#### 4.1.2.9.2 mpp\_exec\_flag\_t

enum [mpp\\_exec\\_flag\\_t](#)

Execution parameters.

These parameters control the execution of the elements of an mpp.

The "mpps" created using the flag MPP\_EXEC\_RC are guaranteed to run up to the completion of all processing elements, while not being preempted by other "mpps".

The "mpps" created using the flag MPP\_EXEC\_PREEMPT are preempted after a given time interval by "mpps" that will run-to-completion again.

The "mpps" created with the MPP\_EXEC\_INHERIT flag inherit the same execution flag as the parent(s) in case of split/join operation.

**Note:** It is not possible to request run-to-completion execution when splitting/joining preemptable-execution "mpps".

##### Enumerator

MPP_EXEC_INHERIT	inherit from parent(s)
MPP_EXEC_RC	run-to-completion
MPP_EXEC_PREEMPT	preemptable

#### 4.1.2.9.3 mpp\_rotate\_degree\_t

enum [mpp\\_rotate\\_degree\\_t](#)

Rotation value.

##### Enumerator

ROTATE_0	0 degree
----------	----------

ROTATE_90	90 degrees
ROTATE_180	180 degrees
ROTATE_270	270 degrees

## 4.1.2.9.4 mpp\_flip\_mode\_t

enum [mpp\\_flip\\_mode\\_t](#)

Flip type.

**Enumerator**

FLIP_NONE	no flip
FLIP_HORIZONTAL	horizontal flip
FLIP_VERTICAL	vertical flip
FLIP_BOTH	vertical and horizontal flip

## 4.1.2.9.5 mpp\_convert\_ops\_t

enum [mpp\\_convert\\_ops\\_t](#)

The convert operations selector flags.

**Enumerator**

MPP_CONVERT_NONE	no frame conversion
MPP_CONVERT_ROTATE	frame rotation
MPP_CONVERT_SCALE	frame scaling
MPP_CONVERT_COLOR	frame color conversion
MPP_CONVERT_CROP	frame crop

## 4.1.2.9.6 mpp\_pixel\_format\_t

enum [mpp\\_pixel\\_format\\_t](#)

Pixel format.

**Enumerator**

MPP_PIXEL_ARGB	ARGB 32 bits.
MPP_PIXEL_RGB	RGB 24 bits.
MPP_PIXEL_RGB565	RGB 16 bits.
MPP_PIXEL_BGR	BGR 24 bits.
MPP_PIXEL_GRAY888	gray 3x8 bits
MPP_PIXEL_GRAY888X	gray 3x8 bits +8 unused bits
MPP_PIXEL_GRAY	gray 8 bits
MPP_PIXEL_GRAY16	gray 16 bits
MPP_PIXEL_YUV1P444	YUVX interleaved 4:4:4.



MPP_PIXEL_VYUY1P422	VYUY interleaved 4:2:2.
MPP_PIXEL_UYVY1P422	UYVY interleaved 4:2:2.
MPP_PIXEL_YUYV	YUYV interleaved 4:2:2.
MPP_PIXEL_DEPTH16	depth 16 bits
MPP_PIXEL_DEPTH8	depth 8 bits
MPP_PIXEL_YUV420P	YUV planar 4:2:0.
MPP_PIXEL_INVALID	invalid pixel format

## 4.1.2.9.7 mpp\_element\_id\_t

```
enum mpp_element_id_t
```

Processing element ids.

**Enumerator**

MPP_ELEMENT_INVALID	Invalid element.
MPP_ELEMENT_COMPOSE	Image composition - NOT IMPLEMENTED YET.
MPP_ELEMENT_LABELED_RECTANGLE	Labeled rectangle - bounding box.
MPP_ELEMENT_TEST	Test inplace element - NOT FOR USE.
MPP_ELEMENT_INFERENCE	Inference engine.
MPP_ELEMENT_CONVERT	Image conversion: resolution, orientation, color format.
MPP_ELEMENT_NUM	DO NOT USE.

## 4.1.2.9.8 mpp\_tensor\_type\_t

```
enum mpp_tensor_type_t
```

Inference tensor type.

**Enumerator**

MPP_TENSOR_TYPE_FLOAT32	floating point 32 bits
MPP_TENSOR_TYPE_UINT8	unsigned integer 8 bits
MPP_TENSOR_TYPE_INT8	signed integer 8 bits

## 4.1.2.9.9 mpp\_tensor\_order\_t

```
enum mpp_tensor_order_t
```

Inference input tensor order.

**Enumerator**

MPP_TENSOR_ORDER_UNKNOWN	Order not set
MPP_TENSOR_ORDER_NHWC	Order: Batch, Height, Width, Channels

MPP_TENSOR_ORDER_NCHW	Order: Batch, Channels, Height, Width
-----------------------	---------------------------------------

## 4.1.2.9.10 mpp\_inference\_type\_t

```
enum mpp_inference_type_t
```

Inference type.

**Enumerator**

MPP_INFERENCE_TYPE_TFLITE	TensorFlow-Lite
MPP_INFERENCE_TYPE_DEEPPVIEWRT	DeepView RT
MPP_INFERENCE_TYPE_GLOW	GLOW

**4.1.3 Return codes****4.1.3.1 Macros**

- #define [MPP\\_SUCCESS](#)
- #define [MPP\\_ERROR](#)
- #define [MPP\\_INVALID\\_ELEM](#)
- #define [MPP\\_INVALID\\_PARAM](#)
- #define [MPP\\_ERR\\_ALLOC\\_MUTEX](#)
- #define [MPP\\_INVALID\\_MUTEX](#)
- #define [MPP\\_MUTEX\\_TIMEOUT](#)
- #define [MPP\\_MUTEX\\_ERROR](#)
- #define [MPP\\_MALLOC\\_ERROR](#)

**4.1.3.2 Detailed Description**

MPP APIs return status definitions.

**4.1.3.3 Macro Definition Documentation**

## 4.1.3.3.1 MPP\_SUCCESS

```
#define MPP_SUCCESS
```

Success return code.

## 4.1.3.3.2 MPP\_ERROR

```
#define MPP_ERROR
```

A generic error occurred.

## 4.1.3.3.3 MPP\_INVALID\_ELEM

```
#define MPP_INVALID_ELEM
```

Invalid element provided.

#### 4.1.3.3.4 MPP\_INVALID\_PARAM

```
#define MPP_INVALID_PARAM
```

Invalid parameter provided.

#### 4.1.3.3.5 MPP\_ERR\_ALLOC\_MUTEX

```
#define MPP_ERR_ALLOC_MUTEX
```

Error occurred while allocating mutex.

#### 4.1.3.3.6 MPP\_INVALID\_MUTEX

```
#define MPP_INVALID_MUTEX
```

Invalid mutex provided.

#### 4.1.3.3.7 MPP\_MUTEX\_TIMEOUT

```
#define MPP_MUTEX_TIMEOUT
```

Mutex timeout occurred.

#### 4.1.3.3.8 MPP\_MUTEX\_ERROR

```
#define MPP_MUTEX_ERROR
```

Mutex error occurred.

#### 4.1.3.3.9 MPP\_MALLOC\_ERROR

```
#define MPP_MALLOC_ERROR
```

Memory allocation error occurred.

## 5 Revision history

[Table 2](#) summarizes the changes done to this document since the initial release.

**Table 2. Revision history**

Revision number	Date	Substantive changes
0	30 June 2022	Initial release
1	06 September 2022	Updated for MCUXpresso SDK 2.12.1

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