

# FaQ 10



Date: Tuesday, 15 March 2011  
Concerns: Q-STAR INSTRUMENT INTEGRATION

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This document addresses the integration of the Q-Star instruments into the test flow, with a particular focus on the integration of the Q-Star instrument control into the test program. Q-Star instruments are designed for high-speed high-quality (accuracy and high measurement repeatability) current measurements. To enable these capabilities the Q-Star instruments need to be positioned close to the Device Under Test and their operation needs to be synchronized with the test pattern execution. This requires the following prerequisites to be fulfilled:

- Hardware Integration
- Software Integration

## **Hardware Integration:**

The hardware integration is easy to realize and has no associated cost factor if it is taken care of during the design of the interface board that links the DUT with the test system (ATE). It requires including the proper instrument footprint into the board design, route the supply or ground path so that it passes through the instrument and hook up the module control lines to designated test channels that will be used to control the module operation and synchronize its measurement operation with the test pattern flow.

Recommendations for the Hardware Integration are extensively given in the product's Hardware Manual.

## **Software Integration:**

The Software Integration is required both to allow to configure Instrument (selects its operation condition) and to trigger the instrument for making measurements (synchronisation with the test pattern flow). The Software Integration has a cost factor associated as it requires engineering efforts. The supporting tools and solutions that are offered allow to keep this effort to a minimum. The Q-Star instruments use a simple 3-wire serial protocol for communication and control. These protocols are described in full detail in the related product Application and Product Notes and (ready to use) examples are provided in STIL (Standard Test Interface Language – IEEE standard) and WGL (Waveform Generation Language). Both formats are commonly used in the context of test program development. Upon demand also a VHDL simulation model is offered. The latter allows to co-simulate the DUT and the instrument behaviour in relation to the test patterns applied and generate simulation results that contain both DUT and instrument control.

The test program generation process involving the Q-Star instrument typically contains the following steps:

1. Test vector generation
2. Insertion of Q-Star instrument control
3. Translation/compilation of the test pattern data to a ready to use test program

### ***Test vector generation.***

The test vector generation is done by the ATPG (Automated Test Pattern Generation) tool, based on circuit information and a fault model. For IDDQ vector generation either use is made of the Toggle Fault (TF) or of the Pseudo Stuck-at Fault (PSAF) model. Using the PSAF yields test patterns that are superior to the TF based patterns from a defect detection perspective. The output of the ATPG process is a set of test vectors with IDDQ test points identified. The IDDQ test point identifiers, which are just comments inserted in the test pattern data) tell after which vector (defining the test condition) in the test program an IDDQ measurement (being the actual test) is to be done. They do not tell how the IDDQ measurement is to be done and what instrument should be used for doing so.

It is the task of the test engineer translating the test vectors in an actual test program to select the measurement to be used and to embed the required instrument control into the test program. When an ATE resource is deployed this simply means to replace the comment with a call to the dedicated ATE instrument. When a Q-Star instrument is used additional effort is required in comparison to using an ATE based instrument.

#### **Insertion of Q-Star instrument control.**

Insertion of Q-Star instrument control involves the following steps:

- Addition of the Q-Star instrument control pins to the pin list and inserting their default signal assignment to the test vector data (making it look like the DUT has 3 additional pins).
- Inserting instrument configuration commands at the start of the test pattern data (this means inserting additional test vectors that drive the Q-Star instrument)
- Replacing the IDDQ test point identifiers with the appropriate Q-Star instrument measurement control routine eventually complemented with the readout routine to extract the measurement result from the instrument.

#### **Translation/compilation of the test pattern data to a ready to use test program.**

The translation/compilation of the test pattern data to a ready to use test program is a straightforward push-button step using the tools provided by the ATE vendor that take in standard formats like WGL or STIL and convert the code in a test system specific executable.

To simplify the insertion of the Q-Star instrument control the following tools and routes are available:

1. VHDL model
2. Synopsys' TetraMax ATPG tool
3. Sourcelll's VTRAN vector translation tool
4. TestInsight's vector translation toolset
5. Q-Star's in-house WGL pattern modification tool

#### **VHDL Model.**

Upon demand Q-Star can provide a VHDL simulation model and a dedicated test-bench of its instruments. This VHDL model allows to co-simulate the DUT and the Q-Star instrument using the ATPG output as a starting point. The output of such a simulation run contains both DUT test patterns and Q-Star instrument control and can be easily converted into a ready to run test program.

This approach works fine if used is made of VHDL during the design process. The drawback is that the whole simulation (which sometimes can be quite time consuming) needs to be rerun if modifications to the vectors are needed.

#### **Synopsys' TetraMax ATPG tool**

Making use of Synopsys' TetraMax ATPG tool and a STIL procedure library provided by Q-Star allows to insert Q-Star instrument control during test pattern generation, having the IDDQ test point identifiers directly replaced by Q-Star instrument measurement control. This yields test pattern data that includes all what is needed.

This approach works fine but is tied to a particular ATPG tool. The drawbacks of the approach are that is that the whole ATPG process (which is quite time consuming) needs to be rerun if modifications to the vectors are needed and that it might be time consuming as well if modifications to the Q-Star pattern data is needed.

#### **Sourcelll's VTRAN vector translation tool & TestInsight's vector translation toolset**

Making use Sourcelll's VTRAN vector translation tool or TestInsight's vector translation tools in combination with a dedicated VTRAN library provided by Q-Star or a STIL library provided by Q-Star allows to insert Q-Star instrument control during test pattern compilation into an ATE specific format.

This approach works fine and is independent on the ATPG tool used. The main advantages are a simple and easy way to insert the Q-Star instrument control, making the use of a Q-Star instrument quite similar to using an ATE instrument and a push button operation under control and guided by the user. The drawback of the approach is that they customer needs to have access to the tools specified and that an additional license fee to the tool provider might be due.

#### **Q-Star's in-house WGL pattern modification tool**

Making use of Q-Star services and Q-Star's in-house tool for WGL pattern modification also provides a simple and easy way to have patterns with Q-Star module control embedded prior to having them translated to an ATE specific format.

This approach works fine, is independent on the ATPG tool used provided that WGL test pattern data is available. The main advantages are a simple and easy way to insert the Q-Star instrument control, making the use of a Q-Star instrument quite similar to using an ATE instrument and a push button operation under control and guided by the user. The drawback of the approach is the need to transfer the WGL data.

When the IDDQ measurement data is also needed then in combination to having the Q-Star instrument control embedded in the test program then depending on the ATE system used also an ATE specific routine might be needed that allows to interpret the serial data coming out of the module and translate that into numbers.

### **ATE Soft Integration:**

ATE Soft Integration is the ultimate target, making the use of a Q-Star instrument similar to making use of a resource that is embedded into and owned by the ATE. This requires to have the Q-Star control and communication routines to be available precompiled on the ATE and mechanisms to have control transferred back and forward between the actual test program and the Q-Star instrument control and communication.

Such features are available on the Verigy V93000 ATE platform. Combining the WGL or STIL routines provided by Q-Star with the multi-port functionality of the V93K operating system makes the use of the Q-Star instruments similar to using a system resource.

The Teseda V5xx verification systems have embedded support for the basic functions of the Q-Star QD-10xx products, turning the application of these products on the Teseda V5xx systems in a plug-and-play solution when used is made of the basic functionality. To make use of the more advanced functionality of the QD-10xx instruments instrument control has to be embedded in the test pattern data using the STIL interface.

The former Inovys Personal Ocelot and Ocelot test systems (now being part of Verigy) have embedded software support for the (very) basic functions of the Q-Star QD-10xx products, turning the application of these products on the Inovys Personal Ocelot and Ocelot test systems in a plug-and-play solution. To make use of the more advanced functionality of the QD-10xx instruments instrument control has to be embedded in the test pattern data using the STIL interface.

For some specific LTX-Credence (Duo, Quartet) or Teradyne (J750) test systems, libraries are available supporting the use of Q-Star products as part of customer specific solutions developed by these companies for particular customers. These solutions can be requested by the ATE customer through LTX-Credence or Teradyne support.