

Keysight Technologies

Flash programming with the Keysight Utility Card – Successful Implementation in the Manufacturing Environment

Case Study

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Overview

This paper discusses the first successful implementation of flash programming with the Keysight Technologies, Inc. utility card on a customer product – a power line carrier (PLC) meter board. The customer, who has high confidence with Keysight’s in-circuit test (ICT) solution, decided on using the utility card flash programming solution for the product upfront. The customer did not think it was necessary to consider the offline pre-programming station option.

For this particular PLC meter board, not one, but three devices were to be programmed – namely, a micro-controller unit (MCU), a serial flash and serial EEPROM.

Adding a challenge to this project was the fact that the customer was testing a panel of four boards and using only resources from one single module. The Keysight project team was then tasked with helping the customer realize a total programming solution in which three different devices had to be programmed, with multiplexing of the programming resources.

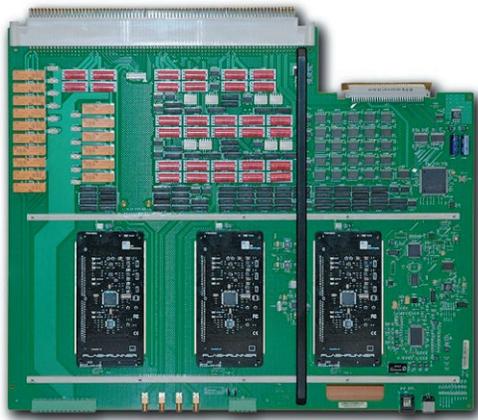


Figure 1. Keysight utility card with programming modules

Project Details

Board type: Power line carrier (PLC) meter board

Fixture: 4-up single-well fixture (panel of 4)

Tester: One module (module 3) with seven double density pin cards (five analog and two hybrid standard cards)

Only one utility card, with three SMH FlashRunner (FR) modules in module 3 slot 3, was installed to perform programming.

Device:

- #1 STM32F101RC - MCU – for programming with 256 Kbit data
- #2 M25P10 – 1 Mbit serial flash – for full programming with 1 Mbit data
- #3 M24512 – 512 Kbit EEPROM – for full programming with 512 Kbit data

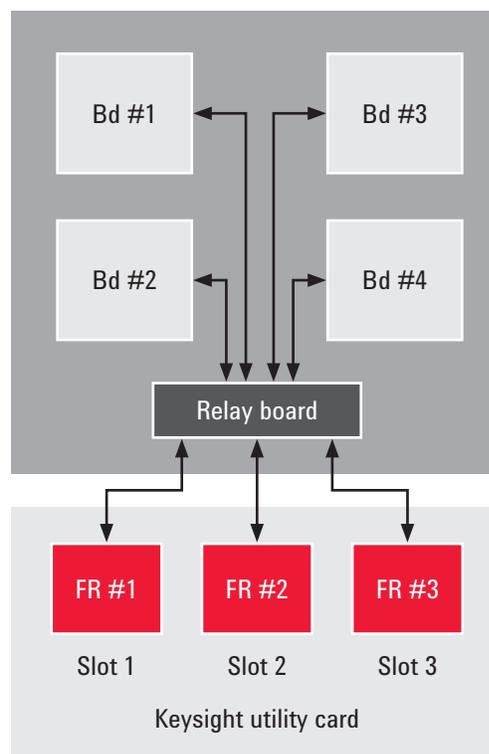


Figure 2. Block diagram connections from FR Modules on the Keysight utility card to devices under test

Programming Solution

The device under test was a panel of four boards, and on each board, there were three different devices (MCU, flash and EEPROM) which required programming. One Keysight utility card, with three FR modules plugged in, was used for the programming. Each FR module was configured to program one of the three different devices, FR #1 for EEPROM, FR #2 for Serial Flash and FR #3 for MCU. All FR modules were then wired to a group of relay boards inside the fixture where it was multiplexed to the panel of four boards.

Table 1. Programming time for each device

Device	Programming time per board (in seconds)	Data size
M24512 – EEPROM Program and verify (via SDA and SCLK lines)	7.75	512 Kb
M25P10 – serial flash Erase, blank check, program and verify (via SI, SO, CS, SCK lines)	4.15	1 Mb
STM32F101RC – MCU Erase, blank check, program and verify (via JTAG)	12	256 Kb

The customer was using resources from only one single module and no throughput multiplier feature was enabled. The ICT test and programming were running sequentially across the four boards. The total ICT and programming test time was well within the customer's requirements.

Key Learning

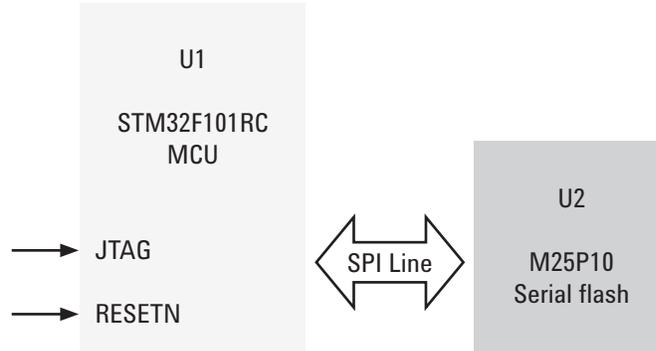


Figure 3. Block diagram of serial flash and upstream MCU

Initially, during the programming debug phase, we encountered a problem programming the serial flash (U2) device. We did pull down the “RESETN” pin of the upstream MCU (U1) device via ‘gprelay’, to reset the MCU device before programming to the serial flash device. However, the programming failed.

With the oscilloscope, we tapped out the SPI signals (namely SI, SO, CS and SCK) and realized that the SPI signals were not swinging to their correct voltage levels. The SPI lines were not properly disabled. This was verified with the MCU datasheet – the RESETN pin does put MCU into the reset state except for the SPI signals.

Upon clarifications with the MCU device vendor (STMicroelectronics), we managed to understand the disabling method for the MCU SPI signals, which was not made known to us previously. We found out that this had to be done with a unique JTAG disable instruction.

Based on the disabling information shared by MCU device vendor, a basic boundary scan disable test was created and successfully used. The serial flash device was programmed successfully upon running the MCU boundary scan disable test. Verification was done by tapping the SPI signals again with the oscilloscope, with the signals swinging fully and the patterns validated.

In conclusion, it is critical that the upstream devices to the targeted programming device can be properly disabled to ensure programming success. It always helps to stand by an oscilloscope for diagnostics and troubleshooting.

Potential Improvement

A better programming solution can be realized with other available Keysight *Medalist* i3070 feature. Below is a summary of the recommendations made to the customer:

- Utilize the Keysight 3070 throughput multiplier and dual well shared wiring features to greatly improve the production throughput.
- Break the panel into four individual boards; each board will definitely fit into one single module resource with Utility Card.
- The ICT tester can be upgraded to two modules with two utility cards (with three FR modules each). With a 2-up dual well fixture, the customer will be able to perform ICT and programming in the throughput mode, and with zero or reduced board handling time.

With the recommendations above, the customer can achieve tremendous improvement (potentially up to a factor of 8x) on the overall production throughput in term of both programming and ICT test time.

Considerations for Implementation of Flash Programming with the Keysight Utility Card

1. The Keysight utility card will take up one slot in the tester configuration.
2. Design for test (DFT) for upstream devices must be taken into consideration for proper disabling.
3. DFT for flash device programming must be taken into consideration, meaning test access must be made available to data, address and control lines of the flash device.

Considerations 2 and 3 are not unique to flash programming with the utility card – they should be considered in all projects for proper disabling and test coverage, even those without programming required.

Conclusions

The first manufacturing-environment project utilizing the Keysight utility card for flash programming solution was successfully implemented. Results show the great flexibility of the Keysight utility card flash programming solution. It is definitely a viable option for manufacturers looking for flash programming solution at the ICT stage to improve production efficiency.

For more details on the Keysight utility card, please refer to available literatures on www.keysight.com/find/utility.

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