Emulation with the *NEW* E3 Bondout from Infineon

March 20, 2000 Version 1.4

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Background

There are many methods to provide emulation capabilities for microcontrollers. These include bondout, Enhanced Hooks, BDM, JTAG and production chips. All provide for effective emulation with different abilities. Infineon has chosen to use Enhanced Hooks for the C500 family and bondout devices for the C166 family. The C161U and C165 UTAH use OCDS (On Chip Debugging Support) which uses the JTAG port for communication. This article is about the new E3 bondout and also provides information about the E2.

Infineon has produced three bondout microcontrollers for the C166 (166E, E and the E2) and now introduces the latest version: the E3. The C166E is for the original SAB80C166 chip and the E (aka E1) was replaced and neither are discussed here. Nohau E1 emulators are supported by the new Seehau software.

These bondouts operate just like the production parts but additionally provide access to internal buses and some additional internal registers. Emulators use these extra facilities to record and trigger on internal events that are not visible on the external bus as well as provide single-chip operation using the 32 bit ROM bus.

The bondout consists of a C166 CPU core, some peripherals (some XBUS), extra address and data bus lines and the usual circuitry such as power, clocks and interrupt pins. The new Nohau EMUL166 E3 bondout emulator is shown in Figure 1 with the cover removed for visibility.

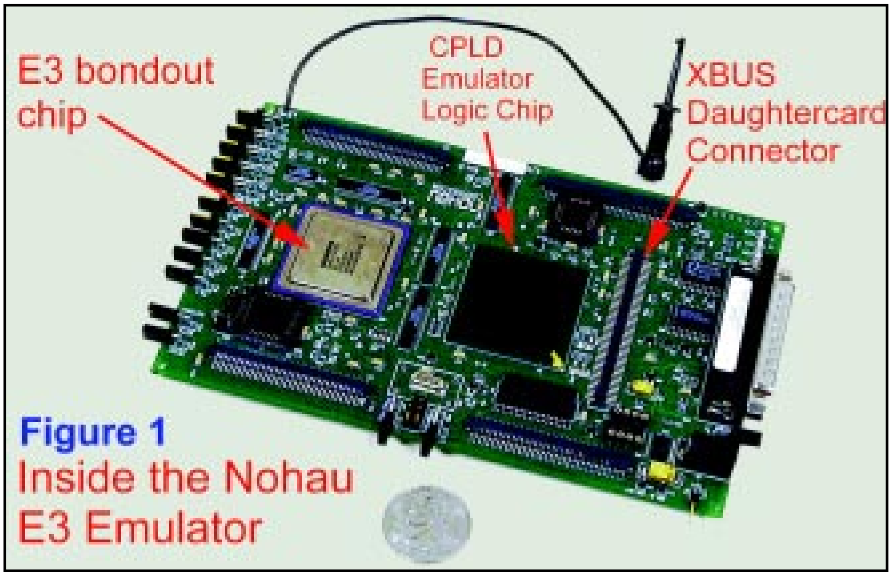


Figure 1
Inside the Nohau E3 Emulator

The E2 Resources

The E2 has these resources built in:

- 3 K DPRAM F200-FDFF
- 2 K XRAM E000-E7FF
- 6 K XRAM C000-D7FF
- 4 K XRAM at EFC000
- Ports P0 through P8
- RTC (Real Time Clock)
- WDT - Watch Dog Timer
- Asynch and Sync Serial ports
- Capture/Compare CAPCOM1 & 2
- PWM Unit and CAPCOM B
- Two A/D Convertors - 10 and 8 bit
- Two CAN ports
- Power Management resources
- Internal Busses brought out

The CAN ports are on the XBUS as is the XRAM and they can be replaced with a second chip in Emulation Mode. The E2 and E3 are very much like a C167CR controller. The E2 operates to 33 MHz.

The *NEW* E3 Resources

The E3 adds these resources:

- 40 MHz operation
- 8 K XRAM C000-DFFF (extra 2 K)
- Bootstrap loader (two actually)
- C167CS support
- Better C161 and C164CI support
- Support for future devices
- One A/D Convertor - 10 bit
- Prescaler for CAN bus added
- Other enhanced emulator features
- Additional registers for Power and Clock Management
- Features for future devices
- Program FLASH emulation control
- PAD Driver Control registers (C161PI and C164CI)

Two Chip Emulation

The E2 and the E3 do not have these peripherals that may need to be emulated:

- I^2C Bus
- J1850 (SDLM) Port
- USB Port
- SSP - Synchronous Serial Port
- Any new peripherals Infineon introduce in the future.

To solve this Infineon uses a two chip emulation system. A production chip containing the XBUS peripheral to be emulated is placed in a special Emulation mode. This disables the CPU and the XBUS peripherals are then available to the bondout controller through the emulation XBUS address and data lines. The input and output pins of the peripheral are routed from this chip to the target system via the regular adapter pins. Figure 2 is a collection of various peripheral daughtercards cards.

An advantage of this is since a regular production chip is used, the exact step of the silicon is used as in your project.

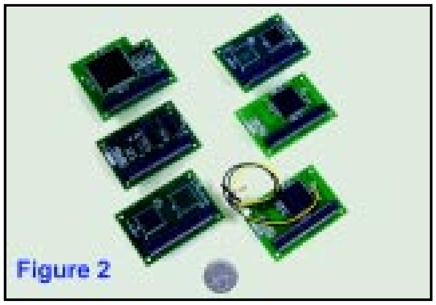


Figure 2

Economical daughtercards are provided by Nohau that plug into the emulator in the socket indicated in the emulator photo. Current devices supported are C163, C161PI, C161RI, C167CS, and XRAM. Additional unannounced devices are supported or are under development.

E2 or E3 ?

Which one to use? The E2 will be available for some time and represents a good emulation solution. It is useful for projects using a 8 bit A/D and for extending the life of existing E2 emulators since the change from an E2 to E3 is not overly radical. Many of the new features will be transparent due to efficient emulator design.

Single-Chip Operation

Single-chip operation is defined where the program comes not from external memory but from a controller's internal ROM, OTP or FLASH. The external address and data bus are generally not used and their pins are used for some sort of I/O ports.

This operation presents some difficulties since an emulator by definition needs access to the address and data busses to control and record program flow and data manipulation. Access into internal busses is a bonus and the E, E2 and E3 bondouts are capable of this.

Instruction fetches from the ROM, OTP or FLASH in a C166 production chip occur over a 32 bit internal data bus (ROMbus). This greatly speeds up execution. The Infineon bondouts do not contain any ROM or FLASH therefore this must be provided for by emulator RAM. This RAM must be accessible by the bondout over a 32 bit

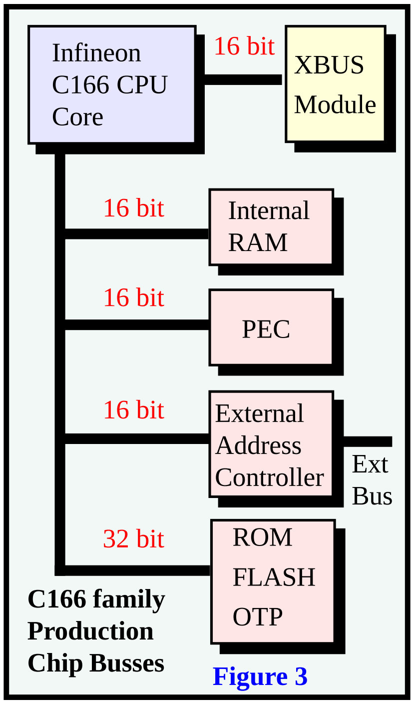


Figure 3

bus in order to match the execution times of the production chip. The bondouts provide this 32 bit data bus to the emulator. The Nohau emulator contains 512 or 1024K of 32 bit RAM.

Production Devices Busses

Each member of the C166 family has an external 16 bit data path (can be set to 8 bits) and up to 24 bits of address while in external mode. These busses occupy ports P0, P1 and P4. In single-chip mode, these can be used as general purpose I/O ports depending on the particular derivative.

There are 4 internal busses: XBUS, PECbus, RAMbus (all 16 bit) and the 32 bit ROMbus. These internal busses are not visible to the outside world except for the XBUS in a production chip. The bondout chips do have access to these directly or indirectly through the ALU results. The XBUS can be made visible by setting the VISIBLE bit in the SYSCON register. These busses are shown in Figure 3.

Bondout Busses

The Infineon bondouts provide five buses to the emulator hardware. These are visible in the trace display in Figure 4. The descriptions of the buses are general in nature and are not true for all cycles.

IA Bus: Instruction Address

ROM Instruction Address Bus. This 18 bit bus shows the address of instruction transfers on the internal ROM bus. This is applicable only in single-chip mode.

ID Bus: Instruction Data

ROM Instruction and Data bus. This 32 bit bus displays instruction and data over the ROM bus. Available only for single-chip and is displayed as 32 bit values.

These two busses are displayed in the Nohau trace under the **IA:ID** field.

OA: Operand Address

This 18 bit bus displays read and write addresses for Long Direct and Indirect internal operations.

OD Bus: Opcode Data

This 16 bit bus displays the instruction opcode or the ALU results. Opcodes of injected instructions (into the pipeline) are visible here. The OD and OA buses are very useful for advanced debugging.

The OA and OD busses are displayed in the **[ORA] ->ORD:OWD->[OWA]** field. The Nohau trace window will be redesigned for added funtionality for 2Q00. These fields can be used to distinguish between executed opcodes and pipeline flushes.

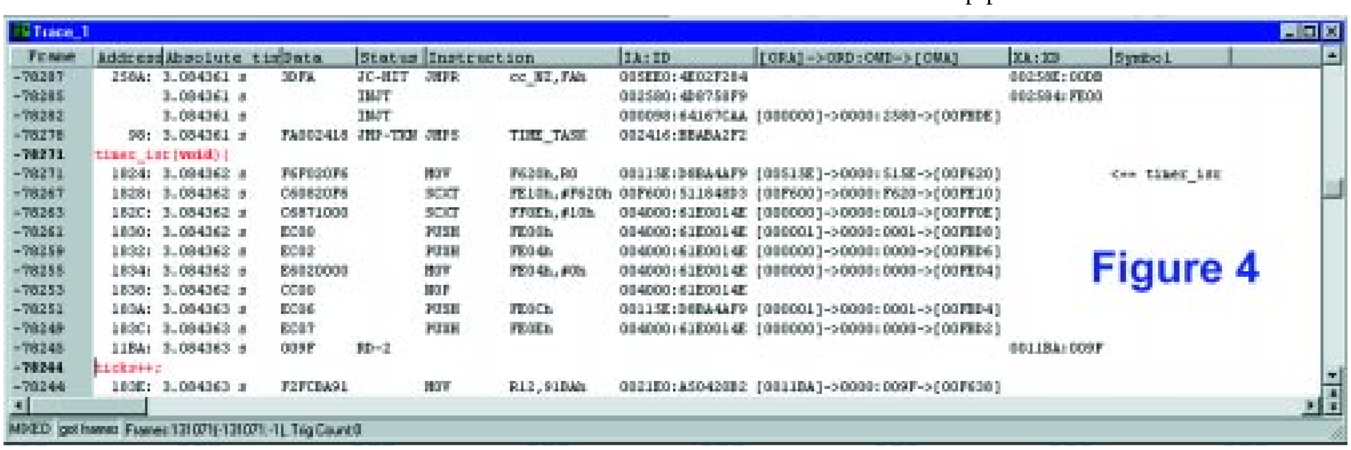


Figure 4

XBUS

The XBUS is an internal representation of the external bus. This 16 bit bus displays the data and address on the internal XBUS as well as data writes to external memory. This bus is displayed in the XA:XD field.

Bondout Control Signals

The bondouts provide many control signals which are used by the emulator hardware. Some of these signals are useful for the user and are displayed in the Status field. These include information on jumps (jump taken), Jump Cache operations (hit and load), pipeline injections, reinjections and read/write operations with their size.

Figure 5 shows the structure of the bondout controller with the emulation RAM attached. Not included in this diagram are hardware breakpoint RAM, Logic controls, trace and triggers.

The Trace Window

Figure 4 is a typical trace window from the Nohau user interface Seehau. Note the various fields and their contents.

The IA:ID field does not have much meaning in this external mode program but note that the opcode field is indeed 32 bits wide.

The OA:OD field shows the data moving across these busses. The read address and data value ([ORA]->ORD) are shown as well as the associated write address and data value (OWD:[OWA].

The XA:XD field shows the address and data value of movements across this bus.

The Status field shows some of the bondout control signals discussed earlier. JMP-TKN and JC-HIT are particularly useful to both software and hardware engineers.

A complete explanation of these fields is beyond the scope of this article. Check out the Nohau website for additional information regarding the interpretation of these fields.

Conclusions

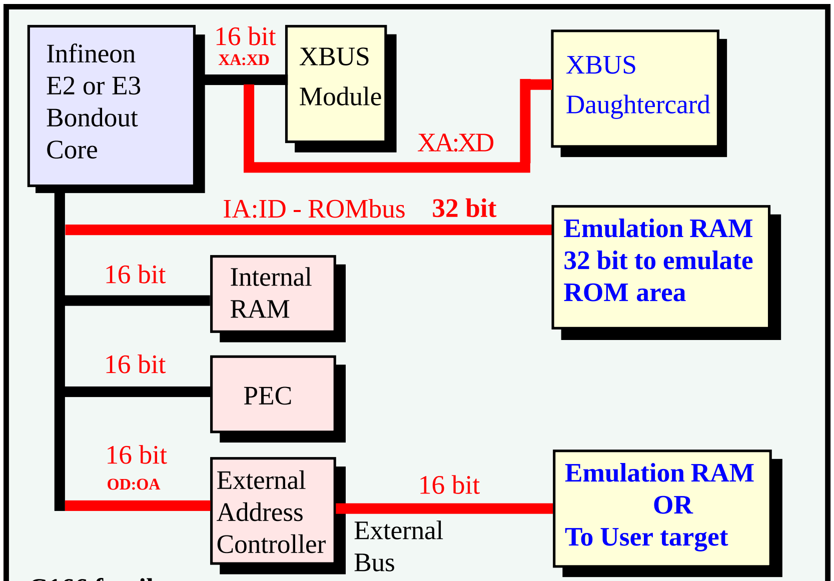
For more information consult the Contact article Debugging with the Infineon E2 Bondout Microcontroller which can be found on the Nohau website: www.nohau.com.

The new E3 bondout and the existing E2 will provide excellent debugging power for years.

Nohau also manufactures emulators for the STMicroelectronics ST10 family. These emulators operate up to 100 MHz. They are compatible with many members of the Infineon C166 family.

Nohau also provides a OCDS debugger for support of the Infineon C161U and C164 UTAH parts.

Contact Nohau at the location nearest you for additional information.



C166 family Bondout Chip Busses **Figure 5**

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