CEIBO EMULATORS AND SILICON VENDORS SUPPORT

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1. EMULATION TECHNOLOGIES

1.a. Standard Microcontrollers

Microcontrollers have I/O lines for user applications. Sometimes these lines can be used either as I/O or bus, depending on the memory location. If the microcontroller is a ROMless device, instructions are fetched outside the device and as the bus is always there, an emulator can be built around it. The main issue is how to emulate a microcontroller in ROM mode, which means when the instructions are fetched inside the chip memory and the I/O lines remain unchanged until a related instruction that affect them is executed. ROM is now not necessarily a Read Only Memory, but it can also be a device with Flash technology, meaning a memory that holds the user code without being erased while power goes down.

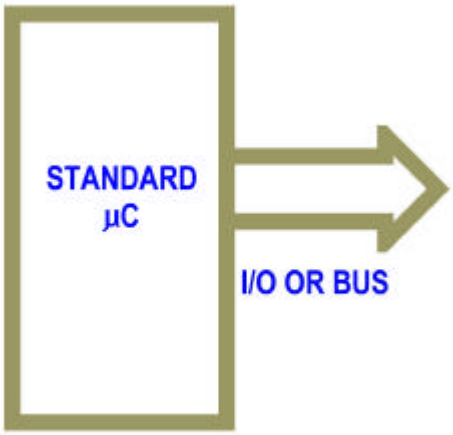

Fig. 1 - Standard Microcontroller

1.b. Bond-outs

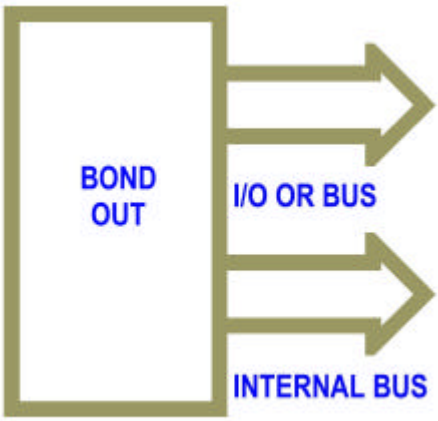

Fig. 2 - Bond-out

Emulators need access to the internal bus especially when the bus signals are shared with I/O lines or when there is no external bus available at all. As a solution the silicon manufacturers used to produce bond-out chips which are the same microcontrollers mounted in a bigger package with more pins that provide the internal bus, status and control signals. I/O lines and the internal bus are accessible through different pins in the chip. Bond-outs are needed only for the emulator vendors.

1.c. Emulation Mode

A solution came a few years ago that consisted of multiplexing the I/O lines with the internal bus while entering the chip into a special emulation mode - an undocumented feature licensed only to emulator vendors. A pattern is sent to the standard chip through one of the pins while the microcontroller is reset. With the addition of external logic, I/O lines are sampled and reconstructed, while the internal bus is available on a different time slot.

The major advantage of the emulation mode is that all the emulation functions are already implemented in the standard silicon, so with new versions of the chip also the emulators are automatically updated. This mode is also called "Emulation Hooks".

I/O lines are fully reconstructed and the user has available all I/O features as in the actual devices.

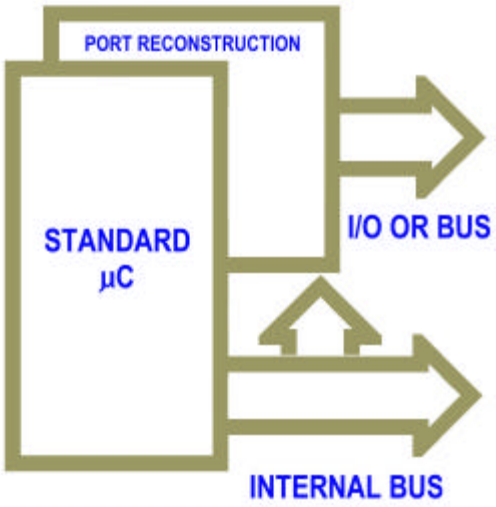

Fig. 3 - Emulation Mode

1.d. ROM and ROMless Support

Some silicon vendors do not have any solution for emulators, that means their microcontrollers do not have Emulation Mode or available bond-outs. Therefore, there are a few solutions for emulation:

1. Use a similar chip from other vendor in the emulator. For the emulator it does not matter which is the memory technology (EPROM, Flash, etc.) so for example a chip like 89C51 (Flash type) can be emulated by a 87C51 (EPROM type).

2. Use the chip in ROMless mode. In this case the emulator may have placed exactly the same silicon as the final design. Nevertheless, the chip will work in ROMless mode. This is not a problem in many cases. For example, if the device is an 8051 derivative and the user code executes MOVX instructions to access data outside the microcontroller, activating Port 0 and 2 as busses, a ROMless type can be used because in any case port contents are changed.

1.e. Low Pin Count Microcontrollers

Sometimes these devices can be emulated using a similar device with standard pinout and a socket converter. For example most of the 20-pin devices have a 40-pin superset with all the same functionality and more. This may not solve all the problems because the small devices may have also pins with dedicated functions not available in any other device.

1.f. Flash Microcontrollers

The Flash technology is now being added to all new microcontrollers to implement the code memory. Flash technology includes ISP and IAP. The ISP (in-system programming) allows loading the user code without removing the chip from the target circuit. The IAP (in-application programming) may be used to let the code to modify itself without affecting I/O lines or activating a bus, and this is also a very basic need of emulators.

All the available emulators work in emulation mode or using bondouts or in ROMless mode, thus allowing access to the internal buses. Therefore the actual code is in the emulator overlay RAM memory and not in the microcontroller Flash. So, ISP or IAP is never used by the emulators. This is a problem for many users that want to emulate these features.

Ceibo developed a new technology that is being implemented by several silicon vendors, which with the addition of a few internal registers inside the microcontroller all the basic emulation functions are already inside the chip. These capabilities are trace memory, breakpoints, code downloading, register modifications and others. The FE-xxxx series of emulators is now available for microcontrollers produced by Atmel, Dallas Semiconductors, Winbond and Philips. Some others will be added soon.

2. ATMEL SUPPORT

Ceibo emulators supporting Atmel: DS-51, EB-51, EB-51X2, FE-xxxx

2.a. ROM and ROMless

Atmel does not have any solution for 8051 emulators, that means their microcontrollers do not have Emulation Mode or available bond-outs. Therefore, there are a few solutions for emulation:

I. Use a similar chip in the emulator. This is a valid approach for some of Atmel derivatives, which do not have any unique function. For example, AT87F51/2 or AT89C51/2 are exactly the same devices as those produced by Intel, Philips and many others. For the emulator it does not matter which is the memory technology (EPROM, Flash, etc.).

II. Use the chip in ROMless mode. In this case the emulator may have placed exactly the same silicon as the final design. Nevertheless, the chip will work in ROMless mode. This is not a problem in case the user code executes MOVX instructions to access data outside the microcontroller, activating Port 0 and 2 as busses.

2.b. Atmel LPC Microcontrollers and Analog In

Atmel has a line of low pin count devices: AT89C1051, AT89C2051 and AT89C4051. These devices do not have a bus at all, so the only way to emulate them is using a similar device with standard pinout and a socket converter. For example, the AT89C1051 can be emulated with any 8xC51 using an adapter to connect only the relevant pins. This may not solve all the problems because these devices have also analog comparators at some of the pins as alternate functions. However, these analog capabilities are also available in some other bigger devices and the user will need to select the closest device to the final design just for emulation purposes.

2.c. Atmel Flash Microcontrollers and ISP

The Flash technology is now being added to all new microcontrollers to implement the code memory. Flash technology includes ISP and IAP. The ISP (in-system programming) allows loading the user code without removing the chip from the target. The IAP (in-application programming) may be used to let the code to modify itself without affecting I/O lines or activating a bus, and this is also a very basic need of emulators.

All the available emulators work in emulation mode or using bondouts or in ROMless mode, thus allowing access to the internal buses. Therefore the actual code is in the emulator overlay RAM memory and not in the microcontroller Flash. So, ISP or IAP is never used by the emulators. This is a problem for many users that want to emulate these features.

The only solution to emulate the microcontroller with code using ISP and IAP is Ceibo FE-xxxx series of emulators.

3. ATMEL (FORMER TEMIC) SUPPORT

Ceibo emulators supporting Atmel C251 family: DS-251, EB-C251

Ceibo emulators supporting Atmel 8051 family: DS-51, EB-51, EB-51X2, FE-xxxx

Ceibo emulators supporting Atmel 8051 LPC family: FE-5111

3.a. Emulators for C251 Microcontrollers

Atmel produces bond-out chips to emulate these microcontrollers. Ceibo uses that technology in the emulators.

3.b. Atmel T89C51xx and AT89C51xx Flash Microcontrollers

These microcontrollers are the best suited for the Flash Emulators. All new devices (AT89C51RD2, AT89C5121/2, AT89C51SND1, AT89C5131, etc.) are fully supported by Ceibo with the FE-xxxx series of emulators. This support includes ISP and IAP.
The ISP (in-system programming) allows loading the user code without removing the chip from the target circuit. The IAP (in-application programming) may be used to let the code to modify itself without affecting I/O lines or activating a bus.

Other Ceibo Emulators may also be used to support these microcontrollers using similar devices from Philips or in ROMless mode.

3.c. Atmel LPC Microcontrollers

Atmel has a line of low pin count devices in different packages: T87C5111. Ceibo supports them with an Atmel bond-out chip. The system is Ceibo FE-5111.

4. PHILIPS SUPPORT

Ceibo emulators supporting Philips 8051 family: DS-51, EB-51, EB-51X2, FE-xxxx

Ceibo emulators supporting Philips P87LPC76X LPC and P89CLPC9xx family: EB-76X, FE-900

Ceibo emulators supporting Philips XA family: EB-XA, EB-XAV2, DS-XA

Ceibo emulators supporting Philips Telecomm family: DS-48

4.a. Emulators for 8051 Microcontrollers

Philips has Emulation Mode (Hooks) in their 8051 microcontrollers. Ceibo uses that technology in the DS-51, EB-51 and EB-51X2 emulators. The great advantage of this technology is that the user can replace the chip on the emulator by any standard microcontroller to emulate it. For example, if the emulator comes with a 80C32 (which can emulate 8xC51/2 and many others) and the 87C51FC is needed now, it is just so simple as replacing the 80C32 by a 87C51FC to get the support. Please note that the above is not a mistake: the 80C32 can emulate the 87C51, because even if the 80C32 is a ROMless device, it works in Emulation Mode and Port 0 and 2 can be recreated.

4.b. Philips 8051 Flash Microcontrollers

The above mentioned Hooks cannot support ISP and IAP Flash features. The ISP (in-system programming) allows loading the user code without removing the chip from the target circuit. The IAP (in-application programming) may be used to let the code to modify itself without affecting I/O lines or activating a bus.

Therefore, a combination of FE-xxxx Flash emulators and any of the Hooks emulators is recommended to cover all the emulation possibilities.

4.c. Philips LPC Microcontrollers

Philips has a line of low pin count devices in different packages: P87LPC762/4/7/8/9 and the new flash P89LPC90x/92x/93x. Ceibo supports all of them with EB-76X and FE-900 emulators, which use Philips bond-out chips. There are different bond-outs for the different derivatives, although some of them are superset chips and they cover most of the functions.

4.d. Philips XA Microcontrollers

Philips 16-bit XA microcontrollers are supported by Ceibo with bond-out based emulators. These special devices provide a transparent emulation of all the microcontroller functions. There are several bond-outs for the different derivatives: G3, G49, C3 and S3.

4.e. Philips Telecomm Microcontrollers

Philips Telcomm microcontrollers (PCD33xx, PCD37xx, etc.) are supported by Ceibo with bond-out based emulators. These special devices provide a transparent emulation of all the microcontroller functions. As some of the devices have port options that can only be configured during the production of the devices, Ceibo developed a Port configuration system, which by provides these extra capabilities not supported by the bond-out chips.

4.f. Philips Mx Microcontrollers

Philips 16-bit Mx microcontrollers are supported by Ceibo with low-cost bond-out based emulators.

5. DALLAS SEMICONDUCTORS SUPPORT

Ceibo emulators supporting Dallas Semiconductors 8051 family: DS-51, EB-51, FE-C420

5.a. Emulators for DS80C320/3, DS87C520, DS87C530 Microcontrollers

Dallas has a bond-out chip that supports most of their microcontrollers: DS80C320, DS87C520, DS87C530. Ceibo DS-51 has a Personality Probe with this bond-out chip. All the derivatives are supported just by replacing the emulation header to fit the desired pinout: 40-DIP, 44-PLCC, 52-PLCC, etc. Some devices like the DS80C320 or DS80C323 which are only ROMless, can be emulated by Ceibo low-cost emulators, like EB-51, because a standard chip can be used for this purpose.

5.b. Emulators for DS80C390 and DS80C400 Microcontrollers

These devices are ROMless only with extended architecture for large memory capabilities. Ceibo supports them with dedicated low cost emulators using standard devices.

5.c. Emulators for DS87C550 Microcontrollers

Ceibo supports DS87C550 with DS-51 emulator using standard devices in ROMless mode only, using standard devices. ROM emulation can be achieved using Philips 87C552, which is a very similar device and has the Hooks mode.

5.d. Flash Emulator for 89C420 Microcontrollers

Dallas 89C490 is one of the fastest devices in the market and featuring Flash memory. Ceibo supports it with FE-C420 that is a Flash emulator that uses standard devices and not limited in frequency or voltage. These emulator supports ISP and IAP. The ISP (in-system programming) allows loading the user code without removing the chip from the target circuit. The IAP (in-application programming) may be used to let the code to modify itself without affecting I/O lines or activating a bus.

6. INTEL SUPPORT

Ceibo emulators supporting Intel MCS-251 family: DS-251, EB-C251

Ceibo emulators supporting Intel 8051 family: DS-51, EB-51, EB-51X2

Ceibo emulators supporting Intel 80C186/8 and 80C86/8 family: DS-186

6.a. Emulators for Intel 80C251Sx/Tx Microcontrollers

Intel produces bond-out chips to emulate these microcontrollers. Ceibo uses that technology in the emulators.

6.b. Intel 8051 Microcontrollers

Most of these microcontrollers have Philips as second source. Ceibo emulators use Philips microcontrollers to fully support all Intel features.

6.c. Intel 80C186/8 and 80C86/8 Microcontrollers

Ceibo supports with one emulator all Intel 16-bit micocontrollers belonging to the 80Cx86 family: 80C86/8, 80C186/8, 80C186/8XL, 80C186/8EA, 80C186/8EB, 80C186/8EC. The system uses standard devices.

7. NEC SUPPORT

Ceibo emulator supporting NEC V-series: DS-186

7.a. NEC V-Series

Ceibo supports with one emulator most of the NEC V-Series which have a core compatible with Intel 80Cx86 16-bit micocontrollers: V20/25/30/40/50. The system uses standard devices.

8. INFINEON (FORMER SIEMENS) SUPPORT

Ceibo emulators supporting Infineon 8051 and SAB-C500 families: DS-51

8.a. Emulator for 8051 Microcontrollers

Infineon has a bond-out chip to emulate the 80C515/535 AND 80C517/537 microcontrollers. Ceibo uses that technology in the DS-51 emulator. These chips can be also emulated as SAB-C515 and SAB-C517 with the Enhanced Hooks technology - see next paragraph.

8.b. Emulator for SAB-C500 Microcontrollers

Infineon has an Emulation Mode called Enhanced Hooks, which basically is similar in concept to the other emulation mode; it uses standard devices and electronics to recreate the I/O lines. Ceibo supports this technology with DS-51 emulator.

9. MICROCHIP SUPPORT

Ceibo emulator supporting Microchip PIC16/17xxx family: DS-M8

9.a. Microchip PIC Microcontrollers

Microchip PIC16xxx and PIC17xxxx are supported by Ceibo with a bond-out based emulator. The bond-outs provide a transparent emulation of all the microcontroller functions. There are several bond-outs for the different derivatives.

Microchip PIC18xxx family is not currently supported by Ceibo.

10. WINBOND SUPPORT

Ceibo emulators supporting Winbond Semiconductors 8051 family: DS-51, FE-xxx

10.a. Emulators for Turbo-51 and standard Microcontrollers

Ceibo uses Winbond bond-out devices to support W77xxx (4 clocks/cycle) and W78xxx (12clocks/cycle) microcontrollers. Ceibo DS-51emulator has two personality probes for the two available bond-outs.

10.b. Flash Emulator for Winbond Microcontrollers

This and other microcontrollers featuring Flash memory are supported by a new series of Ceibo Flash emulators that use standard devices and not limited in frequency or voltage. These emulator supports ISP and IAP. The ISP (in-system programming) allows loading the user code without removing the chip from the target circuit. The IAP (in-application programming) may be used to let the code to modify itself without affecting I/O lines or activating a bus.

11. STMicroelectronics SUPPORT

Ceibo emulators supporting STMicroelectronics ST62 family: EB-ST62

11.a. STMicroelectronics ST62 Microcontrollers

EB-ST62 uses STMicroelectronics microcontrollers for peripheral emulation and a hardware core simulator for instruction emulation. This hi-tech concept avoids the use of special emulation devices and the connection to a target system has all the electrical characteristics of the actual silicon. The system is not frequency or voltage restricted, so it can be used to emulate the microcontroller in the complete range of parameters defined by the device.

12. COMPARISON BETWEEN THE EMULATORS

12.a. CEIBO 8051 Emulators

EB-51 is a system with less features than other Ceibo emulators. EB-51 supports 40-pin DIP and 44-pin PLCC 8051 derivatives from Philips Intel, Dallas, Atmel and other compatible derivatives at 3V or 5V. With the addition of mechanical adapters it supports Atmel low-pin count devices too. EB-51 does not have real-time trace memory or sophisticated hardware breakpoints, supporting only software breakpoints, meaning that code is replaced by a break instruction, and therefore it can only be applied to the code mapped into the emulator memory.

EB-51X2 is an enhanced version of EB-51, adding real-time trace, programmable clock generator and support for new faster derivatives with 6 clock per cycle (Philips, Atmel).

DS-51 supports all 8051 derivatives from 1.5V to 6V. DS-51 has hardware breakpoints, that can be applied to target memory as well, space, so if you have your program on an EPROM inside your target board, you may need the hardware breakpoints. The DS-51 real-time trace can be read "on the fly" and has testpoint clips to record any external signals as if you have a logic analyzer. These clips can be used also to start and stop the trace recording and generate breakpoints.

FE-xxxx series of emulators is now available for microcontrollers produced by Atmel, Dallas Semiconductors, Winbond and Philips. The Flash technology is being added to all new microcontrollers to implement the code memory. Flash technology includes ISP and IAP. The ISP (in-system programming) allows loading the user code without removing the chip from the target circuit. All the available emulators (EB-51, EB-51X2, DS-51) work in emulation mode or using bondouts or in ROMless mode, thus allows access to the internal buses. Therefore the actual code is in the emulator overlay RAM memory and not in the microcontroller Flash. So, ISP or IAP is never used by emulators. If you need to emulate ISP or IAP, the only available solution is FE-xxxx emulator.

FEATURES	FE-51RD2 and other FE-XXXX	EB-51	EB-51X2	DS-51
Frequency of Operation	42 MHz	42 MHz	42 MHz	42MHz
Emulation Memory	64K Code	64K Code and 64K Data	64K Code and 64K Data	Up to 512K memory with bank switching
Mapping Resolution	None	None	None	4K, 8K, 16K, 32K & 64K boundaries
Breakpoints	64K Software Breakpoints	64K Software Breakpoints	64K Software Breakpoints	512K Hardware Breakpoints
Break on Opcode Execution	Yes	Yes	Yes	Yes
Break on Data Read/Write	No	No	No	Yes
Break on External Signals	No	No	No	AND/OR combination of 2 external signals
Source Level Debugging C, PLM and ASM	Yes	Yes	Yes	Yes
Trace	Variable depth, till last non-sequential instruction	No	1K Instructions	32K - displays address, status, trace clips and time stamps
Clocks / Cycle	4 / 6 / 12	4 (Dallas) or 12 (standard 8051)	6 / 12	4 / 6 / 12
LEDs and Switches for Experiments	Yes	Yes	Yes	No

12.b. CEIBO 251 Emulators

EB-C251 is a system with less features than DS-251 and it supports only the currently available MCS-251 and C251 derivatives from Intel and Atmel M&W (former Temic).

EB-C251 has trace and breakpoints less sophisticated than DS-251. EB-C251 has only software breakpoints, meaning that code is replaced by a break instruction, and therefore it can only be applied to the code mapped into the emulator memory.

DS-251 has hardware breakpoints that can be applied to target memory so if you have your program on an EPROM in your target board, you may need the hardware breakpoints. The DS-251 has testpoint clips that can be connected to any external signals to be recorded in the trace memory as if you have a logic analyzer. These clips can be used also to start and stop the trace recording and generate breakpoints.

FEATURES	EB-C251	DS-251
Frequency of Operation	24 MHz	24 MHz
Emulation Memory	256K	256K
Mapping Resolution	4K, 8K, 16K, 32K & 64K Boundaries	1 Byte
Breakpoints	256K Software Breakpoints	256K Hardware Breakpoints
Break on Opcode Execution	Yes	Yes
Break on Data Read/Write	No	Yes
Break on External Signals	No	AND/OR combination of 2 external signals
Source Level Debugging for C, PLM and ASM	Yes	Yes
Trace	2Kx48 bit records: address, data, status	128Kx128 bit records: address, data, status, program counter, trace clips and time stamps
Leds and Switches for Experiments	No	Yes

12.c. CEIBO XA Emulators

EB-XA is the system with less features than DS-XA or EB-XAV2. EB-XA does not have real-time trace memory and memory is limited to 64K for emulation.

EB-XAV2 and DS-XA have longer memory capabilities and programmable clock generator, as well as real time trace.

***** Real-Time Trace: this is a real-time function and records program counter changes due to non-sequential instructions (call, jump, interrupt, etc.). The software completes the executed instructions between non-sequential instructions, so the trace depth is variable and according to this definition. This new concept allows a high performance usage of the trace memory. EB-XAV2 records 1024 non-sequential instructions. DS-XA records 8192 non-sequential instructions. *The recreated trace information in unlimited.*

FEATURES	EB-XA	EB-XAV2	DS-XA
Frequency of Operation	30 MHz	30 MHz	30 MHz
Emulation Memory	64K	512K	2M
Mapping Resolution	4K, 8K, 16K, 32K and 64K Blocks	32K Blocks	2K Blocks
Breakpoints	64K	512K	2M
Break on High Level Lines	Yes	Yes	Yes
Source Level Debugging for C and Assembler	Yes	Yes	Yes
Trace	No	Variable *	Variable *
Supported devices	G3, G49, S3	G3, G49, S3 and C3	G3, G49, S3 and C3
Leds and Switches for Experiments	Yes	Yes	Yes