Application Note #12-0312

Using Corelis Custom Function Modules with Teradyne ICTs

July 12, 2012
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General Description

Corelis ScanExpress is a popular JTAG test development and execution suite used for boundary-scan test, in-system programming of memory and CPLDs, and embedded functional test on printed circuit board assemblies. ScanExpress tests are often developed and deployed through all phases of product development and production. Users of Teradyne TestStations would often like to be able to reuse these applications when moving to TestStation for production test. This application note details a method for integrated Corelis Custom Function Modules (CFMs) with Teradyne TestStations.

Corelis offers three CFMs: USB-1149.1/CFM, QuadTAP/CFM, and QuadTAP/CFM Expander. These modules are test interface boards that install onto a Teradyne Multi-Function Application Board which is in turn installed in the pin bay of a Teradyne TestStation ICT. The USB-1149.1/CFM features a single Test Access Port (TAP), a JTAG, I2C, and SPI protocol control. The QuadTAP/CFM features a 4-TAP controller for one full-signal TAP or two 4-signal TAPs using a single CFM interface. QuadTAP/CFM Expander modules extend the controller’s capabilities to include up to four full-signal TAPs by utilizing multiple CFM ports. The expander module by itself has no controller capability but is instead used to route TAPs from the main QuadTAP/CFM controller board to additional CFM interfaces.

Hardware Requirements

For this application, the TAP interface of the UUT is driven using the Corelis USB-1149.1/CFM or QuadTAP/CFM controller. Both are a respective version of the Corelis USB-1149.1/1E or the Corelis USB-1149.1/4E controller integrated on a custom CFM module. The software integration remains essentially unchanged regardless of which controller is in use.

The Corelis CFMs are installed on a TestStation Multi-Function Application Board in order to route the TAP signals up to the tester interface. The Multi-Function Application Board is installed in the tester pin bay and this makes the TAP port available to any fixture mounted on the tester, with the connections being under relay control. The user simply has to specify the TAP port to UUT wiring when having the fixture fabricated.

The Multi-Function Application Board has 4 CFM locations where user hardware may be installed. If the user already has a Multi-Function Application Board installed in their system they must ensure that they have a spare CFM location on which to install the Corelis CFMs as needed. The interface of any CFM to the Multi-Function Application Board includes a total of four direct signals and four multiplexed signals. Careful consideration must be made when selecting CFM positions for multi-TAP use; one set of four multiplexed channels is shared.

Note: This application note describes the usage of installed CFMs. For detailed installation instructions, please see the respective hardware User’s Manual.

IMPORTANT: Install the software first and then plug in the USB connection for the CFM.
between the CFM1 and CFM2 positions and a second set of four multiplexed channels is shared between CFM3 and CFM4 position on the Multi-Function Application Board.

**Note:** The Teradyne Multi-Function Application Board referred to in this document was previously known as the Teradyne Custom Function Board (CFB).

A dual-stage fixture is considered best practice when fixturing a UUT for third party boundary-scan test at ICT. A dual-stage fixture allows for two levels of nail contact to the UUT. When performing standard in-circuit tests, the full bed-of-nails will be in contact with the UUT. During the boundary-scan test, a minimum set of nails will contact the UUT; typically the nails used are power, ground, TAP, and control. This provides better signal integrity for the boundary-scan tests by removing the loading effects presented by the full bed-of-nails.

**Summary of hardware requirements:**
- Teradyne Multi-Function Application Board
- Dual-stage fixture for UUT
- Corelis CFM (see **Table 1** for available combinations)

<table>
<thead>
<tr>
<th>TAP Configuration</th>
<th>USB-1149.1/CFM</th>
<th>QuadTAP/CFM</th>
<th>QuadTAP/CFM Expander</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single TAP (5 Signals)</td>
<td>1(^1)</td>
<td>1(^1)</td>
<td>0</td>
</tr>
<tr>
<td>Two TAPs (4 Signals)</td>
<td>N/A</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Two TAPs (5 Signals)</td>
<td>N/A</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Three TAPs (4 Signals)</td>
<td>N/A</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Three TAPs (5 Signals)</td>
<td>N/A</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Four TAPs (4 Signals)</td>
<td>N/A</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Four TAPs (5 Signals)</td>
<td>N/A</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

**Table 1:** Total required CFM cards by TAP configuration

\(^1\) Either a USB-1149.1/CFM or QuadTAP/CFM can be used for a single TAP configuration.
Software Requirements

The Corelis ScanExpress software suite consists of a number of applications that perform various JTAG development, test, programming, and diagnostic tasks. In order to execute basic JTAG tests, program Flash and CPLDs, and create diagnostic messages, the user must install ScanExpress Runner and ScanExpress ADO on the Teradyne TestStation. If the user wishes to perform other tasks such as JTAG test generation, debug, flash data preparation, etc., then additional ScanExpress modules will need to be installed. For the purpose of this application note, we will only be considering JTAG test and diagnostics. It is assumed the user has a passing ScanExpress test plan and that no development or debug needs to be done on the tester.

Summary of software requirements:

- Corelis ScanExpress Runner
- Corelis ScanExpress ADO
- Passing ScanExpress Test Plan
Relay Controlled CFM signals

The following tables describe the CFM signals available from the respective CFM board and provide details regarding which relay control signal is to be used to establish contact for each signal.

Note: For detailed information about available signals and relay control, please see the respective hardware User’s Manual.

The Corelis USB-1149.1/CFM single-TAP module can be configured to provide one JTAG, one SPI, or one I²C bus interface, as shown in Table 2.

<table>
<thead>
<tr>
<th>Relays</th>
<th>TAP Description</th>
<th>None</th>
<th>Relay 1</th>
<th>Relay 2</th>
<th>Relay 3</th>
<th>Relay 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFMx_DIR1</td>
<td>-</td>
<td>T1_TDI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CFMx_DIR2</td>
<td>-</td>
<td>T1_TDO</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CFMx_DIR3</td>
<td>-</td>
<td>T1_TMS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CFMx_DIR4</td>
<td>-</td>
<td>T1_TCK</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CFMx_MUX1</td>
<td>T1_GPIO3</td>
<td>T1_GPIO3</td>
<td>T1_SPI-SDO</td>
<td>T1_I2C-SDA</td>
<td>T1_TDI</td>
<td></td>
</tr>
<tr>
<td>CFMx_MUX2</td>
<td>T1_GPIO2</td>
<td>T1_GPIO2</td>
<td>T1_SPI-SCK</td>
<td>T1_I2C-SCL</td>
<td>T1_TDO</td>
<td></td>
</tr>
<tr>
<td>CFMx_MUX3</td>
<td>T1_GPIO2</td>
<td>T1_GPIO2</td>
<td>T1_SPI-CS</td>
<td>Do Not Use</td>
<td>T1_TMS</td>
<td></td>
</tr>
<tr>
<td>CFMx_MUX4</td>
<td>T1_TRST</td>
<td>T1_TRST</td>
<td>T1_SPI-SDI</td>
<td>Do Not Use</td>
<td>T1_TCK</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Corelis USB-1149.1/CFM relay-signal configurations
The Corelis QuadTAP/CFM can be configured for up to two JTAG, two SPI, or two I²C bus interfaces, as shown in Table 3.

<table>
<thead>
<tr>
<th>Relays</th>
<th>TAP Description</th>
<th>Relay 1</th>
<th>Relays 1 &amp; 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>GPIO Only</td>
<td>One TAP – 5 Signals, 3 GPIO</td>
<td>Two TAPs – 4 Signals per TAP</td>
</tr>
</tbody>
</table>

**CFMx Signals**

| CFMx_DIR1 | - | T1_TDI | T1_TDI |
| CFMx_DIR2 | - | T1_TDO | T1_TDO |
| CFMx_DIR3 | - | T1_TMS | T1_TMS |
| CFMx_DIR4 | - | T1_TCK | T1_TCK |
| CFMx_MUX1 | T1_GPIO3 | T1_GPIO3 | T2_TDI |
| CFMx_MUX2 | T1_GPIO2 | T1_GPIO2 | T2_TDO |
| CFMx_MUX3 | T1_GPIO2 | T1_GPIO2 | T2_TMS |
| CFMx_MUX4 | T1_TRST | T1_TRST | T2_TCK |

**Table 3: Corelis QuadTAP/CFM relay-signal configurations**

The Corelis QuadTAP/CFM Expander is an add-on CFM that can be configured to add an additional two JTAG, two SPI, or two I²C bus interfaces, as shown in Table 4.

<table>
<thead>
<tr>
<th>Relays</th>
<th>Description</th>
<th>Relay 1</th>
<th>Relay 2</th>
<th>Relay 3</th>
<th>Relays 1, 2, 5, &amp; 6</th>
<th>Relays 1, 3, &amp; 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>GPIO Only</td>
<td>One TAP – 5 Signals, 3 GPIO</td>
<td>Two TAPs – 4 Signals per TAP</td>
<td>SPI Interface</td>
<td>I²C Interface</td>
<td>Two SPI Interfaces</td>
</tr>
</tbody>
</table>

**CFMx Signals**

| CFMx_DIR1 | - | T1_TDI | T1_TDI | - | - | T2_SPI-SDO | T2_I2C-SDA |
| CFMx_DIR2 | - | T1_TDO | T1_TDO | - | - | T2_SPI-SCK | T2_I2C-SCL |
| CFMx_DIR3 | - | T1_TMS | T1_TMS | - | - | T2_SPI-CS  | Do Not Use   |
| CFMx_DIR4 | - | T1_TCK | T1_TCK | - | - | T2_SPI-SDI | Do Not Use   |
| CFMx_MUX1 | T1_GPIO3 | T1_GPIO3 | T2_TDI | T1_SPI-SDO | T1_SPI-SDO | T2_I2C-SDA |
| CFMx_MUX2 | T1_GPIO2 | T1_GPIO2 | T2_TDO | T1_SPI-SCK | T1_I2C-SCL | T1_SPI-SCK |
| CFMx_MUX3 | T1_GPIO2 | T1_GPIO2 | T2_TMS | T1_SPI-CS | Do Not Use | T1_SPI-CS |
| CFMx_MUX4 | T1_TRST | T1_TRST | T2_TCK | T1_SPI-SDI | Do Not Use | T1_SPI-SDI |

**Table 4: Corelis QuadTAP/CFM expander relay-signal configurations**
Application Example for a Single TAP UUT (Using Direct Signals)

The USB-1149.1/CFM is mounted in a free CFM location on the Multi-Function Application Board as shown in Figure 1. The TAP signals are routed to the tester interface through the Multi-Function Application Board top board. Each CFM is provided with 4 direct and 4 multiplexed connections to the tester interface. Four signals (TCK, TMS, TDI, TDO) use the direct path through the top board and their disconnect relays are mounted on the CFM. TRST is routed though a multiplexed path and Multi-Function Application Board top board relays are used to connect this signal to the interface. The USB-1149.1/CFM Boundary-scan Controller is also connected to a USB port on the tester PC. This cable is routed across the front of the pin bay, into the PC bay.
Table 5: TAP signal and CFB relay assignments for one 5-signal TAP

<table>
<thead>
<tr>
<th>TAP Signal</th>
<th>CFM Signal</th>
<th>CFB Signal</th>
<th>CFB Pin (ZIF)</th>
<th>CFB-Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAP1-TDI</td>
<td>CFM1_DIR1</td>
<td>CFM1DIR1</td>
<td>B8</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TDO</td>
<td>CFM1_DIR2</td>
<td>CFM1DIR2</td>
<td>A9</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TMS</td>
<td>CFM1_DIR3</td>
<td>CFM1DIR3</td>
<td>B14</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TCK</td>
<td>CFM1_DIR4</td>
<td>CFM1DIR4</td>
<td>A15</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TRST#</td>
<td>CFM1_MUX4</td>
<td>APIN05</td>
<td>A27</td>
<td>K175, K129, K119, K41</td>
</tr>
</tbody>
</table>

All user relays and relay control signals on the Multi-Function Application Board & CFM are controlled from the test program using system subroutines.

For example, in order to close relays 41, 119, 129 and 175 on the Multi-Function Application Board top board, you would use the following code (see schematic Figure 3-2 on page 3-7 of the CFB User's Guide 9007-5125-00):

```c
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='41,119,129,175');
```

The code below will energize relay driver signal 1 on CFM1:

```c
CALL CFMSETRLY(UNIT=1,OPERATION='CLOSE',RLYLIST='1');
```

Any relays used to isolate the TAP signals would be closed prior to the boundary-scan test execution and opened when tests are completed. Which relay control signals need to be activated will depend on your application and in which CFM location the controller in located.

Please consult the Corelis USB-1149.1/CFM and Teradyne Multi-Function Application Board documentation for details.

Corelis ScanExpress Runner is a test executive that may be used to execute a predefined boundary-scan test plan. A basic test plan would consist of Infrastructure, Interconnect, Buswire, and Pull-up/Pull-down tests. The user may also add additional steps such as in-system Flash or PLD programming, memory cluster, script, and logic cluster tests.

Corelis ScanExpress Runner includes a command line interface that may be used to execute a test plan from a third party application. One form of the command line call is:

```
"C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
"TestPlanFilename" "CONTROLLER,SETTINGS"
```

The first argument simply calls the executable to run the test plan. The second argument specifies the location and name of the test plan to be executed. The third argument specifies the controller type and parameters such as logic levels and clock speed. If the controller specification and parameters are omitted, then the test plan will be executed with the most recent controller parameters stored in the test plan, as shown below:

```
"C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
"C:\MyTestPlan.tsp"
```

In our example, we chose to execute the command line from a DOS batch file that is spawned from the TestStation test program with the following command:

```c
CALL SPAWN (ARG1='start /MIN /WAIT corelis.bat');
```
The command line will output status information such as pass, fail, or error that can be redirected to a file to be read by the test program. Diagnostic messages will automatically be written to a log file by ScanExpress Runner. When a failure is detected, the log file will be opened and the results redirected to the standard in-circuit failure output.

An example of the batch file is shown below:

```batch
@echo off
REM Set variables for project and ICT locations
set a="C:\MyProjects\MyTestPlan.log"
set b="C:\MyProjects\MyTestPlan.tsp"
set c="C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
REM Clean up old status and log files
if exist status.txt del status.txt
if exist %a% del %a%
REM Run test plan
%c% %b%>status.txt
EXIT
```

An example of the test program code to check test status and redirect diagnostic messages is shown below:

```plaintext
/* Check status of test */
/* Open status file. Exit if failure. */
OPEN ID=STATUS DEV='STATUS.TXT' MODE='READ' [
  WRITE 'CORELIS STATUS FILE NOT FOUND%NL%';
  BITSET(FAIL,1);
  BRANCH BS_DONE;];
/* Read first line of Status file */
READ TIMEOUT=.2 FAIL(1) ID=STATUS '%R%'RECORD;
L3:
/* Check for passing condition. Exit if pass. */
LET N=INDEX(RECORD,'Passed');
IF N<>0 THEN [WRITE 'CORELIS TEST PASSED%NL%';
  BRANCH BS_DONE;];
L2:
/* Test did not pass. Check hardware and license. */
LET N=INDEX(RECORD,'Error');
IF N<>0 THEN [WRITE 'CORELIS ERROR DETECTED%NL%';
  WRITE 'POSSIBLE HARDWARE OR DONGLE PROBLEM%NL%';
  BITSET(FAIL,1);BRANCH BS_DONE;];
ELSE [WRITE 'CORELIS TEST FAILED%NL%';
  BITSET(FAIL,1);]
OPEN ID=RESULTS DEV='MyTestPlan.LOG' MODE='READ';
L1: READ ID=RESULTS '%R%'RECORD [BRANCH L1Z;];
WRITE ID=MESFILE '%S%%NL%'RECORD;
BRANCH L1;
L1Z:CLOSE ID=RESULTS;]
BS_DONE:
CLOSE ID=STATUS;
```
Application Example for a Single TAP UUT (Using Multiplexed Signals)

The installation and location of the CFM is the same as in the previous example. The USB-1149.1/CFM is mounted in a CFM1 location on the Multi-Function Application Board and the same batch file may be used. However, in this example, a fixture had been designed without including the direct signals and we will need to use the multiplexed signals. The JTAG signals are available on the following nail numbers of the UUT:

TDI=298, TDO=329, TMS=281, TCK=267, TRST=258

Using the same CFM1 location as shown in Figure 1, but this time we route the TAP signals to the analog bus.

<table>
<thead>
<tr>
<th>TAP Signal</th>
<th>CFM Signal</th>
<th>CFB Signal</th>
<th>CFB Pin (P1)</th>
<th>CFB-Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAP1-TDI</td>
<td>CFM1_MUX1</td>
<td>ANACH-A1</td>
<td>A1</td>
<td>K181, K132, K91, K87, K29</td>
</tr>
<tr>
<td>TAP1-TDO</td>
<td>CFM1_MUX2</td>
<td>ANACH-C1</td>
<td>A10</td>
<td>K179, K131, K108, K105, K67</td>
</tr>
<tr>
<td>TAP1-TMS</td>
<td>CFM1_MUX3</td>
<td>ANACH-E1</td>
<td>A19</td>
<td>K177, K130, K145, K143, K77</td>
</tr>
<tr>
<td>TAP1-TCK</td>
<td>CFM1_MUX4</td>
<td>ANACH-G1</td>
<td>A28</td>
<td>K175, K129, K158, K157, K93</td>
</tr>
<tr>
<td>TAP1-TRST#</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6: TAP signal and CFB relay assignments for one 4-signal TAP routed to analog channels

Below is a full example code for the tester for this scenario.

```c
/*Start of Code */
DECLARE BSTRING FAIL(5);
DECLARE FILE OUT;
DECLARE FILE STATUS;
DECLARE FILE RESULTS;
DECLARE CSTRING RECORD(80);
DECLARE N;

DECLARE SYSTEM CFMSETRLY(FLOAT UNIT,CSTRING OPERATION(8),
CSTRING RLYLIST(80));
DECLARE SYSTEM CFBSETRLY(FLOAT UNIT,CSTRING OPERATION(8),
CSTRING RLYLIST(80));
DECLARE SYSTEM SPAWN(CSTRING ARG1(80));

CLRALL:
    /* Clear all CFB Top board relays */
    CALL CFBSETRLY(UNIT=1,OPERATION='JAM',RLYLIST='2400');
    /* Clear CFM1 relays */
    CALL CFMSETRLY(UNIT=1,OPERATION='OPEN',
                   RLYLIST='1,2,3,4,5,6,7,8');
    DELAY 0.05;

    SET PIO(0) HRLY(CLOSE 3); /*** Ground UUT ***/
CLOSE_TAP:
```

/*End of Code*/
/* Close CFM1 relays to connect Muxed TAP lines to CFB */
CALL CFMSETRLY(UNIT=1, OPERATION='CLOSE',
RLYLIST='4');

/* Close CFB Top board relays to connect TAP signals to analog bus */
/* Use a separate command line for each to keep these straight */
/* Connect TDI (MUX1) to Channel A */
CALL CFBSETRLY(UNIT=1, OPERATION='CLOSE',
RLYLIST='181,132,91,87,29');

/* Connect TDO (MUX2) to Channel C */
CALL CFBSETRLY(UNIT=1, OPERATION='CLOSE',
RLYLIST='179,131,108,105,67');

/* Connect TMS (MUX3) to Channel E */
CALL CFBSETRLY(UNIT=1, OPERATION='CLOSE',
RLYLIST='177,130,145,143,77');

/* Connect TCK (MUX4) to Channel G */
CALL CFBSETRLY(UNIT=1, OPERATION='CLOSE',
RLYLIST='175,129,158,157,93');

DELAY 0.05;

/* Note that you will have to ensure that ASSIGN LGC levels are correct */
ASSIGN LGC VCDH=3.5 VCDL=.2 VCST=1.5 VTT=1.5
   VIHA=3.5 VILX=0.25 VOHA=2.4 VOLA=0.8 LVLA(258);

/* If you need any other preconditions here they must be added */

DRV_TRST: BURST ACTIVE;
   IC(258) IH(258);
   END BURST;

/* Dummy SET MUX to put scanners in 8-wire mode */
DUM_MUX: SET MUX AT(CHE=0);

/* Connect TAP to UUT via backplane and scanners */
/* CHA=TDI:CHC=TDO:CHE=TMS:CHG=267 */
SCAN_SET: SET SCAN AT(CHA=298:CHC=329:CHE=281:CHG=267);

/* Execute Corelis test */
RUNIT: CALL SPAWN (ARG1='start /MIN /WAIT corelis.bat');

/* Check status of test */

/* Open status file. Exit if failure. */
OPEN ID=STATUS DEV='STATUS.TXT' MODE='READ' [
   WRITE 'CORELIS STATUS FILE NOT FOUND%NL';
   BITSET(FAIL,1);
   BRANCH BS_DONE;]
/* Read first line of Status file */
READ TIMEOUT=.2 FAIL(1) ID=STATUS '%R%'RECORD;

L3:
/* Check for passing condition. Exit if pass. */
LET N=INDEX(RECORD,'Passed');
IF N<>0 THEN [WRITE 'CORELIS TEST PASSED%NL%';
            BRANCH BS_DONE;];

L2:
/* Test did not pass. Check hardware and license. */
LET N=INDEX(RECORD,'Error');
IF N<>0 THEN [WRITE 'CORELIS ERROR DETECTED%NL%';
              WRITE 'POSSIBLE HARDWARE OR DONGLE PROBLEM%NL%';
              BITSET(FAIL,1);BRANCH BS_DONE;];
ELSE [WRITE 'CORELIS TEST FAILED%NL%';
      BITSET(FAIL,1);

OPEN ID=RESULTS DEV='ScanPlus Demo.log' MODE='READ';

    L1: READ ID=RESULTS '%R%'RECORD [BRANCH L1Z;]
        WRITE ID=MESFILE '%S%%NL%'RECORD;
        BRANCH L1;
    L1Z:CLOSE ID=RESULTS;]

BS_DONE:

CLOSE ID=STATUS;

CLR_ALL: CLEAR LGC;
        CLEAR SCAN;

OPEN_RLY:
CALL CFBSETRLY(UNIT=1,OPERATION='JAM',RLYLIST='2400');

CALL CFMSETRLY(UNIT=1,OPERATION='OPEN',RLYLIST='1,2,3,4,5,6,7,8');
SET PIO(0) HRLY(OPEN 3); /*** Open Ground ***/

END;
Application Example for a Quad TAP UUT (using 4-signal TAP)

The QuadTAP/CFM and QuadTAP/CFM Expander modules can be combined to provide 4 TAPs, as shown in the block diagram in Figure 2. The QuadTAP/CFM boundary-scan controller connects to the tester PC by a USB cable located on the right side of the module. The USB cable should be routed across the front of the pin bay and into the PC bay.

Before starting with the application code, a valid CFM combination needs to be selected based on the TAP requirement of the actual UUT. If full 5-signal TAPs are required, then one (1) QuadTAP/CFM and three (3) QuadTAP/CFM Expander cards will need to be installed. See Application Example for a Quad TAP UUT (using full TAP) for details.

For this example, we assume that any required TRST# signal can be set high (inactive) permanently by one or more ICT channel without causing test execution problems. Four 4-signal TAPs will be used for this application—please see Table 3 & Table 4 for the required relay states. Two free CFM locations, which do not share multiplexed channels, need to be used. For example, positions CFM1 and CFM3 will be used.

![Diagram](image)

*Four (4) muxed interface lines are available to share between each pair of CFM modules (1,2) and (3,4). Eight (8) MUX lines are available to each module when one CFM is installed in slot 1 or 2 and the other is installed in slot 3 or 4.

Figure 2: Block diagram of one QuadTAP/CFM connected to one QuadTAP Expander
Figure 3: Teradyne Multi-Function Application Board with one QuadTAP/CFM connected to one QuadTAP/CFM Expander

**Note:** For more information about QuadTAP/CFM and QuadTAP/CFM Expander configuration options, please see the QuadTAP/CFM User’s Manual.

The QuadTAP/CFM provides connections to TAP1 and TAP2 ports while the QuadTAP/CFM Expander module provides connections to TAP3 and TAP4 ports. The two CFMs are
interconnected; the headers labeled TAP3 and TAP4 from the QuadTAP/CFM main card connect to the headers labeled TAP1 and TAP2 on the expander module.

The TAP signals are routed to the tester interface through the Multi-Function Application Board top board. Each CFM is provided with 4 direct and 4 multiplexed connections to the tester interface. The four signals of TAP1 and TAP3 (TCK, TMS, TDI, TDO) use the direct path through the top board and their disconnect relays are mounted on the CFM while the four signals of TAP2 and TAP4 (TCK, TMS, TDI, TDO) use the multiplexed path and Multi-Function Application Board top board relays connect these signals to the interface. All user relays and relay control signals on the Multi-Function Application Board & CFM are controlled from the test program using system subroutines.

For this Example all JTAG signals will be routed to the UUT Interface (ZIF) connector. All signals by default are disconnected until the respective relays are energized. In addition to the TAP signals we strongly recommend to use as many GND pins as possible.

<table>
<thead>
<tr>
<th>TAP Signal</th>
<th>CFM Signal</th>
<th>CFB Signal</th>
<th>CFB Pin (ZIF)</th>
<th>CFB-Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAP1-TDI</td>
<td>CFM1_DIR1</td>
<td>CFM1DIR1</td>
<td>B8</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TDO</td>
<td>CFM1_DIR2</td>
<td>CFM1DIR2</td>
<td>A9</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TMS</td>
<td>CFM1_DIR3</td>
<td>CFM1DIR3</td>
<td>B14</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TCK</td>
<td>CFM1_DIR4</td>
<td>CFM1DIR4</td>
<td>A15</td>
<td>NA</td>
</tr>
<tr>
<td>TAP2-TDI</td>
<td>CFM1_MUX1</td>
<td>APIN03</td>
<td>B16</td>
<td>K181, K132, K122, K48</td>
</tr>
<tr>
<td>TAP2-TDO</td>
<td>CFM1_MUX2</td>
<td>APIN04</td>
<td>A19</td>
<td>K179, K131, K121, K45</td>
</tr>
<tr>
<td>TAP2-TMS</td>
<td>CFM1_MUX3</td>
<td>APIN07</td>
<td>B36</td>
<td>K177, K130, K120, K43</td>
</tr>
<tr>
<td>TAP2-TCK</td>
<td>CFM1_MUX4</td>
<td>APIN08</td>
<td>A39</td>
<td>K175, K129, K119, K40</td>
</tr>
<tr>
<td>TAP3-TDI</td>
<td>CFM3_DIR1</td>
<td>CFM3DIR1</td>
<td>B48</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TDO</td>
<td>CFM3_DIR2</td>
<td>CFM3DIR2</td>
<td>A49</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TMS</td>
<td>CFM3_DIR3</td>
<td>CFM3DIR3</td>
<td>B54</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TCK</td>
<td>CFM3_DIR4</td>
<td>CFM3DIR4</td>
<td>A55</td>
<td>NA</td>
</tr>
<tr>
<td>TAP4-TDI</td>
<td>CFM3_MUX1</td>
<td>APIN11</td>
<td>B56</td>
<td>K174, K128, K118, K38</td>
</tr>
<tr>
<td>TAP4-TDO</td>
<td>CFM3_MUX2</td>
<td>APIN12</td>
<td>A59</td>
<td>K172, K127, K117, K35</td>
</tr>
<tr>
<td>TAP4-TMS</td>
<td>CFM3_MUX3</td>
<td>APIN15</td>
<td>B76</td>
<td>K170, K126, K116, K33</td>
</tr>
<tr>
<td>TAP4-TCK</td>
<td>CFM3_MUX4</td>
<td>APIN16</td>
<td>A79</td>
<td>K168, K125, K115, K30</td>
</tr>
</tbody>
</table>

Table 7: TAP signal and CFB relay assignments for four 4-signal TAPs

In order to connect the 4 multiplexed signals on CFM1 and CFM3, relays 30, 33, 35, 38, 115-118, 125-128, 168, 170, 172, 174 (for CFM3) and 40, 43, 45, 48, 119-122, 129-132, 175, 177, 179, 181 (for CFM1) on the Multi-Function Application Board top board need to be closed with the following code (for reference see schematic Figure 3-2, page 3-7 of the CFB User’s Guide 9007-5125-00):

```call
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='30, 33, 35, 38, 115-118, 125-128, 168, 170, 172, 174');
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='40, 43, 45, 48, 119-122, 129-132, 175, 177, 179, 181');
```

The code below will energize relay driver signal 1 and 2 on CFM3, and signal 1 and 4 on CFM2:
CALL CFMSETRLY(UNIT=3,OPERATION='CLOSE',RLYLIST='1,2');
CALL CFMSETRLY(UNIT=2,OPERATION='CLOSE',RLYLIST='1,4');

Corelis ScanExpress Runner is a test executive that may be used to execute a predefined boundary-scan test plan. A basic test plan would consist of Infrastructure, Interconnect, Buswire, and Pull-up/Pull-down tests. The user may also add additional steps such as in-system Flash or PLD programming, memory cluster, script, and logic cluster tests.

Corelis ScanExpress Runner has a command line interface that may be used to execute a test plan as a third party application. One form of the command line call is:

"C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
"TestPlanFilename" "CONTROLLER,SETTINGS"

The first argument simply calls the ScanExpress Runner executable to run the test plan. The second argument specifies the location and name of the test plan to be executed. The third argument specifies the controller type and parameters such as logic levels and clock speed. If the controller specification and parameters are omitted, then the test plan will be executed with the most recent controller parameters stored in the test plan. It is considered good practice to first use the ScanExpress Runner Graphical User Interface (GUI) to execute the intended test plan while the UUT is in the fixture and powered up and all relays are switched by the TestStation application to ensure hardware configuration works.

An example of a command line to execute a testplan is shown below:

"C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
"C:\MyTestPlan.tsp"

In our example, we chose to execute the command line from a DOS batch file that is spawned from the TestStation test program with the following command:

CALL SPAWN (ARG1='start /MIN /WAIT corelis.bat');

The command line will output status information such as pass, fail, or error that can be redirected to a file to be read by the test program. Diagnostic messages will automatically be written to a log file by ScanExpress Runner. When a failure is detected, the log file will be opened and the results redirected to the standard in-circuit failure output.

An example of the batch file is shown below:

@echo off
REM Set variables for project and ICT locations
set a="C:\MyProjects\MyTestPlan.log"
set b="C:\MyProjects\MyTestPlan.tsp"
set c="C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
REM Clean up old status and log files
if exist status.txt del status.txt
if exist %a% del %a%
REM Run test plan
%c% %b%>status.txt
EXIT
An example of the test program code to check test status and redirect diagnostic messages is shown below:

```c
/* Check status of test */
/* Open status file. Exit if failure. */
OPEN ID=STATUS DEV='STATUS.TXT' MODE='READ' [
WRITE 'CORELIS STATUS FILE NOT FOUND%NL%';
BITSET(FAIL,1);
BRANCH BS_DONE;]
/* Read first line of Status file */
READ TIMEOUT=.2 FAIL(1) ID=STATUS '%R%'RECORD;
L3:
/* Check for passing condition. Exit if pass. */
LET N=INDEX(RECORD,'Passed');
IF N<>0 THEN [WRITE 'CORELIS TEST PASSED%NL';
BRANCH BS_DONE];
L2:
/* Test did not pass. Check hardware and license. */
LET N=INDEX(RECORD,'Error');
IF N<>0 THEN [WRITE 'CORELIS ERROR DETECTED%NL';
WRITE 'POSSIBLE HARDWARE OR DONGLE PROBLEM%NL';
BITSET(FAIL,1);BRANCH BS_DONE];
ELSE [WRITE 'CORELIS TEST FAILED%NL';
BITSET(FAIL,1);
OPEN ID=RESULTS DEV='MyTestPlan.LOG' MODE='READ';
L1: READ ID=RESULTS '%R%'RECORD [BRANCH L1Z];
WRITE ID=MESFILE '%S%%NL%RECORD;
BRANCH L1;
L1Z:CLOSE ID=RESULTS;]
BS_DONE:
CLOSE ID=STATUS;
```
Application Example for a Quad TAP UUT (using full TAP)

The QuadTAP/CFM and QuadTAP/CFM Expander modules can be combined to provide 4 TAPs, as shown in Figure 4. Before starting with the application code, a valid CFM combination needs to be selected based on the TAP requirement. If full 5-signal TAPs are required, then one (1) QuadTAP/CFM and three (3) QuadTAP/CFM Expander cards will need to be installed.

Four 5-signal TAPs will be used for this application—please see Table 3 & Table 4 for the required relay states. All four CFM locations will be utilized; since the TRST# signal is part of the multiplexed channels and shared with an adjacent CFM it requires reconfiguration of the parameter string as part of the driver setup from ScanExpress Runner. For example, positions CFM1 will be used for the QuadTAP and position CFM2, 3 and 4 will be used for the Expander module.

Figure 4: Block Diagram of one QuadTAP/CFM connected to three QuadTAP/CFM Expanders
Figure 5: Teradyne Multi-Function Application Board with one Corelis QuadTAP/CFM connected to three QuadTAP/CFM Expanders

The QuadTAP/CFM provides connections to TAP1 port while the QuadTAP/CFM Expander modules provide connections to TAP2, TAP3 and TAP4 ports. All four CFMs are interconnected; the headers labeled TAP2 on the QuadTAP CFM connects to the header labeled TAP1 on the expander module on position CFM2. TAP3 from the QuadTAP module connects to TAP1 of the
Expander module on position CFM3 and TAP4 from the QuadTAP/CFM main card connect to the headers labeled TAP1 on the expander module on position CFM4 as shown in Figure 5.

The TAP signals are routed to the tester interface through the Multi-Function Application Board top board. Each CFM is provided with 4 direct and 4 multiplexed connections to the tester interface. The four main JTAG signals (TCK, TMS, TDI, TDO) of TAP1, TAP2, TAP3 and TAP4 use the direct path through the top board and their disconnect relays are mounted on the CFM while the respective TRST# signal use the multiplexed path and Multi-Function Application Board top board relays connect these signals to the interface. All user relays and relay control signals on the Multi-Function Application Board & CFM are controlled from the test program using system subroutines.

For this Example all JTAG signals will be routed to the UUT Interface (ZIF) connector. All signals by default are disconnected until the respective relays are energized. In addition to the TAP signals we strongly recommend to use as many GND pins as possible.

<table>
<thead>
<tr>
<th>TAP Signal</th>
<th>CFM Signal</th>
<th>CFB Signal</th>
<th>CFB Pin (ZIF)</th>
<th>CFB-Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAP1-TDI</td>
<td>CFM1_DIR1</td>
<td>CFM1DIR1</td>
<td>B8</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TDO</td>
<td>CFM1_DIR2</td>
<td>CFM1DIR2</td>
<td>A9</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TMS</td>
<td>CFM1_DIR3</td>
<td>CFM1DIR3</td>
<td>B14</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TCK</td>
<td>CFM1_DIR4</td>
<td>CFM1DIR4</td>
<td>A15</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-TRST#</td>
<td>CFM1_MUX1</td>
<td>APIN01</td>
<td>B4</td>
<td>K181, K132, K122, K49</td>
</tr>
<tr>
<td>TAP2-TDI</td>
<td>CFM2_DIR1</td>
<td>CFM2DIR1</td>
<td>B28</td>
<td>NA</td>
</tr>
<tr>
<td>TAP2-TDO</td>
<td>CFM2_DIR2</td>
<td>CFM2DIR2</td>
<td>A29</td>
<td>NA</td>
</tr>
<tr>
<td>TAP2-TMS</td>
<td>CFM2_DIR3</td>
<td>CFM2DIR3</td>
<td>B34</td>
<td>NA</td>
</tr>
<tr>
<td>TAP2-TCK</td>
<td>CFM2_DIR4</td>
<td>CFM2DIR4</td>
<td>A35</td>
<td>NA</td>
</tr>
<tr>
<td>TAP2-TRST#</td>
<td>CFM2_MUX4</td>
<td>APIN06</td>
<td>A27</td>
<td>K176, K129, K119, K41</td>
</tr>
<tr>
<td>TAP3-TDI</td>
<td>CFM3_DIR1</td>
<td>CFM3DIR1</td>
<td>B48</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TDO</td>
<td>CFM3_DIR2</td>
<td>CFM3DIR2</td>
<td>A49</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TMS</td>
<td>CFM3_DIR3</td>
<td>CFM3DIR3</td>
<td>B54</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TCK</td>
<td>CFM3_DIR4</td>
<td>CFM3DIR4</td>
<td>A55</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-TRST#</td>
<td>CFM3_MUX1</td>
<td>APIN09</td>
<td>B44</td>
<td>K174, K128, K118, K39</td>
</tr>
<tr>
<td>TAP4-TDI</td>
<td>CFM4_DIR1</td>
<td>CFM4DIR1</td>
<td>B68</td>
<td>NA</td>
</tr>
<tr>
<td>TAP4-TDO</td>
<td>CFM4_DIR2</td>
<td>CFM4DIR2</td>
<td>A69</td>
<td>NA</td>
</tr>
<tr>
<td>TAP4-TMS</td>
<td>CFM4_DIR3</td>
<td>CFM4DIR3</td>
<td>B74</td>
<td>NA</td>
</tr>
<tr>
<td>TAP4-TCK</td>
<td>CFM4_DIR4</td>
<td>CFM4DIR4</td>
<td>A75</td>
<td>NA</td>
</tr>
<tr>
<td>TAP4-TRST#</td>
<td>CFM3_MUX4</td>
<td>APIN14</td>
<td>A67</td>
<td>K167, K125, K115, K31</td>
</tr>
</tbody>
</table>

Table 8: TAP signal and CFB relay assignments for four 5-signal TAPs

This particular example shows that care has to be taken with shared signals. TRST# by default will connect to the CFMx_MUX4 pin and cause a conflict between CFM1 & CFM2 as well as between CFM3 & CFM4. Please refer to the Corelis executable User Manual for the Controller configuration settings. To resolve this conflict, the JTAG controller TAP pins may be reassigned by following the process described below.
To begin, open the **Controller Configuration** dialog in ScanExpress Runner as shown in [Figure 6](#) and click the **Advanced…** button to launch the **Advanced Configuration** dialog for the USB-1149.1/4E JTAG controller. The **TAP Configuration** displays and allows configuration of the **Pinout** setting for each TAP.

![Configuration dialog](image)

**Figure 6: Controller Configuration GUI**

To change the **Pinout** value, click on the text in the **TAP1** row under the **Pinouts** column. A drop-down menu will be available as shown in [Figure 7](#).
Select **Custom** from the drop-down menu. The **Pinout Configuration** window will open as show in the left half of Figure 8.

**Figure 7: Controller Advanced Configuration interface**

**Figure 8: Pinout Configuration interface**
Figure 8 shows the before and after states of the Pinout Configuration for TAP1. Pin number 15, which correspond to the signal GPIO3, is now reassigned to TRST# and no longer conflicts with the TRST# signal from CFM2. The same process should be followed for TAP3 to avoid any conflict on TRST# of CFM3 and CFM4 (TAP3 and TAP4 respectively).

Once the test plan has been successfully executed using the ScanExpress Runner graphical interface, it should now be ready to be called from the Teradyne system via the CMD-line call. To call a test plan, a specific parameter string needs to be provided as part of the CMD-line argument. This string can be found toward the top of the plain text Test Plan file (*.tsp). The TSP file may be opened and read using a standard text editor such as TextPad.

An example parameter string is listed below as plain text:

```
ControllerParam = USB-1149.1/4E,42,1,114,1,7,1,1,1,42,42,42,42,1,1,1,1,4082605009,324508639,324508639,324508639,4082605009.
```

In order to connect the 4 multiplexed signals (one each of CFM1 through CFM4), relays 49, 122, 132 and 181 (for CFM1), 41, 119, 129 and 176 (for CFM2), 39, 118, 128 and 174 (for CFM3) and 31, 115, 125, 167 (for CFM4) on the Multi-Function Application Board top board need to be closed with the following code (for reference see schematic Figure 3-2 on page 3-7 of the CFB User’s Guide 9007-5125-00):

```
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='49,122,131,181');
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='41,119,129,176');
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='39,118,128,174');
CALL CFBSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='31,115,125,167');
```

The code below will energize relay driver signal 1 on CFM1, CFM2, CFM3 and CFM4:

```
CALL CFMSETRLY(UNIT=1,OPERATION='CLOSE', RLYLIST='1');
CALL CFMSETRLY(UNIT=2,OPERATION='CLOSE', RLYLIST='1');
CALL CFMSETRLY(UNIT=3,OPERATION='CLOSE', RLYLIST='1');
CALL CFMSETRLY(UNIT=4,OPERATION='CLOSE', RLYLIST='1');
```

Corelis ScanExpress Runner is a test executive that may be used to execute a predefined boundary-scan test plan. A basic test plan would consist of Infrastructure, Interconnect, Buswire, and Pull-up/Pull-down tests. The user may also add additional steps such as in-system Flash or PLD programming, memory cluster, script, and logic cluster tests.

Corelis ScanExpress Runner has a command line interface that may be used to execute a test plan as a third party application. One form of the command line call is:
The first argument simply calls the executable to run the test plan. The second argument specifies the location and name of the test plan to be executed. The third argument specifies the controller type and parameters such as logic levels and clock speed. If the controller specification and parameters are omitted, then the test plan will be executed with the most recent controller parameters stored in the test plan. It is considered good practice to use the ScanExpress Runner Graphical User Interface (GUI) to execute the intended test plan while the UUT is in the fixture and powered up and all relays are switched by the TestStation application to ensure hardware configuration works.

**Note:** When using the QuadTAP/CFM controller, select the USB-1149.1/4E icon under the Controller selection section of ScanExpress Runner.

An example of a command line to execute a test plan is shown below:

```
"C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
"TestPlanFilename" "CONTROLLER,SETTINGS"
```

In our example, we chose to execute the command line from a DOS batch file that is spawned from the TestStation test program with the following command:

```
CALL SPAWN (ARG1='start /MIN /WAIT corelis_4TAP.bat');
```

The command line will output status information such as pass, fail, or error that can be redirected to a file to be read by the test program. Diagnostic messages will automatically be written to a log file by ScanExpress Runner. When a failure is detected, the log file will be opened and the results redirected to the standard in-circuit failure output.

An example of the batch file is shown below:

```bash
@echo off
REM Set variables for project and ICT locations
set a="C:\MyProjects\MyTestPlan.log"
set b="C:\MyProjects\MyTestPlan.tsp"
set c="C:\Program Files\Corelis\ScanExpress Runner v6\RunTestPlan.exe"
set e="ControllerParam = USB-1149.1/4E,42,1,114,1,7,1,1,42,42,42,42,1,1,1,4082605009,324508639,324508639,4082605009,"
REM Clean up old status and log files
if exist status.txt del status.txt
if exist %a% del %a%
REM Run test plan
%c% %b% %e%>status.txt
EXIT
```

An example of the test program code to check test status and redirect diagnostic messages is shown below:

```c
/* Check status of test */
/* Open status file. Exit if failure. */
OPEN ID=STATUS DEV='STATUS.TXT' MODE='READ' [
WRITE 'CORELIS STATUS FILE NOT FOUND\%NL\%';
BITSET(FAIL,1);
BRANCH BS_DONE;];
```
/* Read first line of Status file */
READ TIMEOUT=.2 FAIL(1) ID=STATUS '%R%'RECORD;
L3:
/* Check for passing condition. Exit if pass. */
LET N=INDEX(RECORD,'Passed');
IF N<>0 THEN [WRITE 'CORELIS TEST PASSED%NL%;
BRANCH BS_DONE;];
L2:
/* Test did not pass. Check hardware and license. */
LET N=INDEX(RECORD,'Error');
IF N<>0 THEN [WRITE 'CORELIS ERROR DETECTED%NL%;
WRITE 'POSSIBLE HARDWARE OR DONGLE PROBLEM%NL%';
BITSET(FAIL,1);BRANCH BS_DONE;];
ELSE [WRITE 'CORELIS TEST FAILED%NL%;
BITSET(FAIL,1);
OPEN ID=RESULTS DEV='MyTestPlan.LOG' MODE='READ';
L1: READ ID=RESULTS '%R%'RECORD [BRANCH L1Z;];
WRITE ID=MESFILE '%S%%NL%'RECORD;
BRANCH L1;
L1Z:CLOSE ID=RESULTS;];
BS_DONE:
CLOSE ID=STATUS;
Application Example for I²C Direct Programming on Four UUTs

The QuadTAP/CFM not only includes JTAG signals but also features a set of I²C and SPI bus signals on each TAP. In order to have a total of four I²C bus connections available, a minimum of one (1) QuadTAP/CFM and one (1) QuadTAP Expander module are required. Please refer to Figure 2 and Figure 3 on page 15 for the actual installation and CFM location to be used.

The QuadTAP/CFM makes use of the Corelis USB-1149.1/4E JTAG controller as the main controller interface. The USB-1149.1/4E JTAG controller hardware is very flexible and allows for any of the 8 signals pins to be reconfigured to meet custom requirements.

For this example, the I²C signals will be reassigned to the pins normally used for the TDI and TDO signals in a regular JTAG interface. The CFB routing could look like as reflected in Table 9.

<table>
<thead>
<tr>
<th>TAP Signal</th>
<th>CFM Signal</th>
<th>CFB Signal</th>
<th>CFB Pin (ZIF)</th>
<th>CFB-Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAP1-I²C-SDA</td>
<td>CFM1_DIR1</td>
<td>CFM1DIR1</td>
<td>B8</td>
<td>NA</td>
</tr>
<tr>
<td>TAP1-I²C-SCL</td>
<td>CFM1_DIR2</td>
<td>CFM1DIR2</td>
<td>A9</td>
<td>NA</td>
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<tr>
<td>TAP2-I²C-SDA</td>
<td>CFM1_MUX1</td>
<td>APIN03</td>
<td>B16</td>
<td>K181, K132, K122, K48</td>
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<tr>
<td>TAP2-I²C-SCL</td>
<td>CFM1_MUX2</td>
<td>APIN04</td>
<td>A19</td>
<td>K179, K131, K121, K45</td>
</tr>
<tr>
<td>TAP3-I²C-SDA</td>
<td>CFM3_DIR1</td>
<td>CFM3DIR1</td>
<td>B48</td>
<td>NA</td>
</tr>
<tr>
<td>TAP3-I²C-SCL</td>
<td>CFM3_DIR2</td>
<td>CFM3DIR2</td>
<td>A49</td>
<td>NA</td>
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<td>TAP4-I²C-SDA</td>
<td>CFM3_MUX1</td>
<td>APIN11</td>
<td>B56</td>
<td>K174, K128, K118, K38</td>
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<tr>
<td>TAP4-I²C-SCL</td>
<td>CFM3_MUX2</td>
<td>APIN12</td>
<td>A59</td>
<td>K172, K127, K117, K35</td>
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</tbody>
</table>

Table 9: TAP signal and CFB relay assignments for four I²C-signal TAPs

The test plan file to be executed needs to include four copies of the *.fpi test step. Each of these test steps has a different TAP associated to access a different UUT. To select a different TAP for a particular test step, open the test step Options by right-clicking the test step and selecting Options. The *.fpi steps can be included in an individual test plan or added as part an already existing test plan. To enable direct programming for the test step, select the option to “Use Direct (non-JTAG) Programming Port” in the same test step options.

For more information on test plans and how to add and configure test steps, please see the ScanExpress Runner User's Manual.
Troubleshooting

For additional information on Corelis ScanExpress software and hardware products, please visit the Corelis website at [www.corelis.com](http://www.corelis.com) or contact your Corelis representative.

For additional information on the Teradyne TestStation and Multi-Function Application Board, please visit the Teradyne website at [www.teradyne.com](http://www.teradyne.com) or contact your Teradyne representative.

Additional Tools

Using ScanExpress Runner, many types of test steps from different development systems may be executed using the CFM hardware.

- For generating boundary-scan test vectors for boundary-scan, please refer to Corelis ScanExpress TPG intelligent test pattern generator.
- For generating at speed functional test steps, please refer to Corelis ScanExpress JET.
- For generating Flash programming setup files for indirect programming using boundary-scan, please refer to ScanExpress Flash Generator.
- For generating Flash programming setup files for direct programming, please refer to ScanExpress Programmer.
- For generating ISP programming files for FPGAs, CPLDs, and some microcontrollers, please see the respective vendors’ design tool.
Contact Corelis

<table>
<thead>
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<th>Web</th>
<th>Corelis Corporate Headquarters</th>
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<tbody>
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<td>USA</td>
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</table>

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<thead>
<tr>
<th>Email</th>
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Revision History

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<tr>
<th>Date</th>
<th>Version</th>
<th>Revision Summary</th>
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<tr>
<td>7/12/2012</td>
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