

**Core self-test library compliant with IEC 60730, IEC 60335 UL 60730,
UL 1998 documentation**

Digital Input/Output Test

Document revision history

| Date | Author | Version | Notes |
|---------|--------------|---------|------------------------------------|
| 11/2015 | Jozef Sedlak | 0.1 | Initial version |
| 11/2015 | Jozef Sedlak | 1.0 | Version for certification |
| 10/2016 | Jozef Sedlak | 1.1 | NXP |
| 11/2018 | Jozef Sedlak | 3.0 | Release with new compilers support |

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1 Digital Input/Output Test Architecture

The Digital IO test procedure performs the plausibility check of the digital IO interface of the processor. The Digital IO test is performed once after microcontroller reset and also during runtime.

The identification of the safety error is ensured by the specific FAIL return in case of the Digital IO error. The application developer must assess the return value of the test function and if it is equal to the FAIL return then the move into the safety error handling function must occur. The safety error handling function may be specific according to the application and is not a part of our library. The main purpose of this function is to put the application into a safe state.

DIO test functions are designed to check digital input, digital output functionality and short circuit conditions between tested pin and: supply voltage, gnd or optional adjacent pin. Execution of DIO tests must be adapted to the final application. User must pay attention to hardware connections and design. He must be sure which functions can be applied to respective pin. In most of cases, tested and sometimes also auxiliary pin must be reconfigured during the application run. When performing the digital output test, enough time must be ensured between test arrangement and reading of result.

2 Digital Input/Output Test in compliance with IEC/UL standards

The performed overload test fulfils safety requirements according to IEC 60730-1, IEC 60335, UL 60730, and UL 1998 standards as described in the following table:

Table 1. Digital Input/Output Test in Compliance with IEC and UL Standards

| Test | Component | Fault/Error | SW / HW Class | Acceptable Measures |
|------------------------|---|--------------------|---------------|---------------------|
| Input/Output periphery | 7. Input/Output periphery (7.1 – Digital I/O) | Abnormal operation | B/R.1 | Plausibility check |

3 Digital Input/Output Test Implementation

Test functions for the Digital IO test are placed in IEC60730_B_CM4_CM7_dio.c and IEC60730_B_dio_ext.c. The header files with the function prototypes are IEC60730_B_CM4_CM7_dio.h and IEC60730_B_CM4_CM7_dio_ext.h. IEC60730_BCM4_CM7.h is the common file for all components of the library.

Previously mentioned tests can be executed by the proper use of following functions:

- IEC60730B_CM4_CM7_DIO_OutputTest ()
- IEC60730B_CM4_CM7_DIO_InputTest_Ext()
- IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set()
- IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set()
- IEC60730B_CM4_CM7_DIO_OutputTest_RT()
- IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT()
- IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set_RT()
- IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set_RT()

Functions and structures with _RT in name are dedicated for MIMXRT devices.

Pointer to the variable of the dio_test_t or dio_test_rt_t structure type is one parameter of each function. The structure is defined in IEC60730_B_CM4_CM7_dio.h.

typedef struct

```
{  
    unsigned long pcr; /* Pin control register */  
    unsigned long pddr; /* Port data direction register */  
    unsigned long pdor; /* Port data output register */  
} IEC60730_DIO_Backup;
```

typedef struct _dio_test

```
{  
    unsigned long gpio;  
    unsigned long pcr;  
    unsigned char pinNum;  
    unsigned char pinDir;  
    unsigned char pinMux;  
    IEC60730_DIO_Backup sTestedPinBackup;  
} dio_test_t;
```

```
typedef struct
{
    unsigned long mux;      /* SW_MUX control register */
    unsigned long pad;      /* SW_PAD control register */
    unsigned long gdir;     /* GPIO direction register */
    unsigned long dr;       /* GPIO data register */
} IEC60730_DIO_Backup_RT;
```

```
typedef struct _dio_test_rt
{
    unsigned long gpio;
    unsigned long muxAddr;
    unsigned long padAddr;
    unsigned char pinNum;
    unsigned char pinDir;
    unsigned char pinMux;
    IEC60730_DIO_Backup_RT sTestedPinBackup;
} dio_test_rt_t;
```

This variable/variables must be initialized before the call of a test function. Example of initialization is shown below.

```
dio_test_t dio_safety_test_item_0 =
{
    .gpio = IEC60730B_DIO_PORTC,
    .pinNum = 5,
    .pinDir = PIN_DIRECTION_IN,
    .pinMux = PIN_MUX_GPIO,
};
dio_test_t dio_safety_test_item_1 =
{
    .gpio = IEC60730B_DIO_PORTB,
    .pinNum = 22,
    .pinDir = PIN_DIRECTION_OUT,
    .pinMux = PIN_MUX_GPIO,
};
dio_test_t *dio_safety_test_items[] = { &dio_safety_test_item_0, &dio_safety_test_item_1, 0 };

if (dio_safety_test_item_0 .gpio == IEC60730B_DIO_PORTC)
    dio_safety_test_item_0 .pcr = IEC60730B_DIO_PORTC_PCR;

if (dio_safety_test_item_1 .gpio == IEC60730B_DIO_PORTB)
    dio_safety_test_item_1 .pcr = IEC60730B_DIO_PORTB_PCR;
```

3.1 IEC60730B_CM4_CM7_DIO_OutputTest()

To test the digital output functionality of the pin. Principle of test is setup and read of both logical values on the tested pin. Suitable delay parameter must be entered. It must ensure a time interval that is long enough for device to reach desired logical value on the pin. Too low delay parameter causes the fail return value of the function.

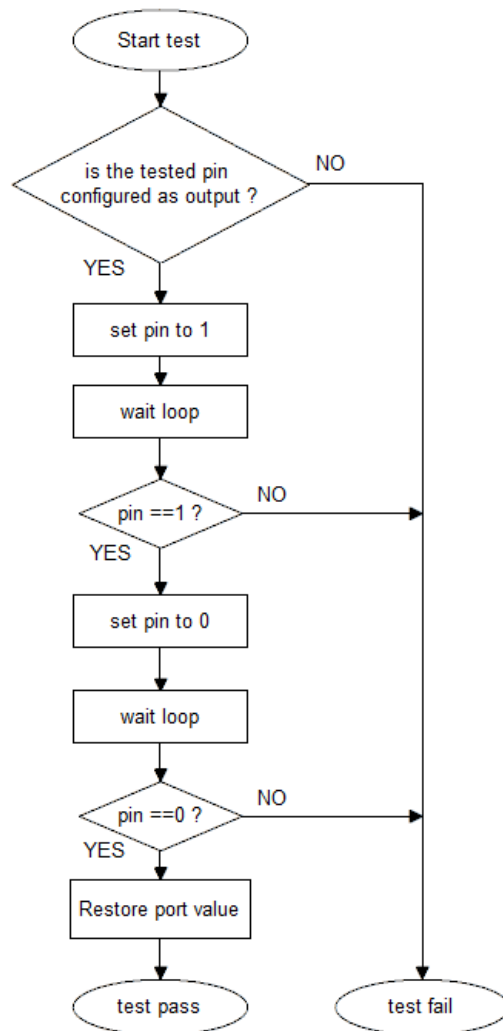


Figure 1. Block diagram for Digital Output test

Function prototype:

IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_OutputTest(dio_test_t *pTestedPin, unsigned int delay).

Function inputs:

pTestedPin – pointer to a variable of the *dio_test_t* type. Specifies the tested pin. See chapter 3.0.
delay – a delay needed to recognize the value change on tested pin

Function output:

The function returns a value of unsigned long data type and has either of the following values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

```
IEC60730B_dio_output_test_result = IEC60730B_CM4_CM7_DIO_OutputTest(dio_safety_test_items[1],\
DIO_WAIT_CYCLE);
```

Function performance:

With delay parameter of 100, the function duration is approximately 2075 cycles (25.9 μ s)¹. Function size is 122 bytes.²

Calling restrictions:

Tested pin must be configured as digital output. Propriate delay must be defined for proper functionality.

3.2 IEC60730B_CM4_CM7_DIO_InputTest_Ext()

This function substitutes the IEC60730B_CM4_CM7_DIO_InputTest() function from the previous version of library. This version is mainly targeted to be used as a get function for short-to tests. The function is applied to the pin that is already configured as GPIO Input and user knows what logical level is expected at the time of test. The logical level can either result from actual configuration in the application, or can be initialized, if possible, for the test. The block diagram of the IEC60730B_CM4_CM7_DIO_InputTest_Ext() function is shown in following picture. Two of the function input parameters are related to an adjacent pin. For simple input test functionality, these parameters are not important. Entering same inputs as for the tested pin is recommended. See the example code.

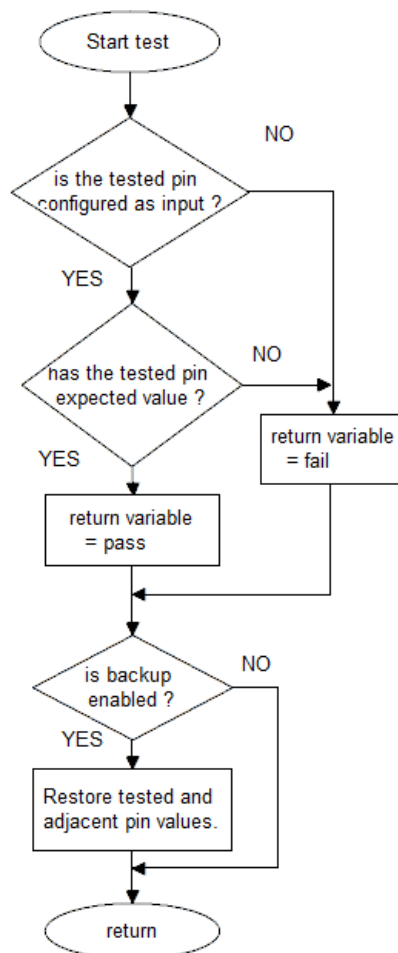


Figure 2. Extended digital input test

Function prototype:

```
IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_InputTest_Ext(dio_test_t *pTestedPin, dio_test_t *pAdjPin, unsigned long TestedPinValue, unsigned short BackupEnable);
```

Function inputs:

pTestedPin – Pointer to a variable of the *dio_test_t* type. Specifies the tested pin. See chapter 3.0.
pAdjPin – Pointer to a variable of *dio_test_t* type. Specifies the adjacent pin. See chapter 3.0.
TestedPinValue – Expected value of the tested input pin. 0 or 1. This parameter needs to be correctly adjusted by the application developer.
BackupEnable – Flag. If is non-zero, backup functionality is enabled.

Function output:

Function return signalizes result of the test. Can have these values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

```
IEC60730B_dio_input_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext(dio_test_t* \
dio_safety_test_item_0, dio_test_t* dio_safety_test_item_0, DIO_EXPECTED_VALUE, BACKUP_ENABLE);
```

Function performance:

With backup functionality enable, function execution time is approximately 145 cycles (1.82 μ s)¹.

Function size is 222 bytes.²

Calling restrictions:

Tested pin must be configured as GPIO Input before the function call. Even if none adjacent pin is involved in the test, the AdjacentPin parameter must be specified. Recommended is to enter same input as for the TestedPin.

3.3 IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set()

This function creates first part of Short-To-Supply test. It can be used for testing short circuit between the tested pin and hardware supply voltage (Vcc, Vdd) or between the tested pin and hardware ground (GND). Its block diagram is showed in the following figure. Second part of the test, result evaluation, is ensured by IEC60730B_CM4_CM7_DIO_InputTest_Ext() function that is described in respective chapter. Main purpose of the IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set() function is to set pull-up or pull-down resistor connection on the tested pin. It also ensures the test whether the pin is correctly configured and make a backup of its settings if it is desired.

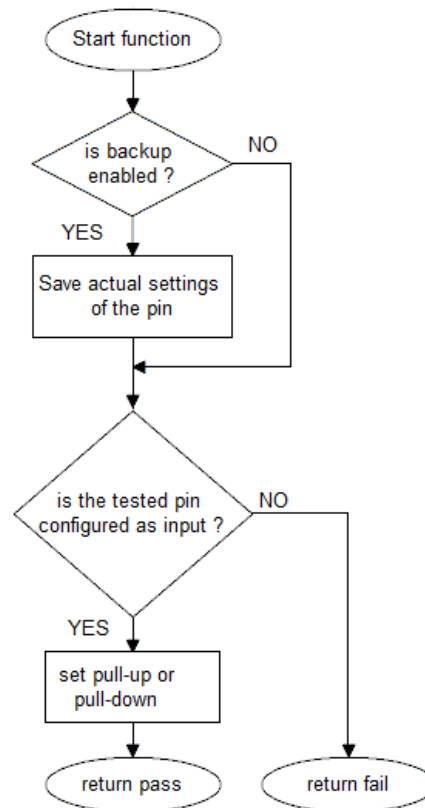


Figure 3. Block diagram of IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set() function

Function prototype:

```
IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set(dio_test_t *pTestedPin, \
    unsigned short ShortToVoltage, unsigned short BackupEnable);
```

Function inputs:

TestedPin – Pointer to a variable of the *dio_test_t* type. Specifies the tested pin. See chapter 3.0.
ShortToVoltage - specify whether pin is tested for short against Gnd, or Vdd. for GND - enter 1 or non-zero, for VDD - enter 0
BackupEnable -flag. If non-zero, backup functionality is enable/active.

Function output:

The function returns a value of unsigned long data type and has either of the following values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

The following is code example of the test for both, short to GND and short to VDD cases. Note that implementation difference is only in one parameter. If short to GND is tested, the parameter must have non-zero value and vice versa.

```
#define DIO_SHORT_TO_GND_TEST 1
#define DIO_SHORT_TO_VDD_TEST 0
dio_short_to_vcc_test_result =
IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set(dio_safety_test_items[0], \
        DIO_SHORT_TO_GND_TEST, BACKUP_ENABLE);

dio_short_to_vcc_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext(dio_safety_test_items[0]), \
        dio_safety_test_items[0], DIO_SHORT_TO_GND_TEST, BACKUP_ENABLE);

dio_short_to_vcc_test_result = IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set( \
        dio_safety_test_items[0], DIO_SHORT_TO_VDD_TEST, BACKUP_ENABLE);

dio_short_to_vcc_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext(dio_safety_test_items[0]), \
        dio_safety_test_items[0], DIO_SHORT_TO_VDD_TEST, BACKUP_ENABLE);
```

Function performance:

With backup functionality enable, function execution time is approximately 120 cycles (1.5 μ s)¹.

Function size is 136 bytes.²

Calling restrictions:

Tested pin must be configured as GPIO output before calling the function. If backup functionality is enabled, function sets input direction for the tested pin, if not, input direction must be configured by user. After the end of the function, application cannot manipulate the tested pin, until the IEC60730B_CM4_CM7_DIO_InputTest_Ext function for the tested pin has not been called.

3.4 IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set()

This function ensures required conditions for a "Short to Adjacent Pin Test". Purpose of this function is to configure the tested pin and the adjacent pin properly. The adjacent pin is an optional pin that can be theoretically shorted with the tested pin. The function block diagram is showed in the following figure. Similarly, as short to supply test, this one requires the use of two functions. Second (get) function evaluates the test result. IEC60730B_CM4_CM7_DIO_InputTest_Ext() function is described with respective chapter. User must specify tested pin and adjacent pin also for the input test function.

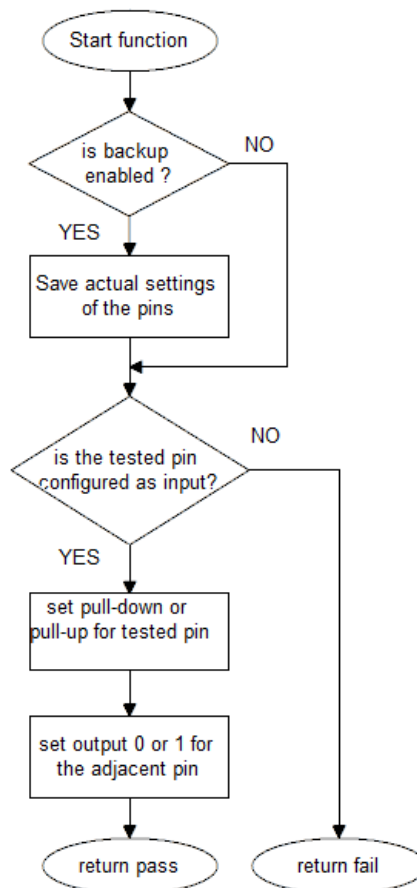


Figure 4. Block diagram of IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set() function

Function prototype:

*IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set (dio_test_t *pTestedPin,
dio_test_t *pAdjPin, unsigned long TestedPinValue, unsigned short BackupEnable);*

Function inputs:

TestedPin - Pointer to a variable of the *dio_test_t* type. Specifies the tested pin. See chapter 3.0.
AdjacentPin - Pointer to a variable of *dio_test_t* type. Specifies the adjacent pin. See chapter 3.0.
TestedPinValue -value that will be set on the tested pin (logical 0 or logical 1)
BackupEnable -flag. if non-zero, backup functionality is enable/active

Function output:

The function returns a value of unsigned long data type and has either of the following values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

The following is code example of the short to adjacent pin test.

```
#define BACKUP_ENABLE 1
#define LOGICAL_ONE 1
#define LOGICAL_ZERO 0
dio_short_to_adj_test_result = IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set
(dio_safety_test_items[0], dio_safety_test_items[1], LOGICAL_ONE, BACKUP_ENABLE);

dio_short_to_adj_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext(dio_safety_test_items[0],
dio_safety_test_items[1], LOGICAL_ONE, BACKUP_ENABLE);
```

Function performance:

With backup functionality enable, function execution time is approximately 183 cycles (2.29 μ s)¹.

Function size is 210 bytes.

Calling restrictions:

Tested and adjacent pin must be configured as GPIO output before calling the function. If backup functionality is enabled, function sets directions for both pins, if not, directions (tested pin as input, adjacent pin as output) must be configured by user. After the end of the function, application cannot manipulate neither the tested or the adjacent pin, until the IEC60730B_CM4_CM7_DIO_InputTest_Ext function for these pins has not been called.

3.5 IEC60730B_CM4_CM7_DIO_OutputTest_RT()

Dedicated for MIMXRT devices, to test the digital output functionality of the pin. Principle of test is setup and read of both logical values on the tested pin. Suitable delay parameter must be entered. It must ensure a time interval that is long enough for device to reach desired logical value on the pin. Too low delay parameter causes the fail return value of the function.

Block diagram is the same as for the IEC60730B_CM4_CM7_DIO_OutputTest() function.

Function prototype:

IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_OutputTest_RT(dio_test_rt_t *pTestedPin, unsigned int delay).

Function inputs:

pTestedPin – pointer to a variable of the *dio_test_rt_t* type. Specifies the tested pin. See chapter 3.0.
delay – a delay needed to recognize the value change on tested pin

Function output:

The function returns a value of unsigned long data type and has either of the following values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

```
IEC60730B_dio_output_test_result = IEC60730B_CM4_CM7_DIO_OutputTest_RT(  
    dio_safety_test_items[1], DIO_WAIT_CYCLE);
```

Function performance:

With delay parameter of 1000, the function duration is approximately 600 cycles (25 μ s)³. Function size is 104 bytes.²

Calling restrictions:

Tested pin must be configured as digital output. Propriate delay must be defined for proper functionality.

3.6 IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT()

Dedicated for MIMXRT devices. It is mainly targeted to be used as a get function for short-to tests. The function is applied to the pin that is already configured as GPIO Input and user knows what logical level is expected at the time of test. The logical level can either result from actual configuration in the application, or can be initialized, if possible, for the test. The block diagram of the IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT() function is shown in following picture. Two of the function input parameters are related to an adjacent pin. For simple input test functionality, these parameters are not important. Entering same inputs as for the tested pin is recommended. See the example code.

Block diagram is the same as for the IEC60730B_CM4_CM7_DIO_InputTest_Ext () function.

Function prototype:

*IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT(dio_test_rt_t *pTestedPin, dio_test_rt_t *pAdjPin, unsigned long TestedPinValue, unsigned short BackupEnable);*

Function inputs:

pTestedPin – Pointer to a variable of the *dio_test_rt_t* type. Specifies the tested pin. See chapter 3.0.
pAdjPin – Pointer to a variable of *dio_test_rt_t* type. Specifies the adjacent pin. See chapter 3.0.
TestedPinValue – Expected value of the tested input pin. 0 or 1. This parameter needs to be correctly adjusted by the application developer.
BackupEnable – Flag. If is non-zero, backup functionality is enabled.

Function output:

Function return signalizes result of the test. Can have these values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

IEC60730B_dio_input_test_result = IEC60730B_CM4_CM7_DIO_InputTest_RT(dio_test_rt_t dio_safety_test_item_0, dio_test_rt_t* dio_safety_test_item_0, DIO_EXPECTED_VALUE, BACKUP_ENABLE);*

Function performance:

With backup functionality enable, function execution time is approximately 23 cycles (0.96 μ s)³.
Function size is 264 bytes.²

Calling restrictions:

Tested pin must be configured as GPIO Input before the function call. Even if none adjacent pin is involved in the test, the AdjacentPin parameter must be specified. Recommended is to enter same input as for the TestedPin.

3.7 IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set_RT()

Dedicated for MIMXRT devices. This function creates first part of Short-To-Supply test. It can be used for testing short circuit between the tested pin and hardware supply voltage (Vcc, Vdd) or between the tested pin and hardware ground (GND). Its block diagram is showed in the following figure. Second part of the test, result evaluation, is ensured by IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT() function that is described in respective chapter. Main purpose of the IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set_RT() function is to set pull-up or pull-down resistor connection on the tested pin. It also ensures the test whether the pin is correctly configured and make a backup of its settings if it is desired.

Block diagram is the same as for the IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set() function.

Function prototype:

```
IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set_RT(dio_test_rt_t *pTestedPin,  
    unsigned short ShortToVoltage, unsigned short BackupEnable);
```

Function inputs:

TestedPin – Pointer to a variable of the *dio_test_rt_t* type. Specifies the tested pin. See chapter 3.0.
ShortToVoltage – specify whether pin is tested for short against Gnd, or Vdd. for GND - enter 1 or non-zero, for VDD - enter 0
BackupEnable –flag. If non-zero, backup functionality is enable/active.

Function output:

The function returns a value of unsigned long data type and has either of the following values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

The following is code example of the test for both, short to GND and short to VDD cases. Note that implementation difference is only in one parameter. If short to GND is tested, the parameter must have non-zero value and vice versa.

```
#define DIO_SHORT_TO_GND_TEST 1  
#define DIO_SHORT_TO_VDD_TEST 0  
dio_short_to_vcc_test_result =  
IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set_RT(dio_safety_test_items[0],  
    DIO_SHORT_TO_GND_TEST, BACKUP_ENABLE);  
  
dio_short_to_vcc_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT(dio_safety_test_items[0]),  
    dio_safety_test_items[0], DIO_SHORT_TO_GND_TEST, BACKUP_ENABLE);
```

```
dio_short_to_vcc_test_result = IEC60730B_CM4_CM7_DIO_ShortToSupplyTest_Set_RT(  
dio_safety_test_items[0], DIO_SHORT_TO_VDD_TEST, BACKUP_ENABLE);
```

```
dio_short_to_vcc_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT(dio_safety_test_items[0]),  
dio_safety_test_items[0], DIO_SHORT_TO_VDD_TEST, BACKUP_ENABLE);
```

Function performance:

With backup functionality enable, function execution time is approximately 40 cycles (1.67 μ s)³.

Function size is 106 bytes.²

Calling restrictions:

Tested pin must be configured as GPIO output before calling the function. If backup functionality is enabled, function sets input direction for the tested pin, if not, input direction must be configured by user. After the end of the function, application cannot manipulate the tested pin, until the IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT function for the tested pin has not been called.

3.8 IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set_RT()

Dedicated for MIMXRT devices. This function ensures required conditions for a "Short to Adjacent Pin Test". Purpose of this function is to configure the tested pin and the adjacent pin properly. The adjacent pin is an optional pin that can be theoretically shorted with the tested pin. The function block diagram is showed in the following figure. Similarly, as short to supply test, this one requires the use of two functions. Second (get) function evaluates the test result. IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT() function is described with respective chapter. User must specify tested pin and adjacent pin also for the input test function. Block diagram is the same as for the IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set() function.

Function prototype:

```
IEC60730B_RESULT IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set_RT(dio_test_rt_t *pTestedPin, \
    dio_test_rt_t *pAdjPin, unsigned long TestedPinValue, unsigned short BackupEnable);
```

Function inputs:

TestedPin - Pointer to a variable of the *dio_test_rt_t* type. Specifies the tested pin. See chapter 3.0.
AdjacentPin - Pointer to a variable of *dio_test_rt_t* type. Specifies the adjacent pin. See chapter 3.0.
TestedPinValue -value that will be set on the tested pin (logical 0 or logical 1)
BackupEnable -flag. if non-zero, backup functionality is enable/active

Function output:

The function returns a value of unsigned long data type and has either of the following values:

- IEC60730B_ST_DIO_FAIL (0x00000801)
- IEC60730B_ST_DIO_PASS (0)

Example of function call:

The following is code example of the short to adjacent pin test.

```
#define BACKUP_ENABLE 1
#define LOGICAL_ONE 1
#define LOGICAL_ZERO 0
dio_short_to_adj_test_result = IEC60730B_CM4_CM7_DIO_ShortToAdjTest_Set_RT(
    dio_safety_test_items[0], dio_safety_test_items[1], LOGICAL_ONE BACKUP_ENABLE);

dio_short_to_adj_test_result = IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT (dio_safety_test_items[0],
    dio_safety_test_items[1], LOGICAL_ONE, BACKUP_ENABLE);
```

Function performance:

With backup functionality enable, function execution time is approximately 47 cycles (1.96 μ s)¹.
Function size is 186 bytes.²

Calling restrictions:

Tested and adjacent pin must be configured as GPIO output before calling the function. If backup functionality is enabled, function sets directions for both pins, if not, directions (tested pin as input, adjacent pin as output) must be configured by user. After the end of the function, application cannot manipulate neither the tested or the adjacent pin, until the IEC60730B_CM4_CM7_DIO_InputTest_Ext_RT function for these pins has not been called.

-
- 1- Execution time and number of cycles were measured with the use of MKV31/ 80 MHz CPU clock/ 20 MHz Flash clock
 - 2- Function compiled by IAR v8.22.2
 - 3- Execution time and number of cycles were measured with the use of MIMXRT1050/ 600 MHz CPU clock

4 Digital Input/Output Test Module Test Concept

- Content moved to document

5 Digital Input/Output Test Validation

- Content moved to document

Table 2. Validation

| Date | Validated by | Validated Revision of Document | Validated Version of Source Code | Validation Result |
|-------------|---------------------|---|---|------------------------------|
| 11/2015 | Jaroslav Lepka | 1.0 | 1.0 | P |
| 11/2016 | Pavel Sustek | 1.1 | 1.0 | P |
| 11/2018 | Jaroslav Lepka | 3.0 | 3.0, 3.0 (_Ext) | P |

Validation result options:

P – Passed

F – Failed

N/A – Not applicable

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