iCE65 mobileFPGA™ Configuration & Programming Overview

05/12/2010

Configuration vs. Programming

- **CONFIGURATION**

  - iCE65 is a standard SRAM FPGA (reconfigurable)

  - During power up, a configuration image is loaded into the iCE65 device to start functioning

    - In Master mode, the iCE65 "CONFIGURES" itself from built-in NVCM or external SPI flash memory

    - In Slave mode, a processor/programmer "CONFIGURES" iCE65 FPGAs
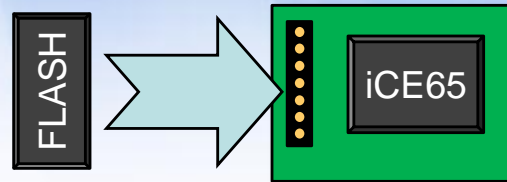
- **PROGRAMMING**

  - Storing the FPGA configuration image into an external SPI flash memory or built-in NVCM

    - By using programming cable and software

    - SPI flash can be programmed many times

    - NVCM can be programmed only once

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iCE65 Configuration Options

- There are "3" ways to configure iCE65 FPGAs
  - SPI flash configuration
  - SysMem configuration
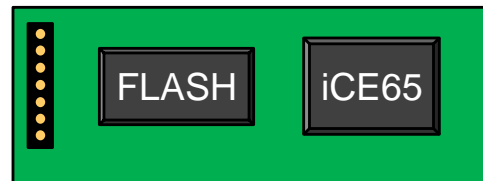 - NVCM configuration

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SPI FLASH Configuration

- Off-board:

  - User-programmed SPI FLASH device connects to header on customer board to configure iCE65 device
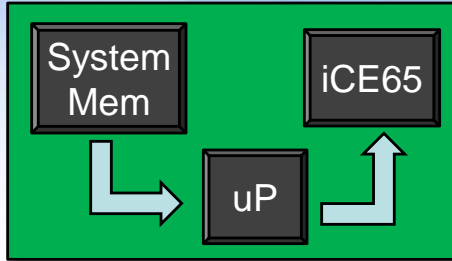
- On-board:

  - User-programmed SPI FLASH device connects directly to iCE65 device
  - Header is typically used to program FLASH device
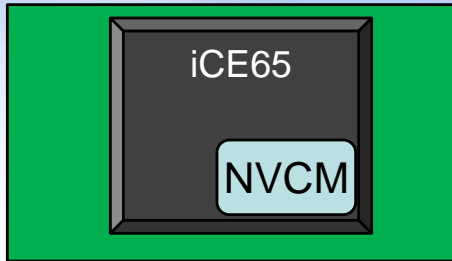
- Benefits
  - Customer in control of SPI FLASH programming (standard programming tools)
  - Familiar to FPGA users
  - Multiple images can be stored

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SysMem Configuration

- User-programmed system memory stores iCE65 configuration bitstream
- Microprocessor used to control configuration process

- Benefits
  - Eliminates needs for separate configuration memory
  - Customer in control of system memory programming
  - Familiar to FPGA users
  - Multiple images can be stored
  - Support field upgrade

- Requires user to implement control program in processor

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NVCM Configuration

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NVCM

NVCM = Non-Volatile Configuration Memory

- On-chip NVCM memory stores iCE65 configuration bitstream

- Benefits
    - One-chip solution eliminates need for separate configuration memory
    - NVCM consumes less power than FLASH solutions
    - Instant-On

- SiliconBlue recommends factory programming of NVCM memory for production phase
    - 100% programming yield guarantee
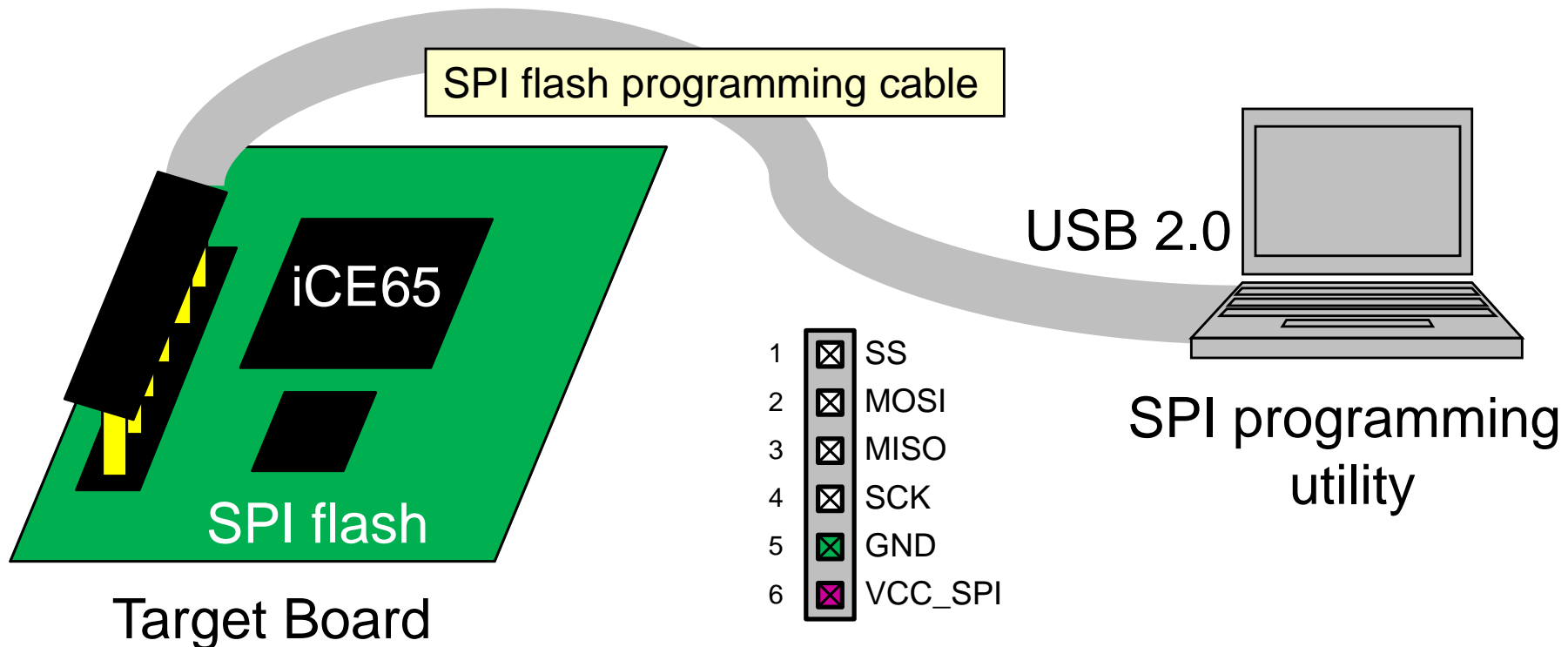   - Can offer other services such as custom marking

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SPI FLASH CONFIGURATION AND PROGRAMMING

SPI Flash Configuration Options

- Two Ways:
  - On-board SPI flash
  - Off-board SPI flash

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On-Board Flash

- *Best for design needing frequent update*
- *Same as standard SRAM-based FPGA approach*

SPI flash programming cable

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SPI flash

Target Board

1	⊠	SS
2	⊠	MOSI
3	⊠	MISO
4	⊠	SCK
5	⊠	GND
6	⊠	VCC_SPI

USB 2.0
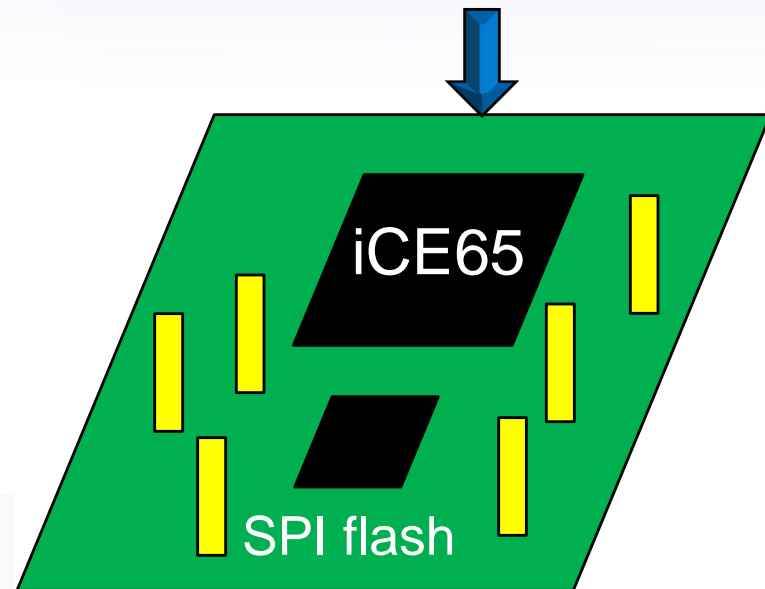
SPI programming utility

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Connections on Prototype

Optional "Flying Leads"

- Little to no board space required on prototype

- Connect to test points on board (Digilent part number: 6-Pin MTE)

- Optionally spot solder leads to pads on prototype

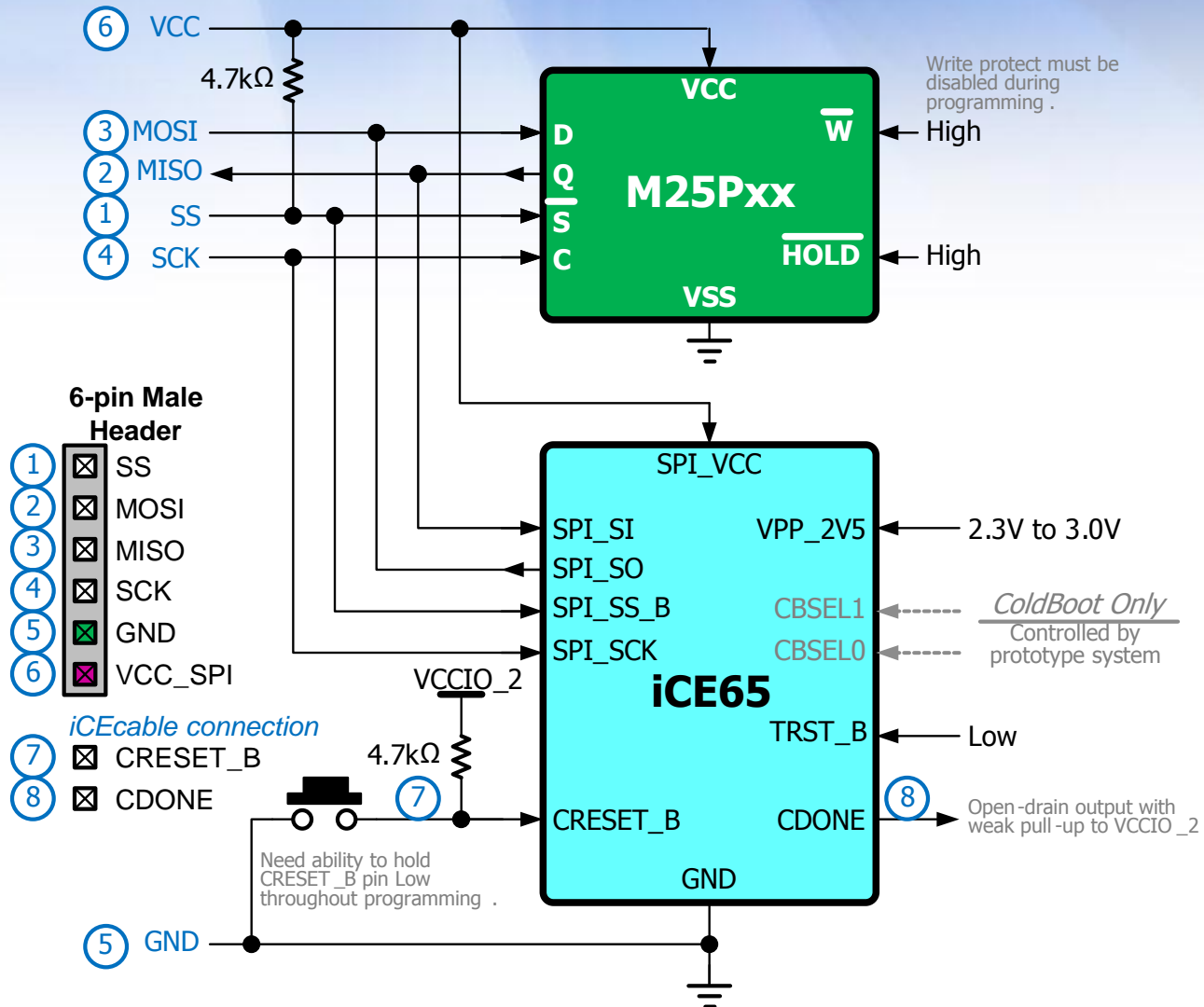Prototype does not have room for 6 pin header, so test points are used

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SPI flash

6-Pin MTE

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Recommended 3rd Party SPI Flash Programming Cables

	Dedi-prog	Aardvark
Product Name	SF100	I2C/SPI Host Adapter
Availability	Now	Now
Software	DediProgrammer Pro	Flash Center Software
Unit Price	$210	$250

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Connection to SPI Flash

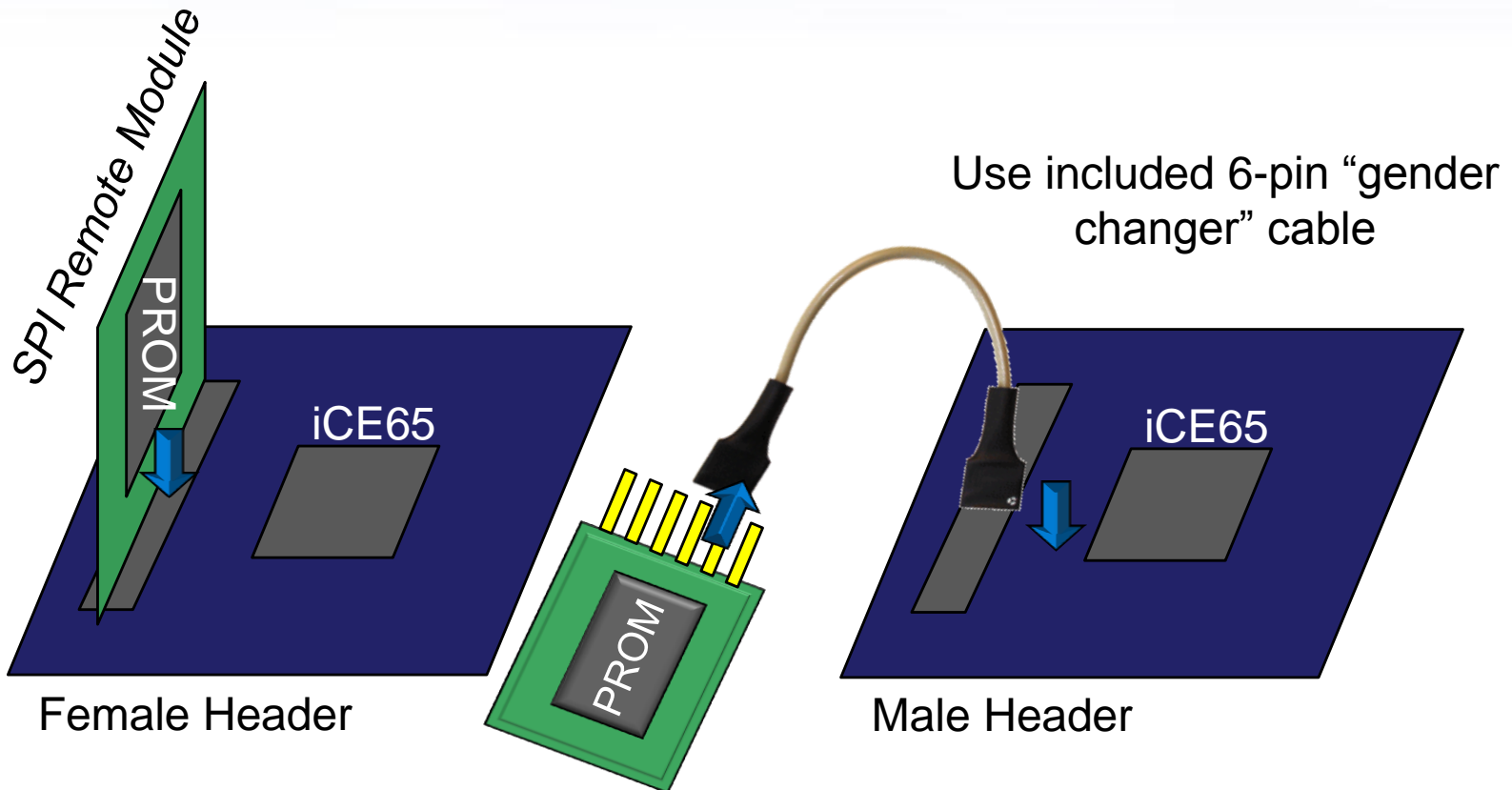SiliconBlue

Using Remote Configuration Module

- *Easier migration to NVCM production model*
- *Same header can be used to program NVCM (ISP)*

Use included 6-pin "gender changer" cable

SPI Remote Module

PROM

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Female Header

PROM

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Male Header

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Remote Configuration Module

- 16Mbit SPI storage module
  - 3.3V M25P16 Flash PROM
  - Large enough for multiple ColdBoot, WarmBoot images

- Program using download cable
  - Plugs directly into cable

- After programming, plug it into iCE65 prototype

- Includes 6-pin "gender changer" cable

- Can be purchased from Digilent Inc.
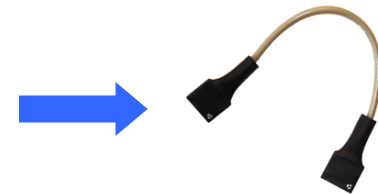
www.digilentinc.com/Products/Detail.cfm?NavTop=2&NavSub=489&Prod=PMOD-SF

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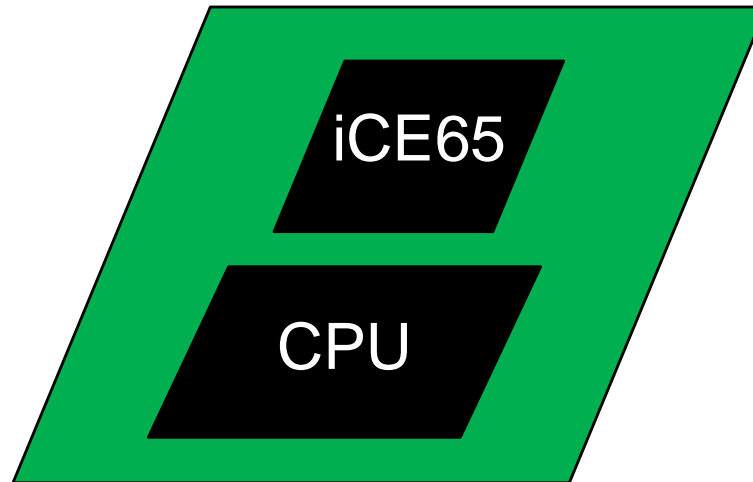
Connection to Remote Configuration Module
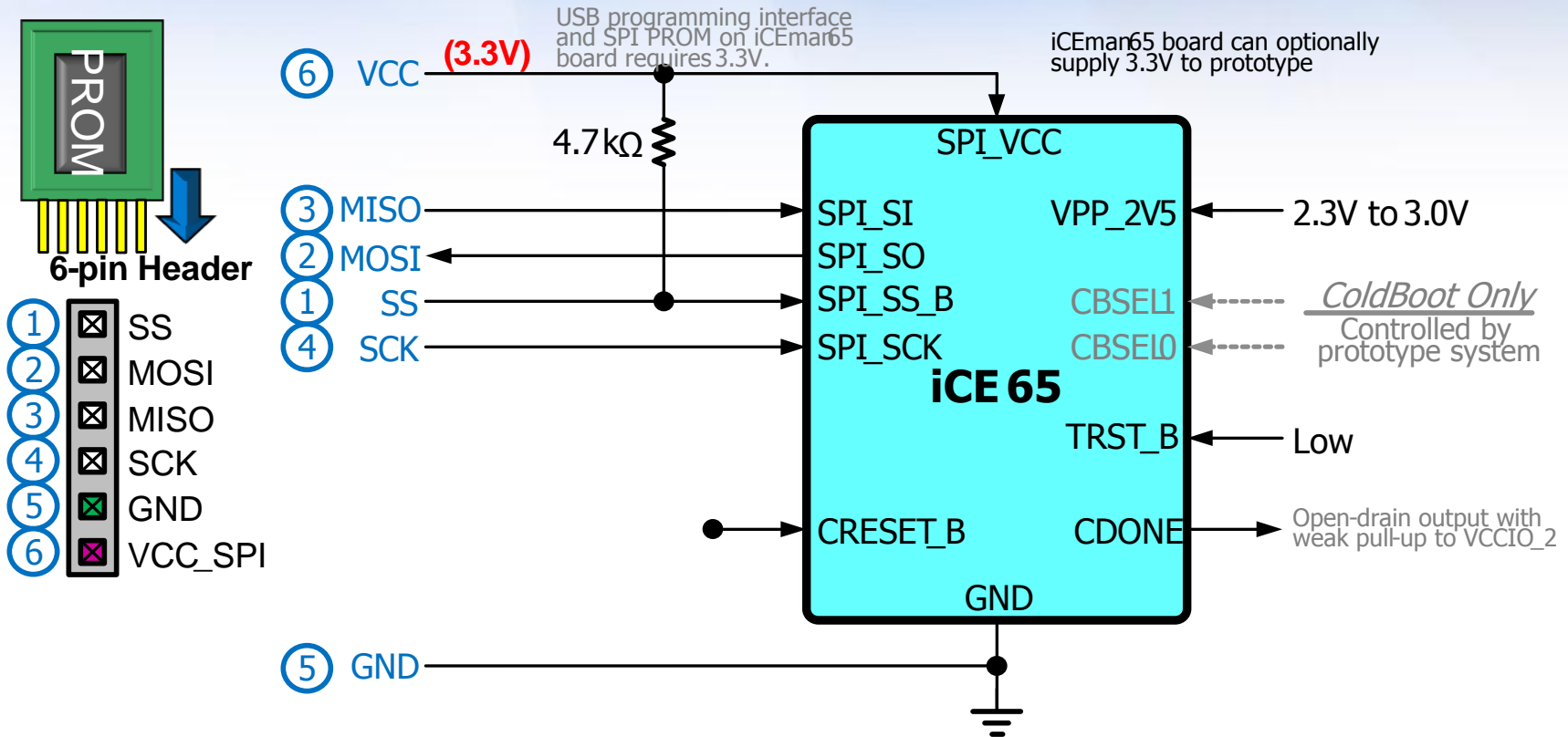
When ready for production, connect CRESET_B to program NVCM

SYSMEM CONFIGURATION AND PROGRAMMING

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SysMem Configuration

- *Saves extra memory cost*
- *Provides seamless field upgrade capability*
- *Familiar to all FPGA designers*
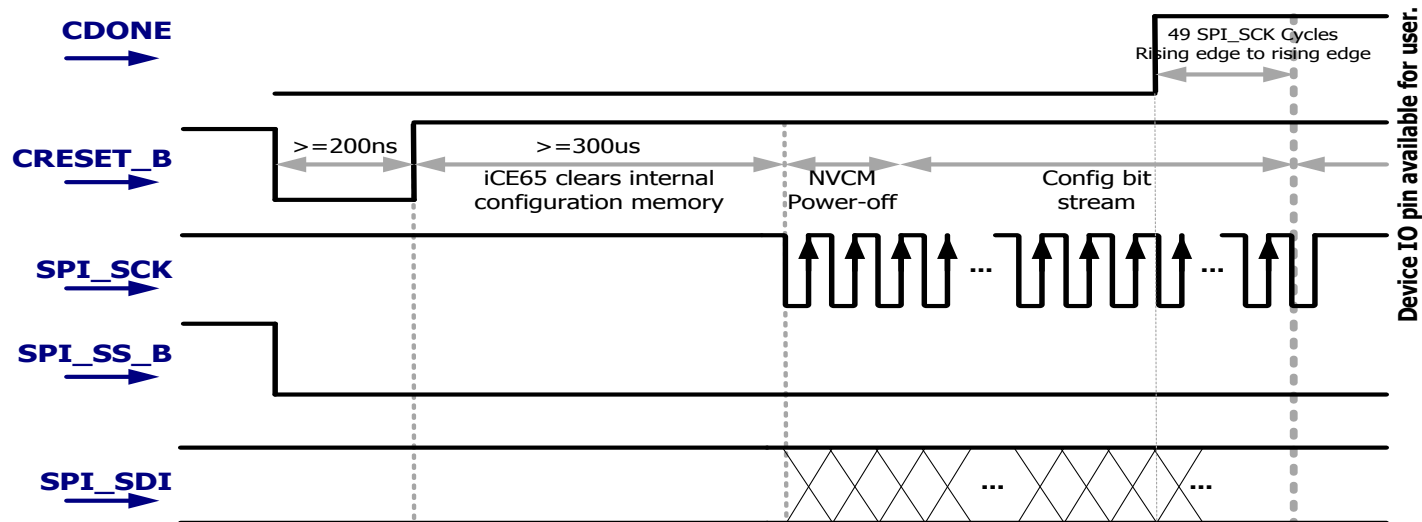
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CPU

Target Board

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SysMem Configuration Connections

- Also known as "processor/CPU configuration"
- Very popular & well known to FPGA designers
- Reference code available in ARM, MIPS, & PXA270

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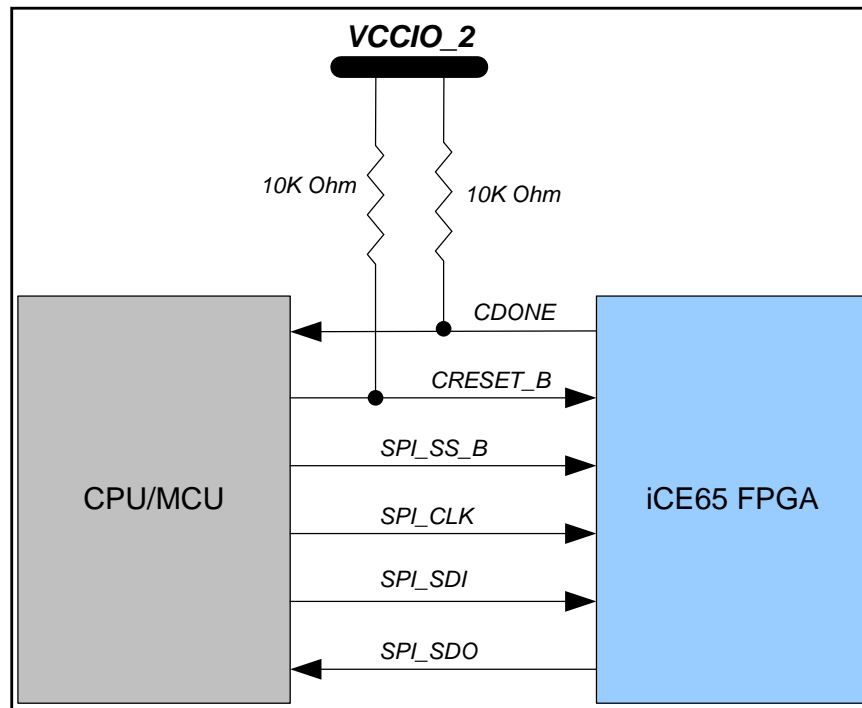
Configuration Procedures

1. Set SPI_SS_B to low
2. Pulse CRESET_B low for at least 200 ns
3. Wait 300 µs for internal CRAM to be cleared
4. Send NVCM power off instructions (to minimize power)
5. Send entire bitstream file with 5 ~ 25MHz and 50% duty cycle clock, drive data with falling edge clock with MSB first
6. Continue to send extra 50 clocks, CDONE pin will go high
7. Release all SPI I/F, iCE65 should enter user mode

CDONE

49 SPI_SCK Cycles
Rising edge to rising edge

CRESET_B

>=200ns   >=300us
iCE65 clears internal   NVCM   Config bit
configuration memory   Power-off   stream

SPI_SCK

...   ...

SPI_SS_B

SPI_SDI

...   ...

Device IO pin available for user.

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Configuration File Update

- Bitstream file can be stored in the system memory or implemented as part of the CPU/processor code

- When implemented as part of CPU code, it will allow virtually seamless field upgrade
  - FPGA configuration file will be updated during firmware update

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Conclusion

- Three options = Maximum flexibility

- Choose the iCE65 configuration mode that best matches *your* application requirements
  - Self-loaded (automatically "boot" at power-up)
  - ASIC-like single chip option
  - Ability to do field upgrade

- No Limits: Use just one mode or use all three in the same application

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NVCM PROGRAMMING LOGISTICS

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Programming Success Factors and Influences

Factor

- Robust electrical connections between the programmer and the device
  - Clean, strong contacts
  - Careful handling

- Proper application of electrical pulses to sufficiently program the device
  - Number of pulses
  - Timing

Influence

- Qualified hardware that is well maintained

- Latest released programming software
- Proper board design and layout (In-System Programming)

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Prototype NVCM Programming

- Prototype programming support is intended for low quantities, typically less than 100 units

- Two methods are supported:
  - **ISP** with iCEcable Programming Kit: Devices are mounted on customer's board with a header for programming
    - Header can be used for both SPI configuring and NVCM programming
  - **Stand-alone station** with iCEprog Programming Kit

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Production Programming

- Production programming support is intended for large quantities

- Objective is to ensure customer satisfaction by:
  - Maximizing programming yield
    - Note that mounted devices are considered "consumed" and not eligible for return
    - SBT will not accept non-blank devices for return
  - Simplify board and system design
  - Removing barriers to customer adoption

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Production Programming Options

- Factory programmed iCE devices
  - **Low programming cost**
  - **No programming yield issues**: All devices shipped are guaranteed to be properly programmed
  - **Secure**: Security bit prevents examination of NVCM contents
  - **Customization** available (such as marking)

- Non-ISP programming by customer
  - Using iCEprog for 1000 to 5000 units
  - Using qualified 3rd party equipment - Dediprog (http://www.dediprog.com)

- Qualified programming house (available mid-2010)
  - Using qualified 3rd party equipment

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Summary of Production Programming Options

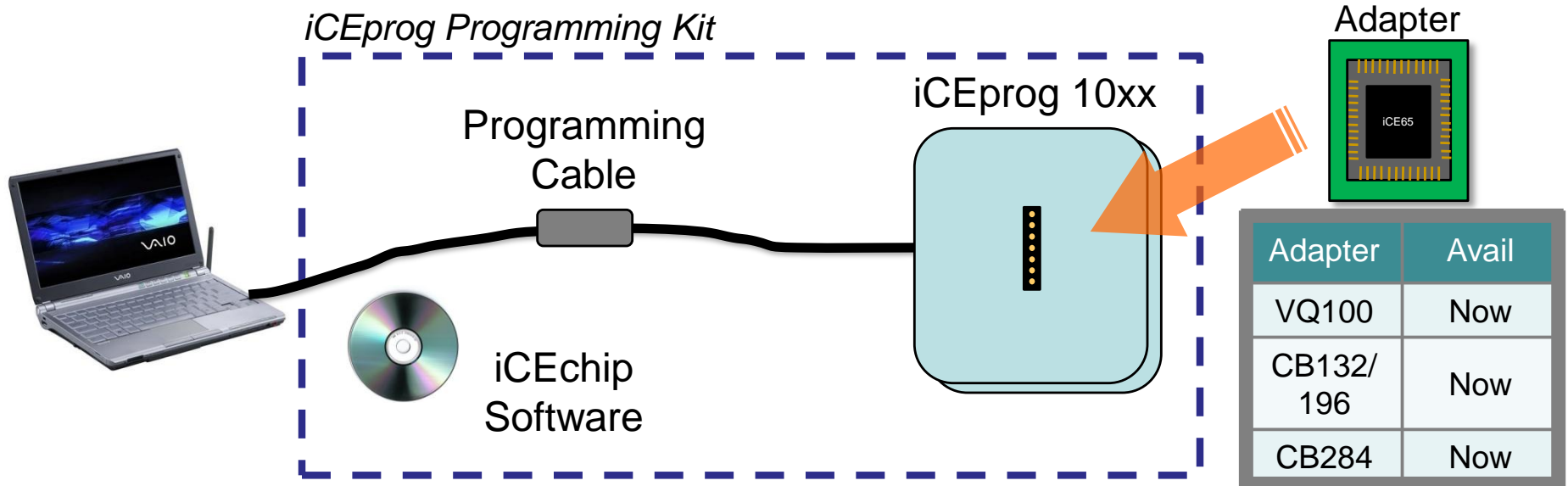| Option	Benefit	Risk	Supported Packages	Other
Factory Programming	• Low (no) cost • Least impact to customer • Secure – security bit locks design • Allows special support (e.g. marking)	• None	• All	
Customer Non-ISP Programming	• Customer controls programming	• Limited quantities for iCEprog stand-alone programmer (1K – 5K) • 3rd party equipment (Dediprog) • Yield loss is customer's responsibility	• VQ100 • CB132/196 • CB284	• CS36, CS63 and CC72 not supported
Qualified Programming House	• Customer can choose vendor	• 3rd party equipment not available until mid - 2010	• VQ100 • CB132/196 • CB284	• CS36, CS63 and CC72 not supported

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SILICONBLUE PROGRAMMING PRODUCTS

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iCEcable Programming Kit

Cable		iCEchip Software		Comments
Model	*Avail*	*Version*	*Avail*	
iCEcable	Now	2.x & Up	Now	Improvements; faster support

iCEcable Kit

Programming
Cable

iCEchip
Software

Customer's
Board

iCE65

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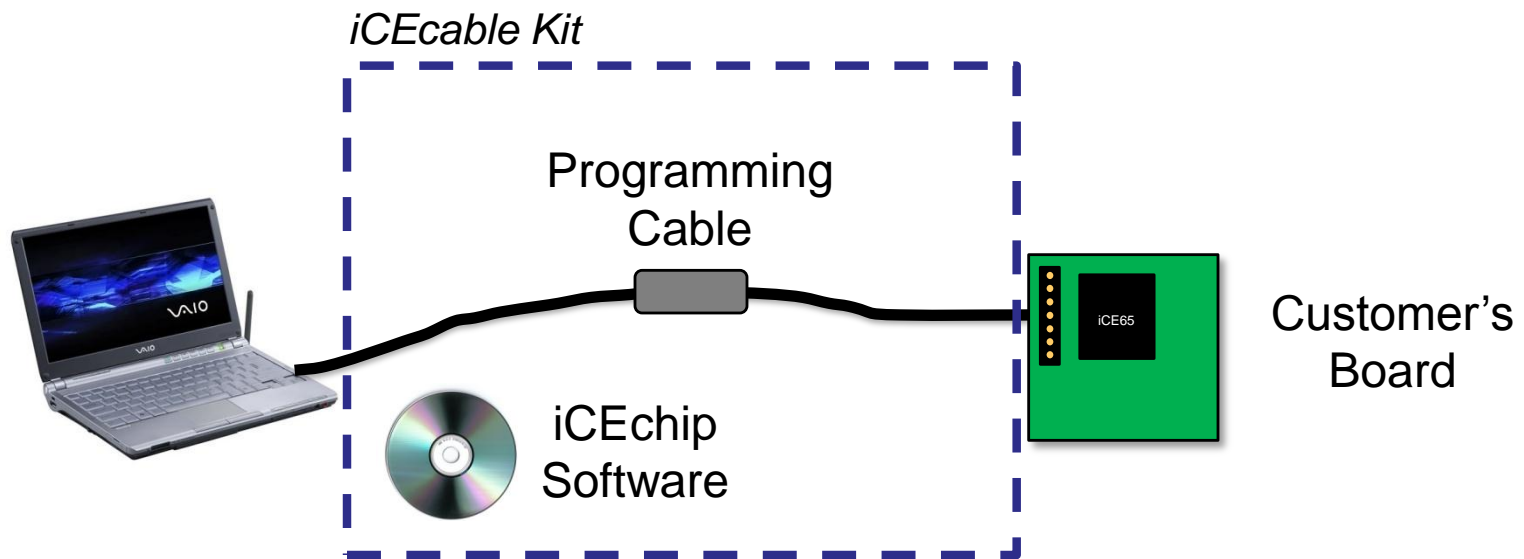
iCEprog Programming Kit

Cable		iCEprog		iCEchip Software		Comments
Model	*Avail*	*Model*	*Avail*	*Version*	*Avail*	
iCEcable	Now	1050	Now	2.1.5	Now	Improve manufacturability

Adapter

iCEprog Programming Kit

iCEprog 10xx

Programming Cable

iCE65

iCEchip Software

Adapter	Avail
VQ100	Now
CB132/ 196	Now
CB284	Now

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DEDIPROG PROGRAMMING PRODUCTS

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Summary of Dediprog Programming Products

Gang Programming Products	Description
Race100-S4	• 4 position gang programmer http://www.dediprog.com/SPI-flash-gang-programmer/Race100-S4
Race 100-S8	• 8 position gang programmer http://www.dediprog.com/SPI-flash-gang-programmer/Race100-S8

Socket Adapter Products	Description
050-VQ100-1414	• Race100 Socket adapter for VQ100 packages
50-CB-196-88	• Race 100 Socket adapter for CB196 packages
50-CB-132-88	• Race 100 Socket adapter for CB132 packages
50-CB-284-88	• Race 100 Socket adapter for CB284 packages

Cable Products	Description
SF100-SBT	• Supports iCE65 SRAM configuration, plus generic SPI flash • NVCM not supported

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ICEMAN EVALUATION BOARD

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iCEman65 Board for Configuration

- iCEman65 evaluation board includes a USB-based programming solution and SPI expansion header
- Use iCEman65 board to configure another prototype iCE65 system
- Connect prototype to 6-pin header J8 on iCEman65 board
- Program SPI serial Flash on iCEman65 board
- Configure iCE65 on prototype PCB from SPI Flash on iCEman65 board
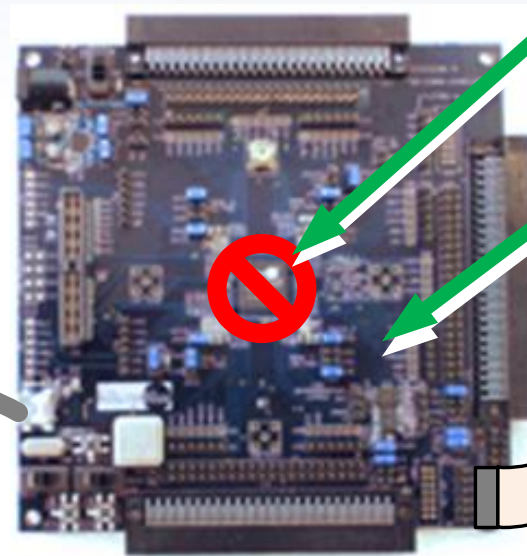- VCC_SPI on prototype must be 3.3V

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iCEman Configuration Setup

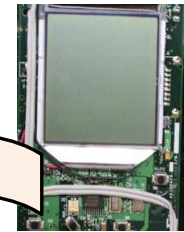Windows-based PC with Adept/ICEUTIL programming software installed
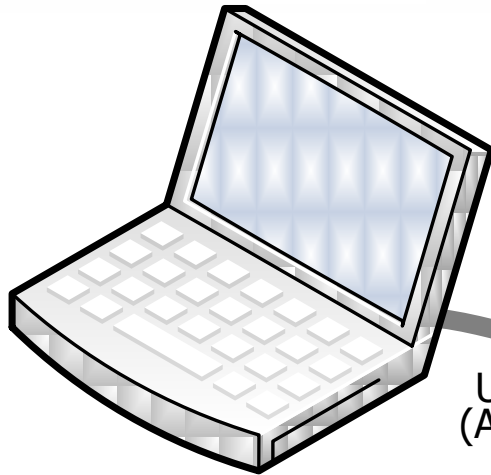
iCEman65 Evaluation Kit Board

iCE65 on iCEman65 board disabled, jumper JP13 installed

SPI Flash PROM on iCEman65 Board

Prototype System with iCE65
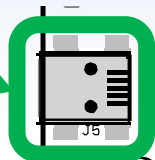
USB Cable (A to mini-B)

Cable or wires connected to Header J8 on iCEman65 board (3.3V interface, power optionally supplied from iCEman65 Board)
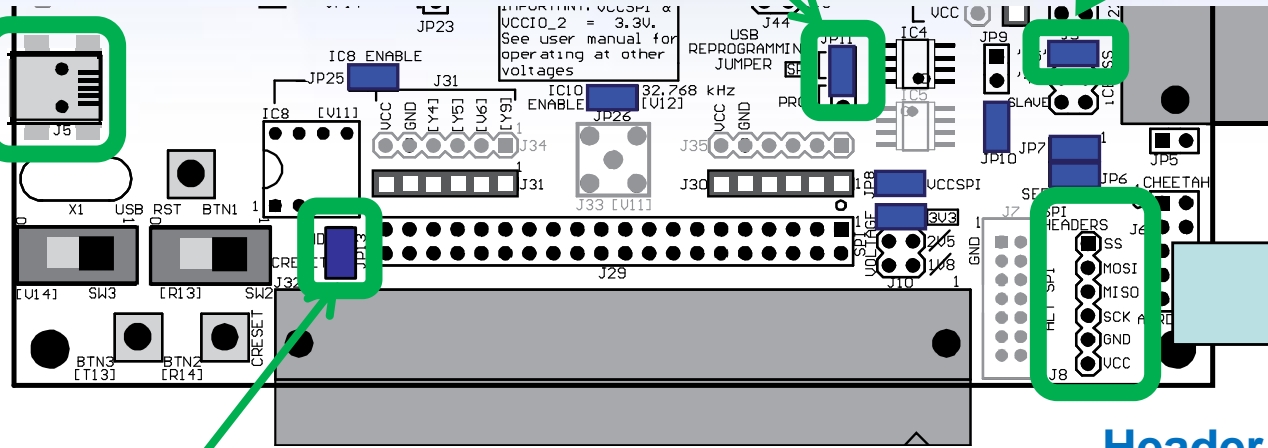
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iCEman Jumper Locations

Jumper J11:
Programming Option, always set to USB (default)

Jumper J9:
Set to '25' (default)

Mini USB connector:
Connect to PC with standard A-to-miniB USB cable.

Header J8:
SPI programming expansion

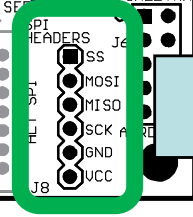**Jumper JP13:**
CRESET_B. Insert jumper to hold iCE65 on iCEman65 board in reset, forcing all I/O pins to Hi-Z. Borrow jumper from JP10 if needed.

Connect to SPI configuration/ programming expansion header to prototype system. Use 6-pin cable included with iCEman65 kit or connect to testpoints on prototype system.

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