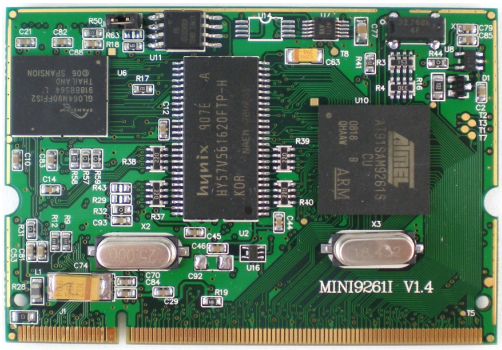
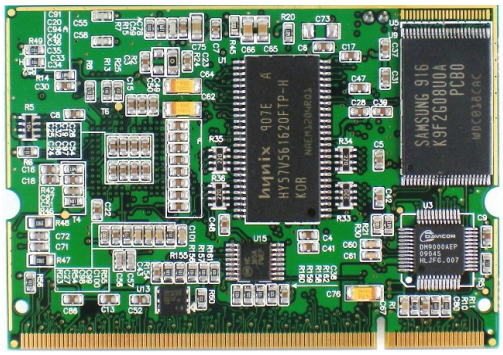
ChipworkX User Manual

Rev.4.3 September 21, 2011 User Manual



Top View



Back View

Document Information

Information	Description
Abstract	This document covers complete information about the ChipworkX™ Module and Development System, specifications, tutorials, and references.

Revision History	
Date	**Modification**
09/21/11	Changed WiFi Module information and various updates
03/11/11	Various updates
09/14/10	Updated in-field update section
07/21/10	Updated information for NETMF 4.1
04/26/10	Updated network section
04/02/10	Updates and fixes
03/12/10	First version

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1. Introduction

1.1. What is Microsoft .NET Micro Framework (NETMF)?

Microsoft's .NET Micro Framework is a lightweight implementation of the .NET Framework. It focuses on the specific requirements of resource-constrained embedded systems. Supporting development in C# and debugging on an emulator or the device, both using Microsoft's Visual Studio. The .NET Micro Framework is also open source, released under the Apache 2.0 license and completely free.

Developers already experienced with .NET and Visual Studio can take advantage of their skills immediately reducing the learning curve. The actual C# application development process is completely shielded from the low-level design details of the hardware platform. Combining the benefits with off-the-shelf, low-cost, network-enabled embedded systems creates a rapid product development solution.

1.2. NETMF - Porting vs. Using

There are two sides to working with NETMF, porting it and using it. For example, writing a JAVA game on a cell phone is much easier than porting the JAVA virtual machine (JVM) to the phone. The phone manufacturer did all the hard work of porting JAVA to their phone allowing the game programmers to use it with ease. NETMF works the same way, porting is not easy but using it is effortless.

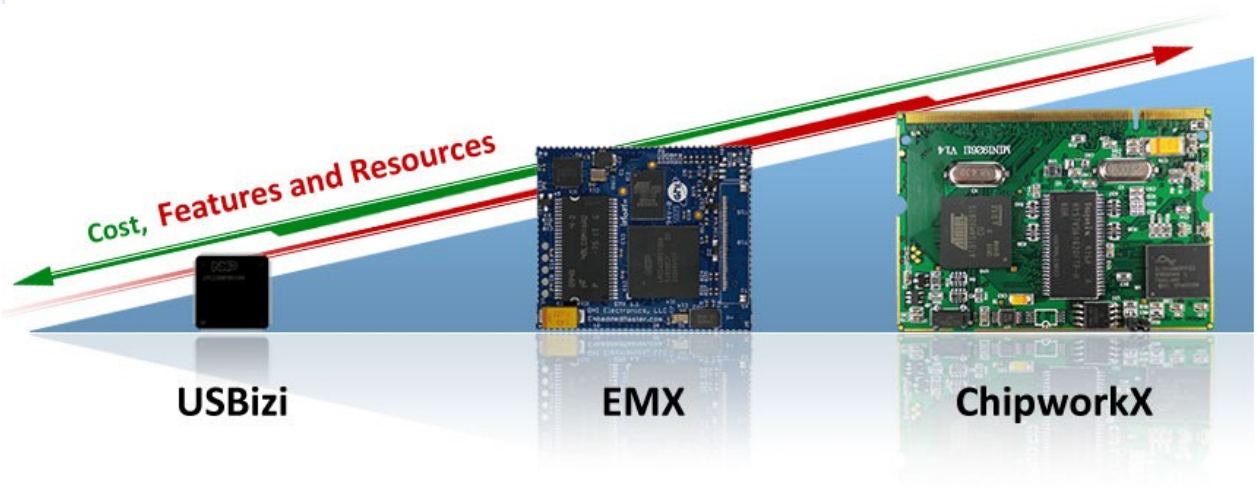
NETMF can be split into two major components, the core (CLR – Common Language Runtime) and HAL (Hardware Access Layer). The core libraries are made so they are hardware independent. Usually, no modifications are needed on the core libraries. A developer porting NETMF for a hardware platform will need to make the HAL to handle interfacing the hardware control to upper layers.

According to GHI's own experience with NETMF porting, it is not feasible to work on porting NETMF to your new hardware in case you are targeting medium or low quantities annually (less than 100,000 units). A faster-to-market option is by using one of the available OEM modules/chipsets. These OEM devices have everything you need built in the hardware and software.

1.3. GHI's .NET Micro Framework Based Solutions

With GHI Electronics, you're getting an experienced partner that offers a wide range of .NET Micro Framework hardware and software capabilities using the various drop-in modules/chipsets such as ChipworkX™, Embedded Master, EMX and USBizi. In addition, our free unlimited support is available to assist you at any point. New features and fixes come seamlessly to your product at no cost to you.

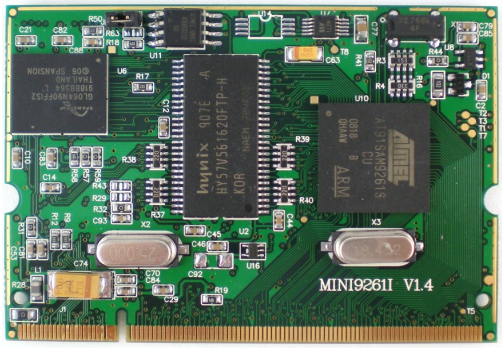
On top of the great features that the .NET Micro Framework provides, such as Ethernet, graphics and touch screen, GHI solutions has additional exclusive features such as USB host, PPP (GPRS/3G), database and native code runtime libraries (RLP). All these exclusive features are included for you at no extra cost.



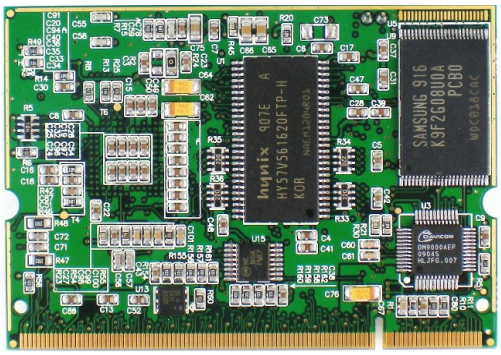
1.4. What is ChipworkX Module?

The ChipworkX™ Module is a combination of hardware (ARM9 Processor, Flash, RAM, Ethernet PHY...etc) on a small (67.6mm x47mm) OEM board MINI9261I with SO-DIMM200 slot that hosts Microsoft's .NET Micro Framework with various PAL/HAL drivers. In addition to the benefits of the .NET Micro Framework, ChipworkX™ includes exclusive software and hardware features.

The ChipworkX™ Module is a vastly sophisticated piece of hardware. This complexity provides the end-user with a remarkably simple platform to implement in any hardware design. Looking at the ChipworkX™ Development System schematic shows just how simple it really is. All you need is 3.3 volts and some connections to bring the latest technologies to your products. With manageable features like USB host, database and WiFi, the possibilities are boundless.



Top View



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1.5. Extended Framework Features

ChipworkX™ supports a complete set of .NET Micro Framework features such as TCP/IP, SSL, FAT, USB device and more. Including support for other exclusive GHI features such as full USB host stack, CAN, ADC, DAC, PPP, GPRS, 3G, etc. ChipworkX™ also allows developers to load their own compiled native code.

Furthermore, ChipworkX™ supports SQLite database, allowing fast logging and retrieval of standard SQL quires.

For real-time and high processing needs, Runtime Loadable Procedures allow users to load their own compiled native code (C or assembly) to run directly through manged Micro Framework, similar to the use of DLLs on PCs.

1.6. ChipworkX Key Features

- .NET Micro Framework
- 200 MHz 32-bit ARM9 Processor, AT91SAM9261S
- 64MB RAM
- 8MB FLASH
- 256MB Internal Flash with File System
- Embedded LCD controller
- Embedded Ethernet PHY with fast DMA communication.
- Runtime Loadable Procedure
- Full TCP/IP Stack
- Web Services
- SSL
- ZG2100 WiFi Driver
- PPP (GPRS/ 3G)
- DPWS
- Embedded USB host/device
- 80 Digital I/O Pins with interrupt capabilities.
- 2 SPI (8/16bit)
- I2C
- 3 UART
- 1 PWM
- 3.3V I/Os voltage
- 0ºC to +70ºC Operational
- Power Consumption (TBD) mA
- Low Power Mode (TBD) mA
- 67.6mmx47mm
- Easily attached with SO-DIMM200 slot.
- RoHS, Lead Free

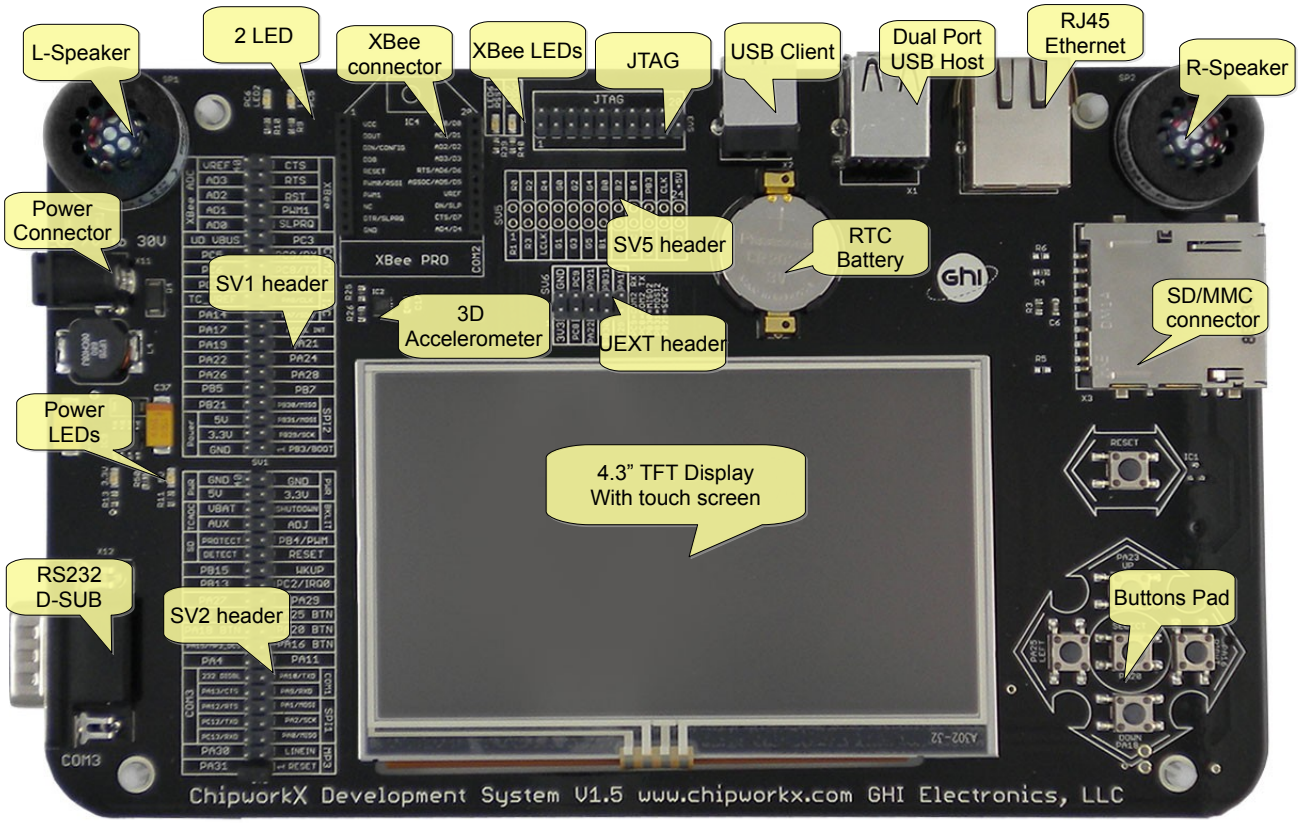
1.7. Example Applications

- Designs with intensive processing or time-critical routines (using RLP)
- Vending machine
- Measurement tool or tester
- Network server device
- Robotics
- GPS navigation
- Medical instrument (with a color touch screen display).
- Central alarm system
- Smart appliances
- Industrial automation devices
- Windows SideShow devices

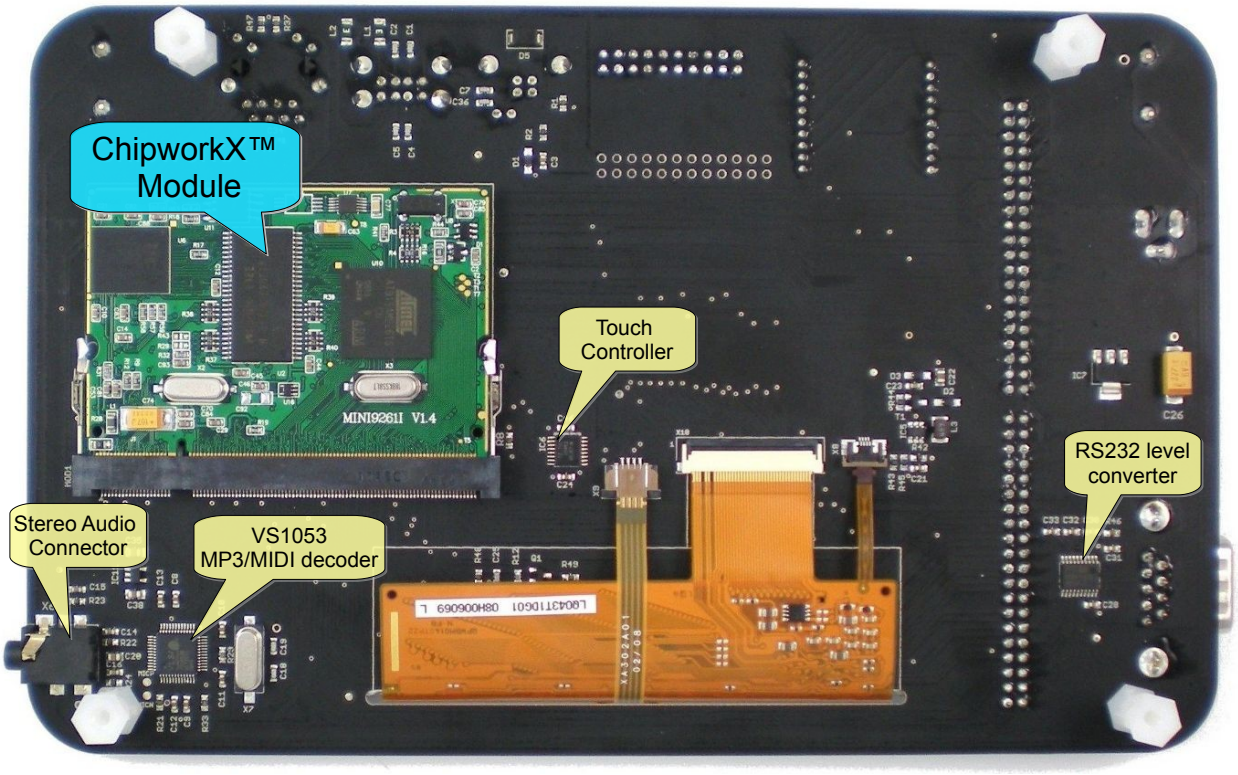
2. ChipworkX Development System

The **ChipworkX™ Development System** is the official kit from GHI Electronics for the ChipworkX™ module. This kit exposes the various peripherals and interfaces that make it an ideal starting point for any .NET Micro Framework project. Furthermore, most of ChipworkX™ module signals such as GPIO, SPI and UART are accessible on a 0.1" header for rapid prototyping.

The ChipworkX™ Development System Brochure and Pin-outs Document provides for a more detailed view of this system.



Front View


ChipworkX™ Module
Touch Controller
RS232 level converter
Stereo Audio Connector
VS1053 MP3/MIDI decoder
MINI9261I V1.4

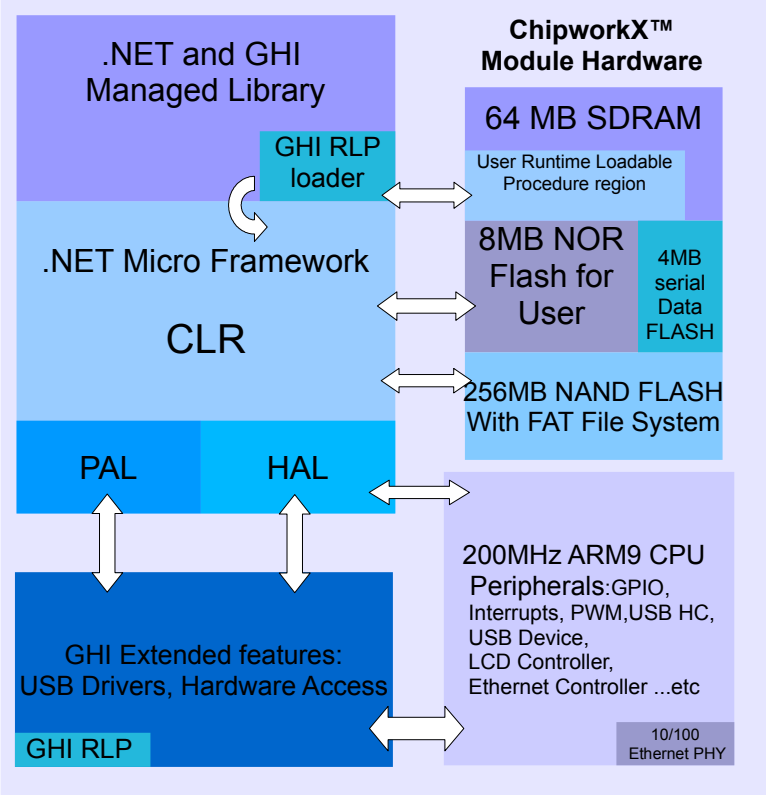
Back View

3. ChipworkX Module Architecture

ChipworkX is a combination of hardware (ARM Processor, Flash, RAM, Ethernet PHY...etc) that hosts Microsoft's .NET Micro Framework with various PAL/HAL drivers. In addition to the benefits of the .NET Micro Framework, ChipworkX™ includes exclusive software and hardware features, such as support for USB host, PPP networking and more.

The (67.6mm x47mm) MINI9261-I module contains everything needed to run the .NET Micro Framework. The module is a sophisticated piece of hardware developed with a complex BGA design. This complexity provides the end-user with a remarkably simple platform to implement in any hardware design.

3.1. Block Diagram



3.2. AT91SAM9261S Microcontroller

AT91SAM9261S 200Mhz ARM9 32-bit processor is the core of the ChipworkX™ Module. The ChipworkX™ firmware includes HAL and PAL drivers for the various peripherals of this microcontroller that can be accessed from the user's managed code.

We recommend you consult the AT91SAM9261S user manual for detailed information on things such as registers, hardware and electrical characteristics.

3.3. SDRAM

64MB of SDRAM comes standard with the ChipworkX™ Module. Approximately 2MB is reserved for developers native executable data, that includes the Runtime Loadable Procedures.

3.4. NOR Flash

8MB of NOR flash is available on ChipworkX™ Modules. This memory is used for ChipworkX™ firmware, user managed code and Extended Weak References.

To ensure long term system stability, GHI used better NOR flash for critical storage, deployment and firmware.

On the other hand, the NAND flash is used only for File System operations where sector failure will not cause system instability.

Note: The user **MUST NOT** access NOR Flash directly (Registers or JTAG...etc). This might damage your ChipworkX™ module.

3.5. NAND Flash

256MB of NAND flash is used as FAT file system storage under the .NET Micro Framework. It can be accessed just like any other media, SD card or USB storage device.

3.6. Serial DATAFLASH

ChipworkX™ includes a 4MB Atmel serial Dataflash chip which is used for the boot-up process, GHI system configuration and TinyBooter.

3.7. Ethernet PHY

The ChipworkX™ Module hardware includes an industrial Ethernet PHY along with the needed circuitry. The Ethernet oscillator is controlled by the processor allowing the user to control its power consumption. The designer only needs to wire the signals to the Ethernet connector. The recommended Ethernet connector is J0026D21.

3.8. Runtime Loadable Procedure (RLP)

A highly useful and unique feature in ChipworkX™ is allowing users to load their own compiled native code (C or assembly) and run it directly through managed code. This feature is similar to the use of DLLs on PCs. RLP can be used to implement processing intensive and time-critical routines.

3.9. Database Support

ChipworkX™ supports SQLite which is useful for logging and retrieving data through standard SQL queries to databases created on SD card, NAND Flash or even on a USB thumb drive.

4. Pin-Out Description

Most signals on the ChipworkX™ Module are multiplexed to offer more than one function for every pin. It is up to the developer to select which one of the functions to use. GHI drivers and the .NET Micro Framework does some checking to make sure the user is not trying to use two functions on the same pin. However, the developer should still understand what functions are multiplexed so there is no conflict.

- The schematics of the ChipworkX™ Development System board should be used as a reference design.
- Advanced details on oscillator and power tolerance can be found in the AT91SAM9261S datasheet from Atmel website.
- Digital I/O pins are named **`IOxx`**, where **`xx`** is an assigned number.

SODIMM200 Pin-out

No.	Name			ChipworkX Pin Description	
	MINI9261I AT91SAM9261S H/W Name	ChipworkX IO	2nd Feature		
1	GND_BG			Connect to GroundConnect to Ground	
2	ENET_TX-			Ethernet transmit data minus.	Recommended Ethernet connector is J0026D21. Please refer to ChipworkX Development System schematic. Ethernet PHY is not needed since it is embedded in ChipworkX hardware.
3	ENET_2.5			Connect to Ethernet Connector Magnet TCT and RCT pins.	
4	ENET_TX+			Ethernet transmit data plus.	
5	GND			Connect to Ground	
6	ENET_RX-			Ethernet receive data minus.	
8	ENET_RX+			Ethernet receive data plus.	
11	ENET_LED1			Ethernet interface connection indicator LED	
12	ENET_LED2			Ethernet interface activity indicator LED	
13	GND3			Connect to Ground	
20	3.3V_0			Connect to 3.3 volt source.	
27	GND4			Connect to Ground	
32	3.3V_1			Connect to 3.3 volt source.	
40	GND16			Connect to Ground	
41	GND5			Connect to Ground	
46	3.3V_2			Connect to 3.3 volt source.	
51	GND6			Connect to Ground	
60	3.3V_3			Connect to 3.3 volt source.	
65	GND7			Connect to Ground	
72	3.3V_4			Connect to 3.3 volt source.	
79	GND8			Connect to Ground	
88	3.3V_5			Connect to 3.3 volt source.	
89	NAND_RE (PC0)*			Leave unconnected. Reserved for ChipworkX's NAND Flash use.	
90	NAND_WE (PC1)*			Leave unconnected. Reserved for ChipworkX's NAND Flash use.	
91	PC2 (IRQ0)	IO66	N/A	General purpose digital I/O	
92	PC3	IO67	N/A	General purpose digital I/O	

No.	Name: MINI9261I AT91SAM9261S H/W Name	Name: ChipworkX IO	2nd Feature	ChipworkX Pin Description	
93	PC4	IO68	N/A	General purpose digital I/O	
94	PC5	IO69	N/A	General purpose digital I/O	
95	GND9			Connect to Ground	
96	PC6	IO70	N/A	General purpose digital I/O	
97	PC7	IO71	N/A	General purpose digital I/O	
98	PC8	IO72	COM2	Serial port (UART) TXD transmit signal (Out) for COM2.	
99	PC9	IO73		Serial port (UART) RXD receive signal (In) for COM2.	
100	PC10	IO74	N/A	General purpose digital I/O	
101	MAC_INT(PC11)*			Leave unconnected. Reserved for ChipworkX's Ethernet PHY use.	
102	PC12	IO76	COM3	Serial port (UART) TXD transmit signal (Out) for COM3.	
103	PC13	**IO77**		Serial port (UART) RXD receive signal (In) for COM3.	
104	NAND_CS(PC14)*			Leave unconnected. Reserved for ChipworkX's NAND Flash use.	
105	NAND_BSY(PC15)*			Leave unconnected. Reserved for ChipworkX's NAND Flash use.	
106	3.3V_6			Connect to 3.3 volt source.	
107	PA0	IO0	SPI1	SPI master bus interface MISO signal (Master In Slave Out) for SPI1.	SPI1 is shared with SD card driver, touch screen controller.
108	PA1	IO1		SPI master bus interface MOSI signal (Master Out Slave In) for SPI1.	
109	PA2	IO2		SPI master bus interface SCK signal (Clock)for SPI1.	
110	DataFlash_CS (PA3)*			Leave unconnected. Reserved for ChipworkX's DataFlash use.	
111	PA4	IO4	N/A	General purpose digital I/O	
112	PA5	IO5	N/A	General purpose digital I/O	
113	GND10			Connect to Ground	
114	PA6	IO6	SDCard_ CS	Used as a Chip Select signal for SPI-based SD/MMC card communication.	
115	PA7	IO7	I2C	**(open drain pin)** I2C Interface SDA	
116	PA8	IO8		**(open drain pin)** I2C Interface SCL	
117	PA9	IO9	COM1	Serial port (UART) RXD receive signal (In) for COM1.	
118	PA10	IO10		Serial port (UART) TXD transmit signal (Out) for COM1.	
119	PA11	IO11	N/A	General purpose digital I/O	
120	PA12	IO12	COM3 HW HS	Serial port (UART) RTS hardware handshaking signal for COM3.	
121	PA13	IO13		Serial port (UART) CTS hardware handshaking signal for COM3.	
122	PA14	IO14	N/A	General purpose digital I/O	
123	PA15	IO15	N/A	General purpose digital I/O	
124	3.3V_7			Connect to 3.3 volt source.	
125	PA16	IO16	N/A	General purpose digital I/O	
126	PA17	IO17	N/A	General purpose digital I/O	
127	PA18	IO18	Down Button	General purpose digital I/O and TinyBooter/Firmware **Down Button** (Check hardware design consideration).	
128	PA19	IO19	N/A	General purpose digital I/O	
129	PA20	IO20	Select Button	General purpose digital I/O and TinyBooter/Firmware **Select Button** (Check hardware design consideration).	
130	PA21	IO21	N/A	General purpose digital I/O	
131	GND11			Connect to Ground	
132	PA22	IO22	N/A	General purpose digital I/O	
133	PA23	IO23	Up Button	General purpose digital I/O and TinyBooter/Firmware **Up Button** (Check hardware design consideration).	
134	PA24	IO24	N/A	General purpose digital I/O	

	Name			
No.	MINI9261I AT91SAM9261S H/W Name	ChipworkX IO	2nd Feature	ChipworkX Pin Description
135	PA25	IO25	N/A	General purpose digital I/O
136	PA26	IO26	N/A	General purpose digital I/O
137	PA27	IO27	N/A	General purpose digital I/O
138	PA28	IO28	N/A	General purpose digital I/O
139	PA29	IO29	N/A	General purpose digital I/O
140	PA30	IO30	N/A	General purpose digital I/O
141	PA31	IO31	N/A	General purpose digital I/O
142	3.3V_8			Connect to 3.3 volt source.
143	PB0	IO32	LCD V-Sync	TFT Display, Vertical sync.
144	PB1	IO33	LCD H-Sync	TFT Display, Horizontal sync.
145	PB2	IO34	LCD CLK	TFT Display, Clock.
146	PB3	IO35	LCDDEN / BMS	General purpose digital I/O. Some LCDs may operate using the LCD Enable pin. This pin is multiplexed with BMS (Boot Mode Select)signal. Care should be taken during reset time. and it should not be set high on reset. For more information about BMS, check AT91SAM9261S user manual.
147	PB4	IO36	PWM	PWM feature is mainly utilized to control the LCD back light illumination.
148	PB5	IO37	N/A	General purpose digital I/O
149	PB6	IO38	TOUCH IRQ	If TSC2046 touch controller chip (similar to the one on the Development System) is used then wire this pin to PENIRQ at the controller's side (pin 11). Refer to ChipworkX Development System schematic. TSC2046's communication interface is SPI. (connect to SPI1 on ChipworkX)
150	PB7	IO39	N/A	General purpose digital I/O
151	GND12			Connect to Ground
152	PB8	IO40	LCD B0	TFT Display, Blue signal bit 0.
153	PB9	IO41	LCD B1	TFT Display, Blue signal bit 1.
154	PB10	IO42	LCD B2	TFT Display, Blue signal bit 2.
155	PB11	IO43	LCD B3	TFT Display, Blue signal bit 3.
156	PB12	IO44	LCD B4	TFT Display, Blue signal bit 4.
157	PB13	IO45	N/A	General purpose digital I/O
158	1WIRE_EEPROM (PB14)*			Leave unconnected. Reserved for ChipworkX's EEPROM use.
159	PB15	IO47	N/A	General purpose digital I/O
160	3.3V_9			Connect to 3.3 volt source.
161	PB16	IO48	LCD G0	TFT Display, Green signal bit 0.
162	PB17	IO49	LCD G1	TFT Display, Green signal bit 1.
163	PB18	IO50	LCD G2	TFT Display, Green signal bit 2.
164	PB19	IO51	LCD G3	TFT Display, Green signal bit 3.
165	PB20	IO52	LCD G4	TFT Display, Green signal bit 4.
166	PB21	IO53	N/A	General purpose digital I/O
167	PB22	IO54	TOUCH CS	If TSC2046 touch controller chip (similar to the one on the Development System) is used then wire this pin to CS at the controller's side (pin 15). Refer to ChipworkX Development System schematic. TSC2046's communication interface is SPI. (connect to SPI1 on ChipworkX)
168	PB23	IO55	LCD R4	TFT Display, Red signal bit 4.
169	GND13			Connect to Ground
170	PB24	IO56	LCD G5	TFT Display, Green signal bit 5.
171	PB25	IO57	LCD R0	TFT Display, Red signal bit 0.
172	PB26	IO58	LCD R1	TFT Display, Red signal bit 1.

No.	Name			ChipworkX Pin Description
	MINI9261I AT91SAM9261S H/W Name	ChipworkX IO	2nd Feature	
173	PB27	IO59	LCD R2	TFT Display, Red signal bit 2.
174	PB28	IO60	LCD R3	TFT Display, Red signal bit 3.
175	PB29 (IRQ2)	IO61	SPI2	SPI master bus interface SCK signal (Clock)for SPI2.
176	PB30 (IRQ1)	IO62		SPI master bus interface MISO signal (Master In Slave Out) for SPI2.
177	WKUP			Wake Up (Input). Falling edge signal would wake up the processor and clear the Shut Down signal. If Sleep feature is not required, pull down this pin to ground.
178	PB31	IO63	SPI2	SPI master bus interface MOSI signal (Master Out Slave In) for SPI2.
179	SHDN			Shut Down (Output) can be wired to sleep circuit. Refer to ChipworkX Development System schematic. If Sleep feature is not required, leave this pin unconnected.
180	3.3V_10			Connect to 3.3 volt source.
181	EN_1.2V			ChipworkX's Internal power supply circuit enable. this pin can be wired to sleep circuit. Refer to ChipworkX Development System schematic. If Sleep feature is not required, pull down this pin to ground.
182	USBD+ Port B USB Host Feature			USB positive data line of the USB hosting feature, Port B.
183	VBAT			Connect to 3.3 volt backup battery to keep the real-time clock running.
184	USBD- Port B USB Host Feature			USB negative data line of the USB hosting feature, Port B.
185	GND14			Connect to Ground
186	GND17			Connect to Ground
187	JTAG NRST			JTAG NRST signal. Connect to TRST.
188	USBD+ Port A USB Host Feature			USB positive data line of the USB hosting feature, Port A.
189	JTAG RTCK			JTAG RTCK signal.
190	USBD- Port A USB Host Feature			USB negative data line of the USB hosting feature, Port A.
191	JTAG TDO			JTAG TDO signal.
192	3.3V_11			Connect to 3.3 volt source.
193	NTRST			JTAG NTRST signal. Connect to TRST.
194	USBD+ USB client feature			USB positive data line of the USB debugging interface (access interface) and for the USB client feature.
195	JTAG TDI			JTAG TDI signal.
196	USBD- USB client feature			USB negative data line of the USB debugging interface (access interface) and for the USB client feature.
197	JTAG TCK			JTAG TCK signal.
198	GND18			Connect to Ground
199	JTAG TMS			JTAG TMS signal.
200	PIN200			Pull up with 10K resistor

N/A and * : Reserved pins, user should NOT connect or use.

5. ChipworkX On Boot Up

ChipworkX™ includes three pieces of embedded software, bootstrap loader, TinyBooter and ChipworkX firmware.

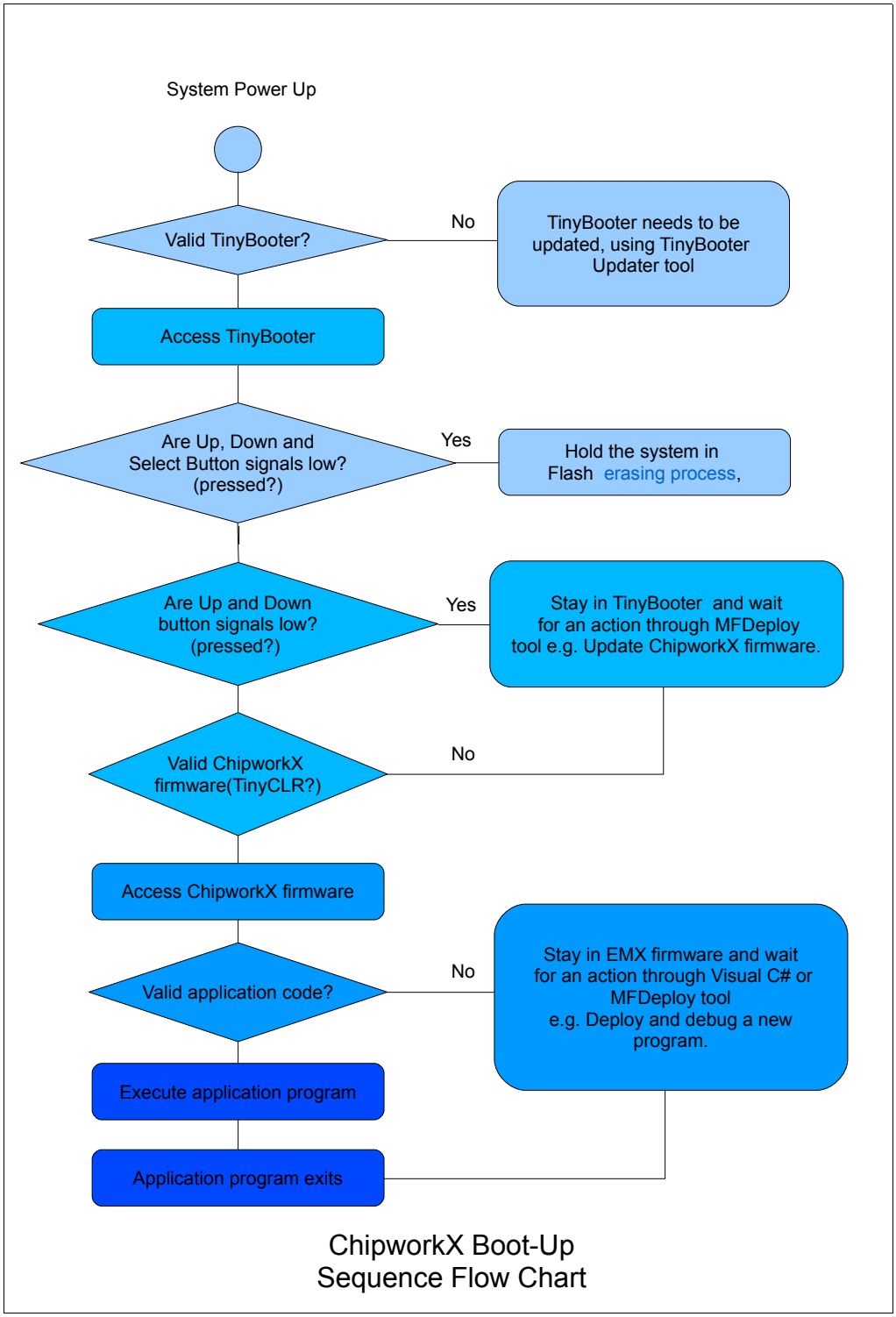
Upon system boot up, the Atmel bootstrap loader initializes Flash and RAM memory then it looks for the TinyBooter image in the 4MB serial DataFlash chip and lets it execute from RAM. After TinyBooter takes over the hardware, it prepares the resources to be handled by the ChipworkX™ firmware. The ChipworkX™ firmware is the main software that runs the .NET Micro Framework core and the user managed application.

During boot-up, a user can interrupt the sequence to remain in boot loader, TinyBooter, or firmware by changing the state of the following signals on **start-up**:

Pin 133	**Pin 127**	**Pin 129**	**Description**
Up Button signal	Down Button signal	Select Button signal	
High or unconnected	High or unconnected	High or unconnected	This indicates the user has no interference on boot up process, and the system will boot in normal mode sequence.
Low	Low	Low	Hold the system in Flash memory erasing process, preparing the hardware to be accessed by the bootstrap loader for TinyBooter update. TinyBooter section provides more details.
Low	Low	High or unconnected	Hold the system in TinyBooter mode access

These pins are exposed on the ChipworkX™ Development System to Up, Down and Select buttons with a high default state. In other words, the pin is low when the button is pressed.

The following flow chart clearly explains the boot up sequence:



ChipworkX Boot-Up Sequence Flow Chart

5.1. Bootstrap Loader vs. TinyBooter vs. ChipworkX Firmware

The following table lists the major properties of each software:

Bootstrap Loader	ChipworkX™ TinyBooter	ChipworkX™ firmware
Used to update ChipworkX™ TinyBooter	Used to update the ChipworkX™ firmware, maintenance application code region, get system information and to update system configurations such as networking settings.	Used to deploy, execute and debug the managed NETMF application code. In other words, it plays the role of a virtual machine.
Emergency use or when GHI releases a new TinyBooter.	frequently used	always used
Pre-placed on the chipset (provided by Atmel on SAM processors).	The user can download to the ChipworkX™ Module, through GHI boot loader for instance.	The user can download to ChipworkX™ Module, through the TinyBooter for instance.
Fixed and can not be updated	Latest file is included with every GHI NETMF SDK, not necessarily changed in every new SDK	Latest file is included with every GHI NETMF SDK, not necessarily changed in every new SDK
Access interface is USB (Virtual COM, CDC device).	Access Interface (debugging interface) can be USB or serial port.	Access Interface (debugging interface) can be USB, Ethernet or serial port.
User access is through the Atmel In-system Programmer sam-ba software tool. GHI provides simple script files for easy use of this loader to update Tinybooter	User access it through MFDeploy tool to maintain firmware, configurations (networking, USB) and application code region.	Users access it through Microsoft's Visual C# to deploy, execute and debug the managed NETMF application through the debugging interface. Users can access it using Microsoft's NETMF MFDeploy tool to maintain the firmware or application code region.
Very compact to accomplish only the flash memory maintenance functions.	Compact enough to handle the assigned functions	Highly sophisticated with the .NET Micro Framework and requires HAL and PAL drivers to provide the various ChipworkX™ features.

Next sections provide more details.

5.2. ChipworkX Access Interface

The default access interface on ChipworkX™ is USB.

Bootstrap Loader USB driver:

%GHI NETMF SDK%\ChipworkX\Firmware\TinyBooter Updater\USB Tinybooter Updater driver\ChipworkX-updater.inf

TinyBooter and the ChipworkX™ Firmware USB driver:

%GHI NETMF SDK%\USB Drivers\GHI_NETMF_Interface\GHI_NETMF_Interface.inf

Other Interfaces

You can set other access interfaces and even save them to the device using software. In case problems occur for the access interface, holding center and down buttons upon start-up will force ChipworkX™ to ignore the software settings and use the USB interface.

Please see debug interface section for details.

6. TinyBooter

The ChipworkX™ Module implements a software from Microsoft, called TinyBooter. This software can be used to update the ChipworkX™ firmware.

Typically, a user would never need to update the TinyBooter as it is not used in the final application. For rare cases, especially when changing to a different .NET Micro Framework version -- *e.g. 3.0 to 4.0* -- **or when it is mentioned in the release notes of a new GHI NETMF SDK to update the TinyBooter**, there is a way to update it through bootstrap loader.

The TinyBooter is loaded from the serial DataFlash on power up. On the other hand, TinyCLR is loaded by TinyBooter from NOR Flash. For compatibility reasons, the user has to erase both DataFlash and NOR Flash before updating the TinyBooter.

6.1. TinyBooter update using bootstrap loader

The user can update the TinyBooter using "TinyBooter *Updater"* included with the GHI NETMF SDK under the ChipworkX\firmware folder. This updater tool consists of the *Atmel sam-ba* tool with the required script and the BIN file that has to be loaded to the serial DataFlash chip. It also includes the TinyBooter Updater driver that defines the USB port as a virtual Serial Port used to upload the new BIN file through.

The following instructions explain how to successfully accomplish this:

Erasing Process:

1. Power up the ChipworkX™ hardware.
2. Press and hold the **Up, Select and Down** buttons, **keep holding** and reset the system.
3. Release the buttons when prompted to do so then you will see instructions about how to proceed.
4. Press **Up** three times to proceed with the erasing process, or press **Down** to abort.

Emergency Bootstrap access

Use this method of access whenever something wrong happens during the TinyBooter update process, like uploading the wrong bin file and the ChipworkX™ tinybooter is not accessible at all.

1. Disconnect the power.
2. Remove the jumper placed on the ChipworkX™ Module.
3. Re-connect power.

4. Place the jumper back.
5. Connect the USB cable.
6. Follow the same next steps for updating the TinyBooter.

Installing TinyBooter Updater USB Driver:

1. After erasing the serial DataFlash and NOR Flash successfully following the previous steps.
2. Power up the ChipworkX™ hardware.
3. Connect the USB cable to your PC, then Windows will ask for driver INF file.
4. The driver file is located in the following path:

   %GHI NETMF SDK%\ChipworkX\Firmware\TinyBooter Updater\USB Tinybooter Updater Driver\
5. **Important Note (for Windows 7 users only):** Windows 7 installs the driver automatically but it mistakenly considers it a GPS camera device. Although the name is wrong the driver is OK and you may proceed with the steps.
6. After Windows is done installing the driver, you will see a new serial port (COM port) in your system. It will take the first available COM port number, e.g. COM5.
7. This port is used by the TinyBooter Updater script to upload the new *tinybooter.bin* file to the serial DataFlash, or it can be used to access the processor using the Atmel tool SAM-BA (*sam-ba_cdc_2.9.xp_vista.exe)* to manually upload bin files to the serial DataFlash.

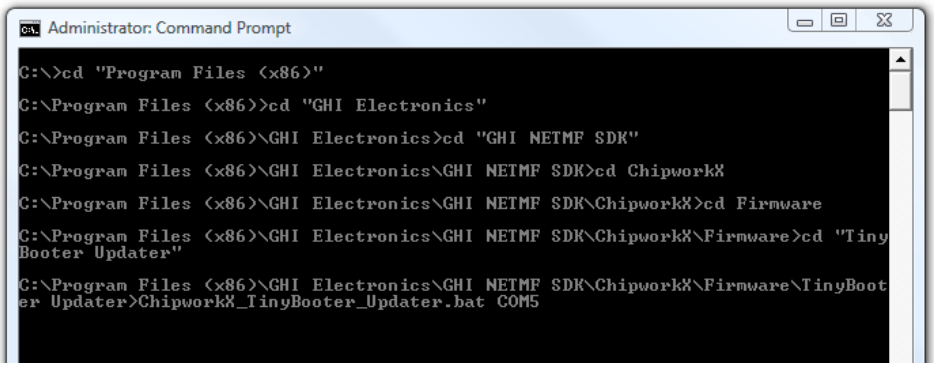
Updating Tinybooter:

1. After installing the TinyBooter Updater USB Driver and recognizing the new COM port number, open command prompt and go to the following folder

   %GHI NETMF SDK%\ChipworkX\Firmware\TinyBooter Updater
2. Run the following command to run the script:

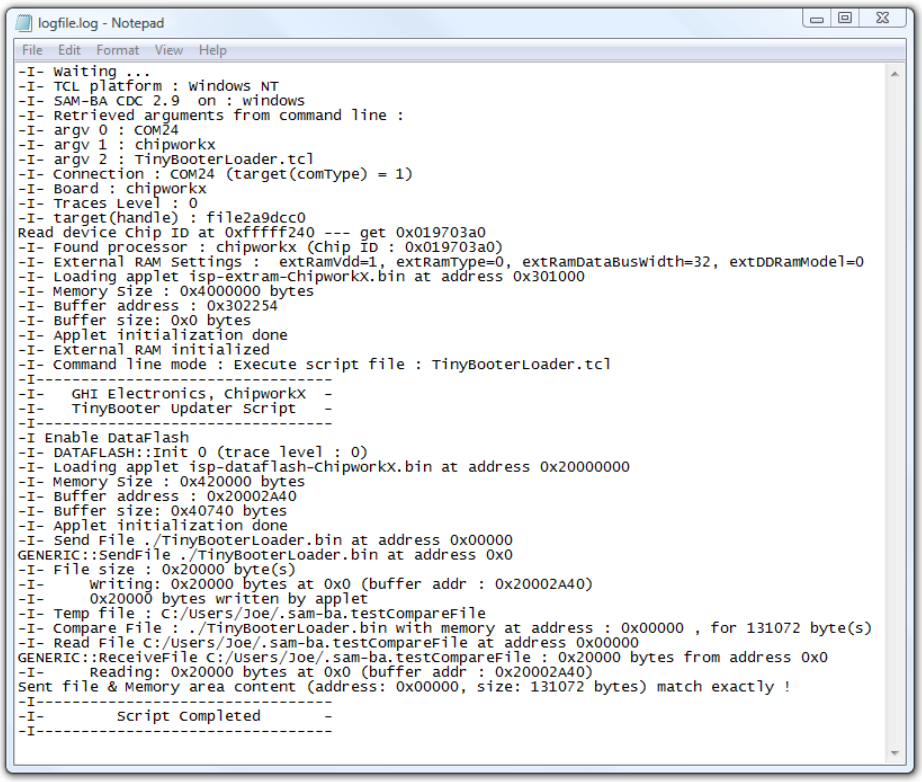
   ChipworkX_TinyBooter_Updater.bat COMx

   where x is the number of newly created Serial Port. See example below:



3. When you run the batch file, if you get an Access Denied message from Windows, try to run the batch file as an Administrator, or copy the batch file to your desktop and run it from there.
4. The script will run to upload the new TinyBooter bin file to the serial DataFlash. This process takes several seconds to complete.
5. When it is done, *logfile.log* will be created and opened using notepad automatically. It contains information about the updating process. Make sure the end of the file says "Sent file & memory area content (....) match exactly!"

   The following is an example *logfile.log* of a successful update:



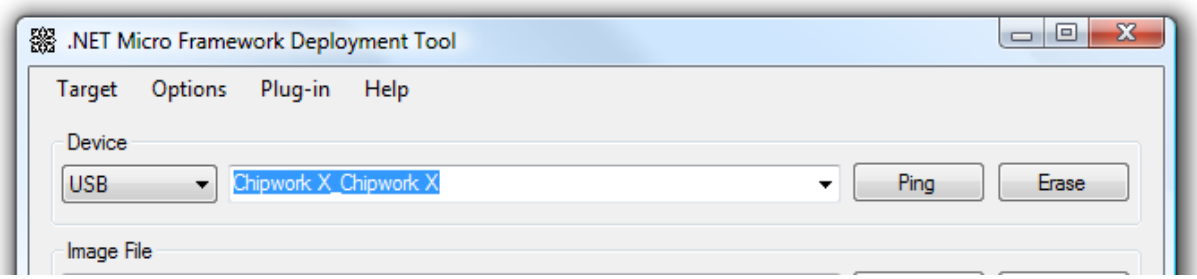
6. Reset the system and then the Tinybooter will execute. Make sure to update TinyCLR firmware.
7. The system is now ready to deploy new managed applications.

6.2. ChipworkX firmware update through TinyBooter

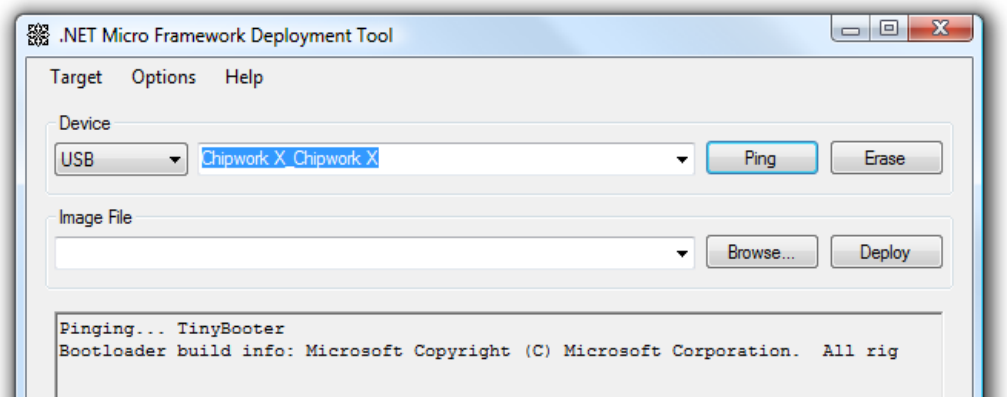
The objective of this section is to provide simple steps to access the TinyBooter on your ChipworkX™-based system from your PC so you will be ready to update the ChipworkX™ firmware using MFDeploy.

In the following steps, it is assumed that the user is using the USB access interface with the GHI NETMF interface driver installed. Refer to ChipworkX access interface section for more details.

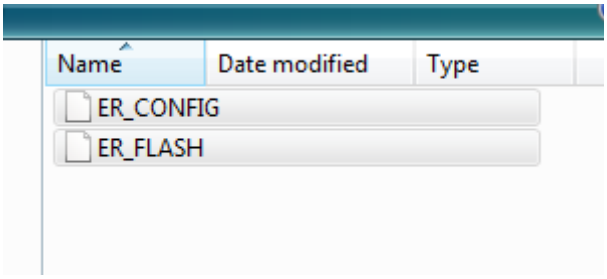
1. First, install the latest GHI NETMF SDK (which includes the ChipworkX™ firmware).
2. Ensure there is no need to update the TinyBooter. This information is usually mentioned in the GHI NETMF SDK release notes. If a new TinyBooter is needed, update the TinyBooter then update the ChipworkX™ firmware.
3. Press the Up and Down buttons then reset to set the access interface. Refer to the ChipworkX on boot up section to learn about the boot-up sequence.
4. Run MFDeploy and select USB from the Device list, you should see ChipworkX_ChipworkX in the drop-down list.

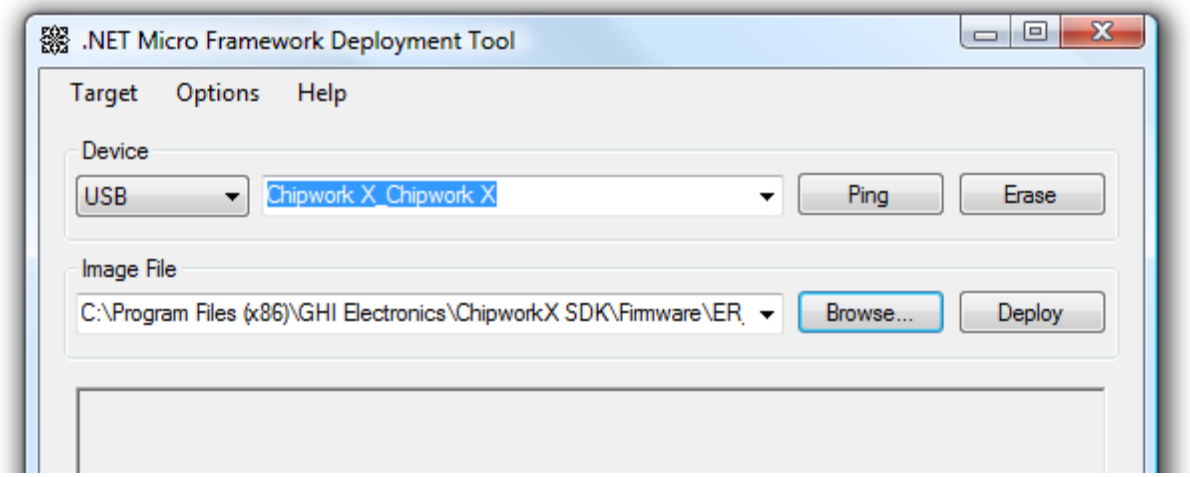


5. Check the communication between MFDeploy and the TinyBooter by pinging the device. Press Ping and you should see this message:



6. Now we can lead MFDeploy to the new ChipworkX™ firmware files. Click Browse and direct MFDeploy to the firmware HEX files. These can be found under ChipworkX\firmware folder in the SDK. The other files with “sig” extension must exist in the same folder as the HEX files. Select **ALL** of the HEX files at once and start deploying the firmware by pressing Deploy.





7. Loading the files takes about a minute. On completion, the firmware will execute. Double check the version number to make sure the correct firmware is loaded.
8. Loading new firmware will not erase the deployed managed application. If you need to erase the managed application, click Erase.

Important Note: After updating the ChipworkX™ firmware, if you see a message on the LCD or on the ChipworkX™ access debugging interface stating that you need to update the TinyBooter, this means that the TinyBooter version is not suitable for the current firmware. In this case, update the TinyBooter then update ChipworkX™ firmware again.

7. ChipworkX Firmware

The ChipworkX™ firmware is the main piece of embedded software in the ChipworkX™ Module which hosts the .NET Micro Framework core with the required HAL drivers to provide the various ChipworkX™ features a user can control with C#. A user deploys and debugs the managed application code directly on ChipworkX™ Modules from Microsoft's Visual Studio through the ChipworkX™ debugging interface.

The ChipworkX on boot up section provides the required information on how to choose an access interface and how to access the ChipworkX™ firmware.

The ChipworkX™ firmware is different than the TinyBooter or bootstrap loader. The Bootstrap loader vs. TinyBooter vs. ChipworkX firmware section lists the features and properties of each piece of software.

Users can update the ChipworkX™ firmware through the TinyBooter. Refer to TinyBooter to learn how to update the firmware. The ChipworkX™ firmware can be updated with the In-Field Update feature.

The end-user software interface that communicates with the ChipworkX™ firmware is MFDeploy, which comes with the Microsoft .NET Micro Framework SDK and Microsoft's Visual C# with installed .NET Micro Framework SDK.

7.1. Getting Started with ChipworkX

The objectives of this section are to provide simple steps to setup your ChipworkX™-based system on your PC so you will be ready to develop your application on Visual Studio C# with .NET Micro Framework.

All you need to start up

- The ChipworkX™ Development System.
- A USB Cable (included with the kit).
- Microsoft's Visual Studio 2010 or Microsoft's Visual C# Express Edition (free download) installed with latest updates.
- Microsoft's .NET Micro Framework SDK Version 4.1.
- The latest GHI NETMF SDK (available on the GHI Electronics website).

If you got a new ChipworkX™ Development System, it is recommended that you update the ChipworkX™ firmware and TinyBooter if needed, with the files available in the latest GHI NETMF SDK within the ChipworkX™ folder before you start these steps.

The suggested access interface in these steps is USB (the default on the ChipworkX™

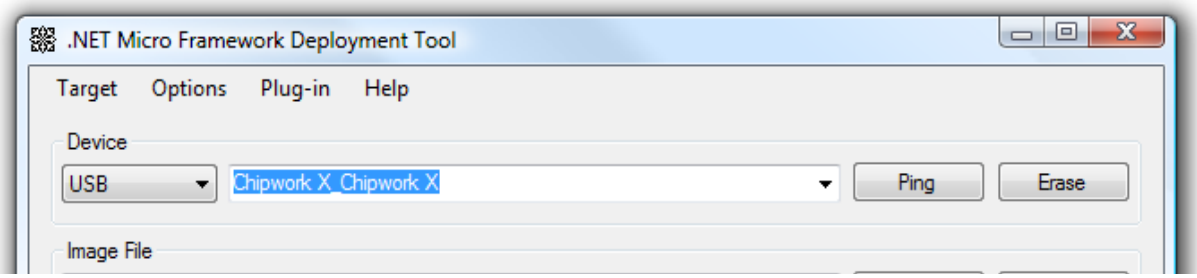
Development System).

Development System First Power-up

The development system comes loaded with the latest firmware and an example application. Power up the device using a power pack or a USB cable and you will see the example running on the LCD.

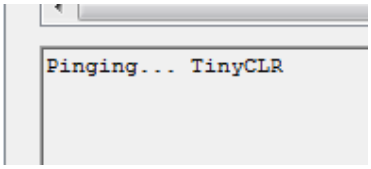
Once the system is tested for functionality, try to deploy your own application.

1. Install the latest Microsoft .NET Micro Framework SDK Version 4.
2. Install the latest GHI NETMF SDK.
3. Power up the development system board. It is recommended to use any regular 9~15 Volt DC adapter, with the inner connector positive, to power-up the system. It can be powered-up over a USB cable but it should be connected directly to PC USB port or to a powered USB hub to ensure sufficient power for the board.
4. Connect USB cable to your PC on other end, if it was not connected.
5. On the Display you will see some information including the debugging interface which is **USB** by default.
6. Install the USB driver if it is not yet installed.
7. Run the MFDeploy tool, choose USB from device list then you'll see *ChipworkX_ChipworkX* in the drop-down list.



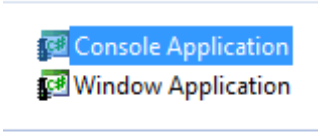
Note: if you did not see that string you might have different default debugging interface, you did not install the driver correctly, or the processor is shutdown.

8. Pressing the “ping” button on MFDeploy should return “TinyCLR”. This verifies that the board is responsive. See MFDeploy description in next sections.

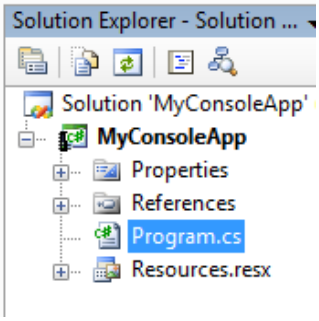


9. Open Visual Studio and start a new Micro Framework “console” application. This is the simplest application that can be loaded. All it does is printing a string to the

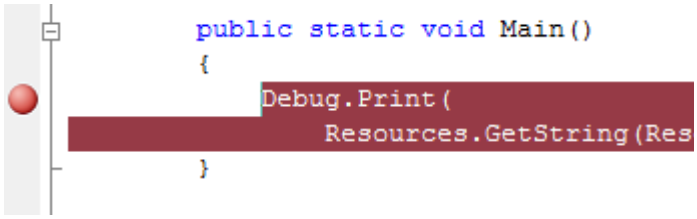
debug output. Name your project MyConsoleApp



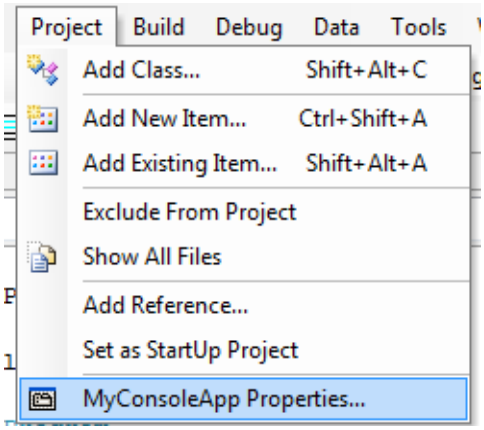
10. Visual Studio will now generate all needed project files. One of the files is called Program.cs. Open it...

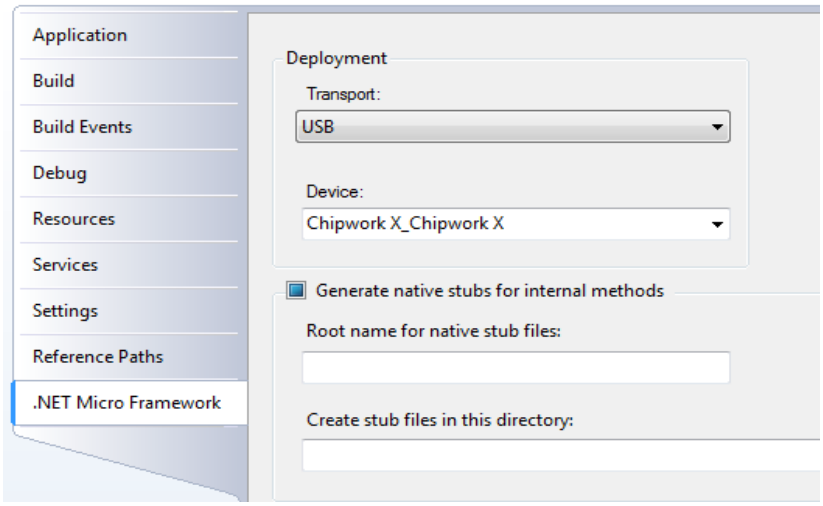


11. Place a breakpoint at Debug.Print line. You can do this by clicking on the line and then pressing F9.

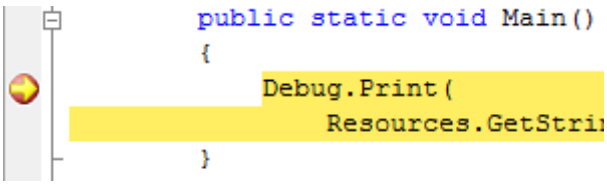


12. Compile the application. There should be no errors.
13. Go to the menu and select **Project > MyConsoleApp Properties...** and in the new window select the **Micro Framework** tab. In the tab, there are options for deployment. Select USB for transport and select *ChipworkX_ChipworkX* .

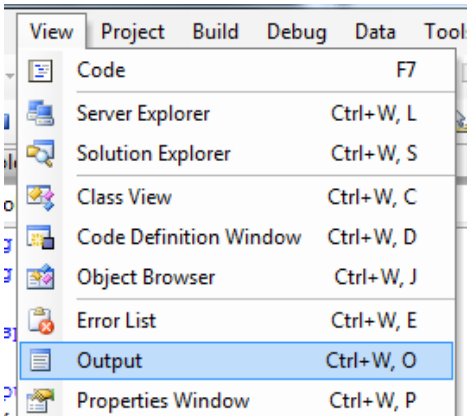




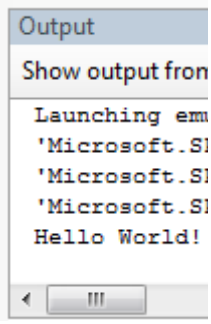
14. Press F5 (Debug). You will see how Visual Studio loads the application and runs it. Visual Studio should pause at the breakpoint we placed in step 4.



15. Make sure you have the output window open. If not, open the window by selecting **View > Output**.



16. Press F10 to step over Debug.Print and watch the output window. The output window should display “Hello World!”



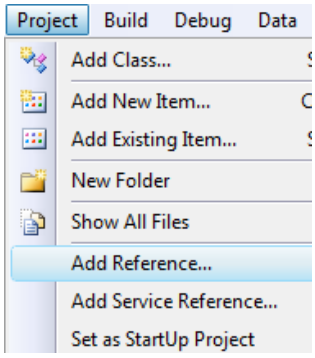
17. Press F5 and the code will continue executing until it reaches the end of the program.
18. Now, try to modify the string to “Amazing Framework!” and run the program again.

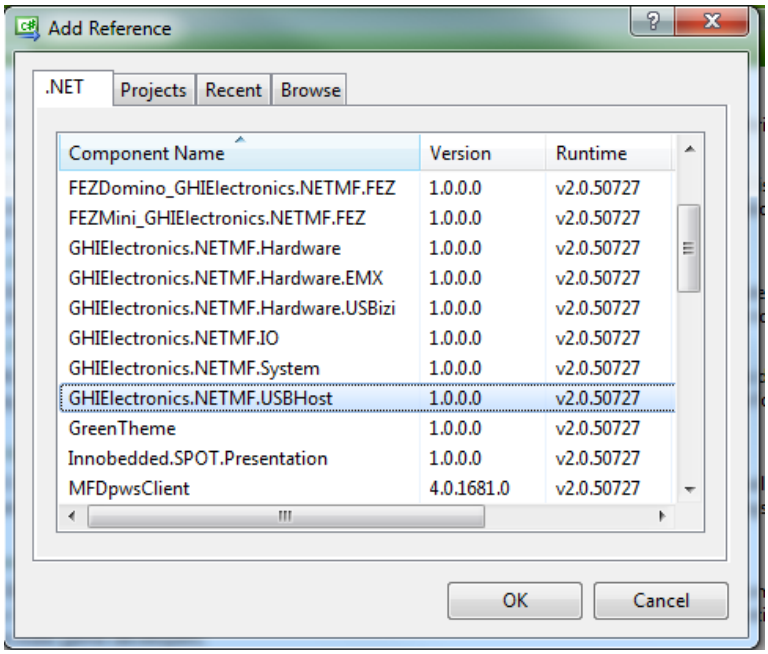
```
namespace MyConsoleApp
{
    public class Program
    {
        public static void Main()
        {
            Debug.Print("Amazing Framework!");
        }

    }
}
```

Adding GHI NETMF Library

1. Go to the **Project** tab and click **Add Reference**.





2. Let's add USB Host library. Select it and click OK.
3. Add "using" for the name space at the beginning of the file:

   ```
   using GHIElectronics.NETMF.USBHost;
   ```

4. As an example, we will get a list of currently connected devices. Add this in Main() method:

   ```
   USBH_Device[] devices = USBHostController.GetDevices();
   ```

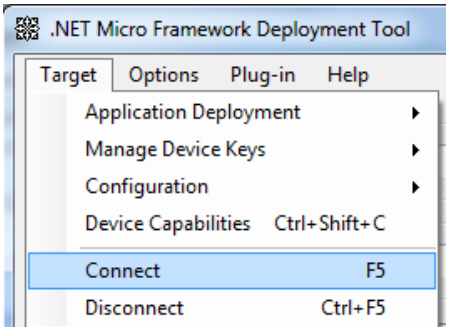
5. Similarly, you can use any other functionality provided by the GHI library. Press F5 in Visual Studio and the program will run.

   If the program does not run, then there is something incompatible on your system.

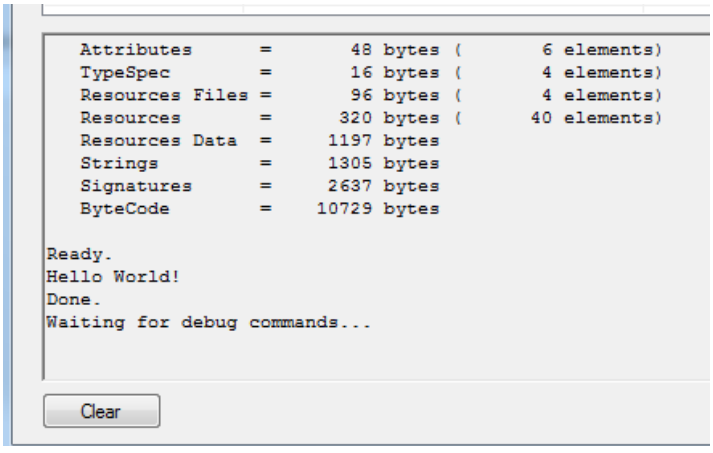
For example, you're using a new/incorrect version of the GHI library and an old/incorrect version of the firmware. This is simply resolved by upgrading the firmware to the one included in your SDK and making sure the Added Reference is from the SDK as well.

MFDeploy is helpful to investigate these errors as explained next.

Using MFDeploy, you can see debug messages, exceptions or errors from your device. Make sure Visual Studio is not in debug mode. Open MFDeploy and make sure you can ping as explained in previous steps. Now, Click on **Target > Connect**.



Now, reset your hardware and click Ping. You will see debug output of what the device is doing, for example loading assemblies and any debug messages printed by your application.



In case the program did not run because of incompatibility, the debug output will show these errors. This is useful for debugging certain applications.

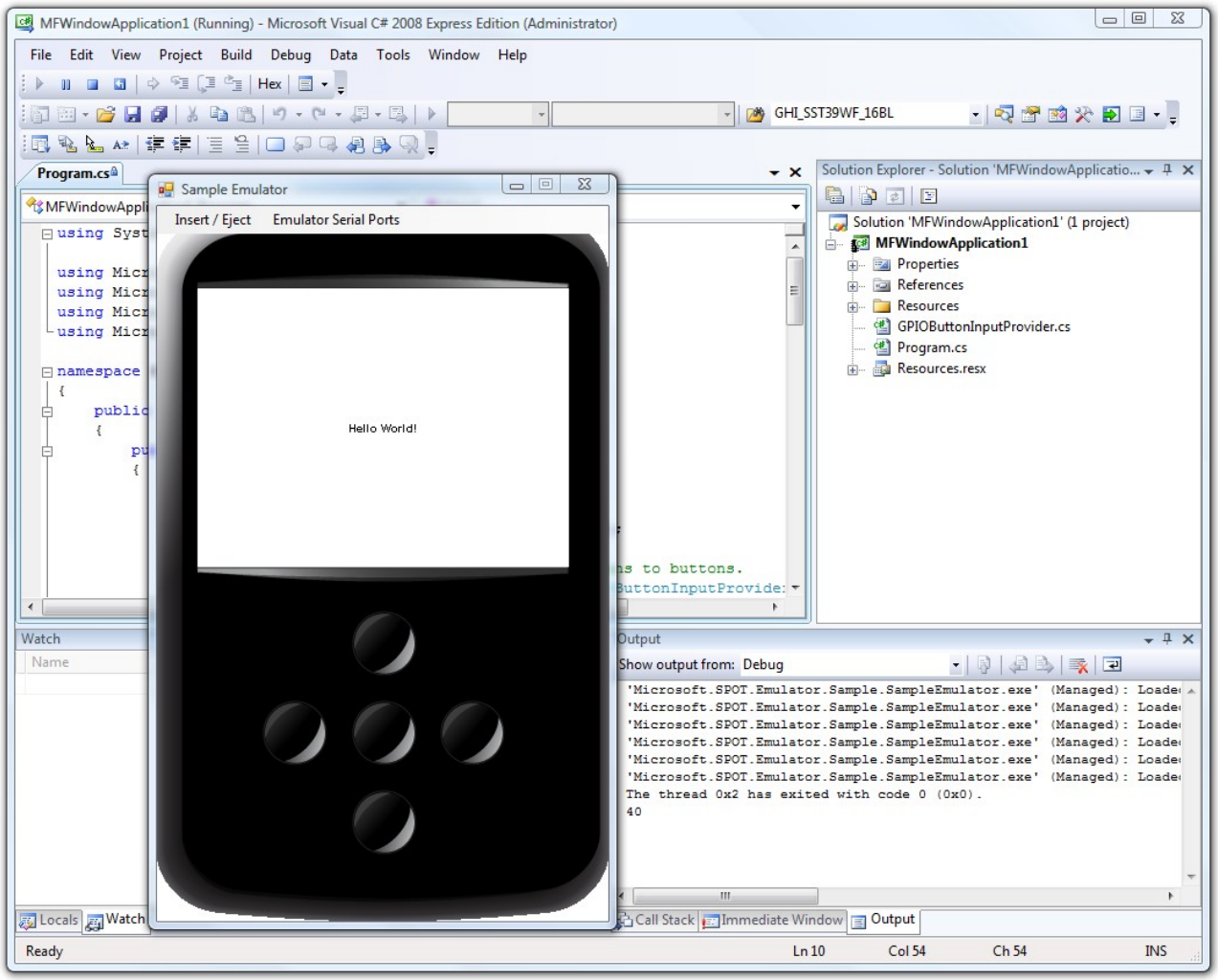
Note: If you Connect through MFDeploy, you cannot deploy using Visual Studio. MFDeploy must be disconnected or closed before you can go back to Visual Studio. Only one of these two programs can be connected to your platform at a time.

7.2. ChipworkX Emulator

The .NET Micro Framework has a powerful emulator that can be extended or changed to suite the developer's needs. This is useful as you can do most of the development and testing before building the actual hardware.

ChipworkX™ has an emulator available that maps the buttons and LCD dimensions as provided on the Development System. However, support for the extended features provided by GHI (PWM, USB Host, etc.) are not supported in the emulator. Using any of these extended features will result in an error on the emulator.

A user can choose the emulator from the Device list in Visual Studio project properties.



8. ChipworkX Features

ChipworkX™ supports all of the necessary features of the .NET Micro Framework with the required HAL and PAL drivers such as Graphics, TCP/IP, SSL and FAT File System. The .NET Micro Framework SDK includes full documentation and examples about the usage of these features with the related libraries.

Furthermore, ChipworkX™ supports other exclusive GHI hardware and software features such as USB host, PPP, GPRS/3G, Database, RLP and Internal FAT storage. The GHI NETMF SDK includes the required library files with full documentation and examples about the usage of these features with the related libraries.

The following sections clarify necessary guidelines about ChipworkX™ features.

8.1. Application Flash/RAM/EWR

8MB of external flash is available on ChipworkX™ Modules. External flash is used for firmware, system assemblies, user deployment and EWR storage.

64MB of SDRAM comes standard with the ChipworkX™ Module, enough for applications using the .NET Micro Framework and SideShow.

Extended Weak References (EWR)

EWR (Extended Weak References) is a way for managed applications to store data on FLASH memory. Stored data has priorities, if more data needs to be stored and the flash EWR region is full, some lower priority data will be overwritten. Consult the .NET Micro Framework documentation for more details.

If more storage is needed, Internal 256MB Flash, SD memory cards and/or USB memory devices can be used. EWRs do not work with removable media devices.

NAND Flash

256MB of NAND flash is used as FAT file system storage under the .NET Micro Framework. It can be accessed just like any other media, SD card or USB storage device.

8.2. Debugging Interface (Access Interface)

The Access Interface with the ChipworkX™ firmware is usually named NETMF debugging interface which is the communication interface between the ChipworkX™ firmware and the application code terminal (Visual C# debugger). It can be configured as USB, serial port, or Ethernet.

The Access Interface section provides the required information on how to access the ChipworkX debugging interface.

Changing the debug interface might be necessary for some applications. The default debug interface is USB, but some application might need to use the USB Client feature to connect to PC as a different device, for example a USB Storage. In this case, you should change the debug interface.

Other access interfaces can be enabled using software. Using GHI's library, you can set the interface and it is saved. So, it will keep this setting after you reset the device. Only TinyCLR (Firmware) and TinyBooter interfaces can be changed. The boot loader cannot be changed using software.

You can force ChipworkX™ to ignore the software settings and use the default USB interface. This is helpful in case the incorrect settings are stored. This is done by holding the Center and Down buttons upon start-up.

If you are not able to access the device after setting the debug interface, for example it was set incorrectly, you can reboot the device in boot loader mode, erase and update the TinyBooter and firmware again.

Software settings is done using GHI NETMF library under:

GHIElectronics.NETMF.Hardware.Configuration

8.3. Digital Inputs/Outputs

The module has 80 digital I/O pins that can be used in managed applications. All digital I/O pins are 3.3V only. This means that signals coming from another circuit can NOT be higher than 3.6V. All pins support input and output with pull-up feature.

All digital I/O pins are interrupt capable. Interrupt pins asynchronously call functions in managed applications. Interrupts can be activated on rising or falling edges with optional glitch filter. Enabling interrupts for both rising and falling edges is supported but in this case the glitch filter is disabled.

Refer to the Pin-Out Description section for more information about Digital I/O assignment to the ChipworkX™ hardware pins.

The I/Os are numbered as in the following table:

AT91SAM9261S Peripheral IO		ChipworkX™
Port Name	Pin name	IO number
PA	PA0...PA31	0..31
PB	PB0...PB31	32..63
PC	PC0...PB31	64..95

8.4. Serial Peripherals

Serial Port (UART)

One of the oldest and most common protocols is UART (or USART). ChipworkX™ hardware exposes three UART ports

Serial Port	AT91SAM9261S UART	Hardware Handshaking
COM1	Debug Unit DBGU	Not Supported
COM2	USART0	Not Supported
COM3	USART2	Supported

Important Note: Serial port pins have 3.3V TTL levels where the PC uses RS232 levels. For proper communication with RS232 serial ports (PC serial port), an RS232 level converter is required. One common converter is MAX232.

Note: If the serial port is connected between two TTL circuits, no level converter is needed but they should be connected as a null modem. Null modem means RX on one circuit is connected to TX on the other circuit, and vice versa.

Refer to the Pin-Out Description section for more information about UART signals assignment to ChipworkX™ hardware pins.

SPI

ChipworkX supports two SPI Interfaces SPI1 and SPI2. SPI Bus is designed to interface multiple SPI slave devices, the active slave is selected by asserting the Chip Select line on the relative slave device.

SPI1 is used to interface the touch screen controller, MS1053 codec and SD card. Therefore, if the developer is using an additional SPI slave device through SPI1, this device must use SPI bus only when its chip select signal is active and that could be accomplished by dedicating one of the Digital I/Os to do this function in SPI configuration *ChipSelect_Port*.

A good example is reading analog inputs of the touch screen controller and to control VS1053 MP3 decoder chip on the development System. Example project source code included in the GHI NETMF SDK is a good reference on how to do so.

IMPORTANT NOTE: The ChipworkX™ module uses SPI-based flash for bootstrap. This flash is connected to SPI1 bus, SPI2 is completely free. A SPI bus master (ChipworkX™) is designed to work with multiple slaves. For example, the ChipworkX™ Development System uses SPI1 for flash, touch screen controller and MP3 decoder chip. Our WiFi module uses SPI1 as well by default. They all work in sync because only one slave is selected at any time. This is accomplished by passing the Chip Select pin along with SPI configurations so the pin is selected only when data is being sent and then it is automatically deselected.

If you are not sure of how SPI works or your slave cannot be deselected (doesn't have Chip Select pin, SSEL) then you must use SPI2, which is completely free.

This applies to all SPI1 bus pins. Those are SPI1-MOSI, SPI1-MISO, SPI1-SCK.

Ideally, SPI1 can only be used when a developer has already used all pins and must use SPI1; otherwise, SPI1 pins should be left unused by the developer.

Refer to the Pin-Out Description section for more information about SPI signals assignments to the ChipworkX™ hardware pins.

I2C

I2C is a two-wire addressable serial interface. ChipworkX™ supports one master I2C port.

Refer to the Pin-Out Description section for more information about I2C signals assignments to the ChipworkX™ hardware pins.

I2C on ChipworkX™ is implemented using sofware. Users should note these few points:

1. I2C blocks managed threads. It is recommended to use small data chucks.
2. The I2C clock rate is not accurate but this should not affect the I2C functionality. For example, using 100Khz for clock will result in 70Khz.
3. Losing Arbitration is not supported.
4. Read and Write timeouts are not supported.
5. Using buses like SPI and UART is recommended over I2C.

One-wire Interface

Through one-wire, a master can communicate with multiple slaves using a single digital pin. One-wire can be activated on any Digital I/O on ChipworkX™.

This is available through the GHI NETMF library.

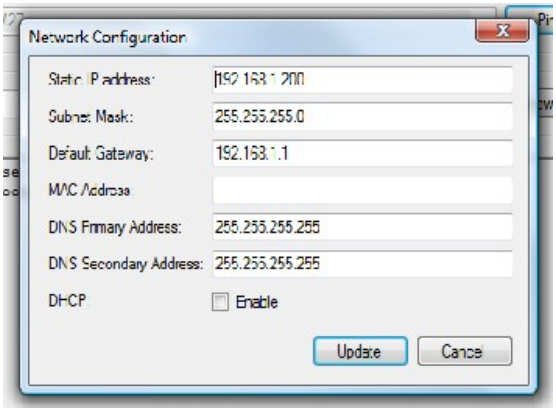
8.5. Networking (TCP/IP)

Networking is a crucial part in today's embedded devices. The .NET Micro Framework includes a full TCP/IP stack with complete socket support for manged applications. ChipworkX™ networking implementation includes PPP, WiFi, Ethernet, TCP/IP, SSL, HTTP, and Device Profile for Web Services.

MAC address setting

Users can use MFDeploy to update the correct MAC address before the device is connected to a network. Network settings can also be changed dynamically from the managed code.

```
NetworkInterface[] netif = NetworkInterface.GetAllNetworkInterfaces();
 // Set new MAC address
byte[] newMAC = new byte[] { 0x00, 0x1A, 0xF1, 0x01, 0x42, 0xDD };
netif[0].PhysicalAddress = newMAC;
```



IP address (DHCP or static):

DHCP (dynamic) IP and Static IP are supported when using Ethernet or WiFi on ChipworkX™. If using dynamic IP, ChipworkX™ will not obtain IP lease at power up. DHCP can only be enabled from software. MFDeploy has a DHCP enable option but it has no effect on getting the IP lease on start-up.

```
NetworkInterface[] netif = NetworkInterface.GetAllNetworkInterfaces();
 // Get an IP address from DHCP server
if (netif[0].IsDhcpEnabled)
{
   netif[0].RenewDhcpLease();
}
else
{
   netif[0].EnableDhcp();
}
```

Ethernet

The ChipworkX™ Module includes a 10/100 base PHY DM9000 with all required circuitry. Users who wish to use Ethernet have to add an Ethernet connector with magnetic connectors such as J0026D21 or any other compatible connector.

Refer to the Pin-Out Description section for more information about Ethernet signals assignments to the ChipworkX™ hardware pins.

GHI Electronics supplies a dedicated MAC address for each ChipworkX™ Module. The address can be found on a sticker on the module.

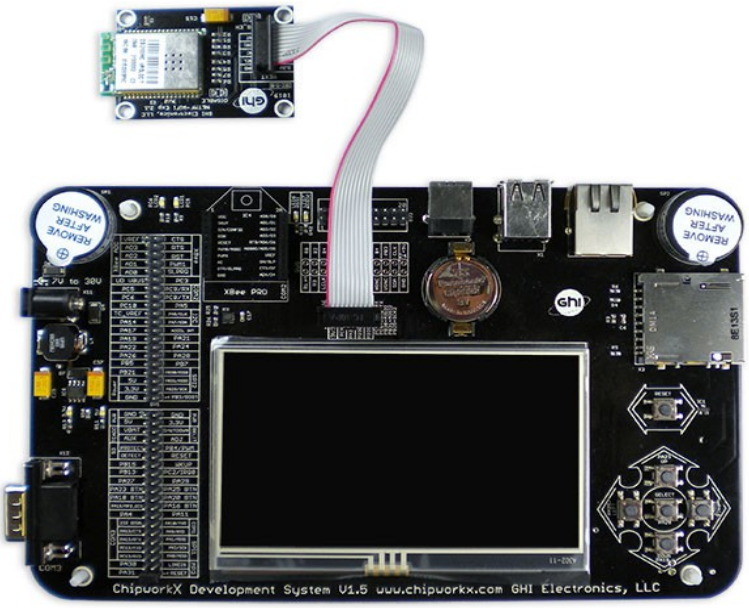
Wireless LAN WiFi (IEEE 802.11b)

ChipworkX™ provides WiFi support through the RS9110-N-11-21-01 WiFi module by Redpine Signals. This module allows for real "Socket" connection over WiFi. For example, you can open up to 127 TCP/UDP sockets simultaneously with SSL security. This is not a simple WiFi-Serial bridge commonly used on simple embedded systems.ule.

RS9110-N-11-21-01 WiFi module

WiFi RS21 Module with UEXT Connector

This module from Redpine's Connect-io-n™ family is a complete IEEE 802.11bgn WiFi client device with a standard SPI interface to a host processor or data source. It integrates a MAC, baseband processor, RF transceiver with power amplifier, a frequency reference, an antenna, and all WLAN protocol and configuration functionality in embedded firmware to provide a self-contained 802.11n WLAN solution for a variety of applications.

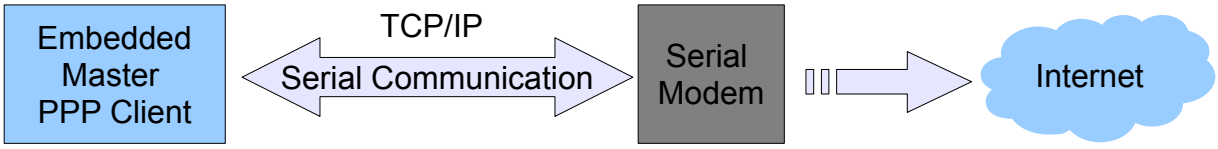


GHI Electronics offers the WiFi RS21 Module with UEXT Expansion to evaluate this WiFi module with the ChipworkX™ Development System.

PPP (TCP/IP access through serial modems)

Using this feature, users can create sockets and communicate over links that are not Ethernet, serial, or wireless links for example.

This includes PPP Client with PAP authentication protocol. This feature allows the user to dial in through serial modem (V.90/GPRS/3G) to access the Internet or Extranet.



In this case, network settings will be taken from the hosting terminal server (e.g. Internet Service Provider).

Important Note: If the terminal server (ISP) does not require authentication credentials, a user must use this type of communication anyway with any random user name and password.

Important: The Ethernet port or WiFi cannot be used when using the GHI PPP Stack, however, an Ethernet cable or WiFi physical link can be traced.

This is available through GHI's NETMF library. Example code is also included in the SDK.

SSL

The .NET Micro Framework includes an SSL stack to enable secure network communication. **The user must update the SSL seed through MFDeploy before using SSL**, *MFDeploy* > *Target* > *Manage Device Keys* > *Update SSL Seed*.

Consult the .NET Micro Framework documentation for more information about SSL.

8.6. Graphics / Display

The ChipworkX™ Module supports 16bit color displays natively. The default resolution is 480x272 which matches the Sharp 4.3” (480x272) LQ043T1DG01 TFT display available on the ChipworkX™ Development System. This display is common and similar to what is used in the Sony PSP. What makes this display better than others is that it embeds all required circuitry to run with only supplying 5V, 3.3V, Ground, LCD digital signals, and back light power.

Developers can use almost any digital TFT display. This is accomplished by connecting HSYNC, VSYNC, CLK, ENABLE and 16Bit color lines. The color format is 5:6:5 (5Bits for red, 6Bits for green and 5Bits for blue). If the display has more than 16Bits, connect the MSB (high Bits) to ChipworkX™ and the extra LSB (low Bits) to ground.

Displays with VGA input (monitors) can be supported using a frame generator chip like Chrontel's CH7025 to convert LCD signals into VGA analog signals with the suitable timing.

Currently the highest supported resolution is 800x600. If your application requires a higher resolution, please contact us.

Refer to the ChipworkX™ Development System schematic for more information about hardware design (the backlight circuit, TFT signal connections).

Refer to the Pin-Out Description section for more information about TFT signals assignments to the ChipworkX™ hardware pins.

With ChipworkX™ graphics support, users can leverage the .NET Micro Framework graphics features such as:

- Windows Presentation Foundation (WPF)
- BMP, GIF and JPEG image files.

Consult the .NET Micro Framework documentation for more information on graphics support.

Developers can either use the same TFT display or other ones. This can be achieved by customizing the LCD controller registers to match the requirement of the new LCD.

Displays with VGA input (monitors) can be supported using a frame generator chip to convert LCD signals into VGA analog signals with the suitable timing.

For more information about LCD controller registers refer to the AT91SAM9261S User Manual.

8.7. PWM

The ChipworkX™ hardware includes a PWM output which is mainly utilized to control the LCD back light illumination.

This is available through the GHI NETMF library.

8.8. Touch Screen Control

By default, ChipworkX™ supports touch screen using the TSC2046 touch controller chip with two analog inputs which are used to access the touch screen which is controlled though SPI1.

Developers can support different kinds of touch screens and touch controllers easily by writing a simple driver and exposing the position parameters to touch screen methods.

Refer to the Pin-Out Description section and the ChipworkX™ Development System schematic for more information about touch screen controller TSC2046 connections signals.

8.9. USB Device (Client)

USB Clients (device) *and* ***USB Hosts*** *are completely different. Many designers confuse USB when it comes to hosts and devices. A USB Host is the master of the bus where all the work is done. USB devices are simple compared to hosts and they can only connect/communicate with a host and not other devices. The USB host and device on ChipworkX™ are two separate peripherals, so there would be no conflict when using them both simultaneously.*

The USB client interface is usually used as the ChipworkX™ access interface for debugging and application deployment through Microsoft's Visual Studio. However, developers have full control over the USB client interface. For example, the USB client can be made to simulate a USB keyboard or USB mass storage.

Controlling a ChipworkX™ USB client requires intricate knowledge of how USB works. The user should refer to the .NET Micro Framework documentation for complete details on how to use this feature.

Fortunately, GHI Electronics offers a USB Client library (available in the SDK) to ease development and provide direct support for some USB devices, such as, Mass Storage (Virtual Disk) and CDC (Virtual COM Port). The library is capable of creating a USB client that's composed of multiple USB interfaces. Please refer to the GHI NETMF Library for more information.

The ChipworkX™ Module contains a USB host and USB client (both can work simultaneously).

Refer to the Pin-Out Description section for more information about USB device signals assignment to the ChipworkX™ hardware pins.

Important Notes:

- **Be CAREFUL when changing the USB configuration and settings**, as you go on with development and creating your USB device and connecting it to the PC, Windows might save the device information in its registry. Therefore, if you change the USB device settings/interfaces and connect it again, it might not work correctly. Make sure to be careful with changing your USB device settings. You may also need to delete all the settings from Windows registry manually.
- By default, the Micro Framework debug interface is USB. If you need to use the USB Client feature to build a USB device, you should select a different debug interface first (COM1).

USB cable connection detection

USB VBUS (USB power) can be connected, through a protection resistor, to any digital I/O to detect the presence of a USB cable.

8.10. USB Host and Supported USB Drivers

USB Clients (device) *and* ***USB Hosts*** *are completely different. Many designers confuse USB when it comes to hosts and devices. A USB Host is the master of the bus where all the work is done. USB devices are simple compared to hosts and they can only connect/communicate with a host and not other devices. The USB host and device on ChipworkX™ are two separate peripherals, so there would be no conflict when using them both simultaneously.*

The USB Host allows the use of USB Hubs, USB storage devices, joysticks, keyboards, mice, printers and more. With ChipworkX™ supported class drivers, you don't have to worry about the inner workings. For USB devices that do not have a standard class, low level USB access is supported. The ChipworkX™ Module contains a USB host with two ports and USB client (both can work simultaneously).

Refer to the Pin-Out Description section for more information about USB Host signals assignment to the ChipworkX™ hardware pins.

This is available through the GHI NETMF library.

8.11. Storage Devices (Internal Flash, SD, USB) / File System

File System lets you create and manipulate files and folders on the connected SD and USB storage devices.

With .NET Micro Framework V4.0, FAT32 and FAT16 are supported by NETMF. The user should refer to the .NET Micro Framework documentation for details on handling files and folders.

Note: FAT32 and FAT16 formats are supported, but FAT12 is not. You can format your storage device on a PC with a FAT32 or FAT16 option before using on ChipworkX™.

Before using the storage devices and accessing them with NETMF, the user must mount the file system first. This is done using the ChipworkX™ library provided with the SDK. SD cards and USB storage devices are **NOT** mounted automatically.

Please refer to library documentation: GHIElectronics.NETMF.IO.PersistentStorage

Internal Flash Storage

The ChipworkX™ Hardware has 256MB NAND Flash which is utilized as file storage with FAT file system. The NAND is used only for File System operations were sector failure will not cause the system to be unstable. NAND flash devices have a limited life span on how many erases can be done on one sector. This should not be a problem for many applications as the limits are 100,000 erase cycles minimum. Also, with wear leveling support, this will dramatically increase the NAND life span.

SD/MMC Memory

SD and MMC memory cards have a very similar interface. The ChipworkX™ Module

supports both cards and also supports SDHC (over 4GB) cards. ChipworkX™ uses SPI1 to access SD/MMC cards and PA4 Digital I/O for chip select signal. There are two smaller versions of SD cards, mini SD and micro SD. All card sizes are identical as far as the interface. The only difference is the physical dimensions.

A user may be interested in mounting or unmounting the file system on the SD card automatically when a SD card is inserted or ejected. To do this, there is a pin on the SD card connector called Card Detect which works like a switch. Connect this to a GPIO InterruptPort on ChipworkX™ and call mount, unmount appropriately.

USB Memory

Before proceeding, make sure you have an understanding of how USB devices are inserted and detected on your .NET Micro Framework device. Refer to the USB Host section.

Similar to SD cards, the user may be interested in mounting/unmounting the file system on the USB drive automatically when a USB drive is inserted or ejected. To do this, you can get events from ChipworkX™ about connection/disconnection of USB devices and call mount, unmount appropriately.

8.12. Output Compare

By using output compare, developers can generate different waveforms. This is available on any digital output pin.

This is available through the GHI NETMF library.

8.13. Database

ChipworkX™ supports SQLite which is useful for logging and retrieving data using standard SQL queries. A database can be created in RAM or saved on Storage Media with file system (SD,NAND or USB mass storage). Refer to ChipworkX.Database for reference on creating databases in RAM or non-volatile memory.

The GHI NETMF SDK includes a simple example code on how to use the database feature.

8.14. Power Control / Hibernate

Power Control

ChipworkX™ is running at 200MHz. However, the user can, using register access, change the clock speed. This way, the processor will run slower and consume less power.

Hibernate

The user can put ChipworkX™ in hibernate mode through the PowerState functionality in the Micro Framework. Only “DeepSleep” mode is supported. In this mode, the processor is set into idle wait-for-interrupt mode in which the clock to the ARM core stops, reducing the power used when the processor is not busy. Note that the rest of the device is still clocked by the master clock. If needed, clocks of the unused peripherals can be deactivated (through register access) to participate in power saving.

Here's an example to sleep and then wake up on an interrupt pin:

```
// Must enable an interrupt event on the user "wake up" pin.
InterruptPort wakeUpPin = new InterruptPort(ChipworkX.Pin.PA25, false,
Port.ResistorMode.PullUp, Port.InterruptMode.InterruptEdgeBoth);
wakeUpPin.OnInterrupt += new NativeEventHandler(wakeUpPin_OnInterrupt);

// Sleep. Specify waking up on GeneralPurpose IO
PowerState.Sleep(SleepLevel.DeepSleep, HardwareEvent.GeneralPurpose);
```

8.15. Real Time Clock

The AT91SAM9261S includes a real-time clock that can operate while the processor is off. The developer only needs to wire a 3V battery or a super capacitor to the VBAT pin. A 32KHz crystal is already included in the ChipworkX™ module.

This is available through the GHI NETMF library.

8.16. Battery RAM

There are 16 Bytes of RAM that is backed-up by battery. Data is retained on power loss. The developer only needs to wire a 3V battery or a super capacitor to the VBAT pin.

This is available through the GHI NETMF library.

8.17. Processor Register Access

The ChipworkX™ Module allows direct access to the AT91SAM9261S registers. The user can write, read or manipulate the bits as needed. This can be useful, enabling some features that may not be already exposed.

This is available through the GHI NETMF library.

8.18. JTAG access

The ChipworkX™ hardware exposes JTAG which can be used to download different firmware or to debug user defined native code (Runtime Loadable Procedure code).

8.19. Runtime Loadable Procedure RLP

A highly useful and unique feature in ChipworkX™ is allowing users to load their own compiled native code (C or assembly) and run it directly through managed code. This feature is similar to the use of DLLs on PCs. RLP can be used to implement processing intensive and time-critical routines.

This is available through GHI NETMF library.

8.20. In-Field Update

This functionality allows devices that are deployed in the field to update their software automatically without external help. This is very useful in remote and end users' applications.

You can either update the entire device (including GHI firmware files) or update the managed application only. Also, this feature includes a managed C# boot loader that the user will provide. This is different from the GHI low level boot loader that already exists on the device.

This is available through the GHI NETMF library.

8.21. Watchdog

Watchdog is used to reset the system if it enters an erroneous state. The Watchdog is enabled with a specified timeout. The user must keep resetting the Watchdog time counter within this timeout interval or otherwise the system will reset.

This is available through GHI NETMF library.

9. Advanced Users

The ChipworkX™ Module is based on the Atmel AT91SAM9261S microcontroller. With ChipworkX™ firmware's register access feature, advanced users familiar with this microcontroller, can manipulate the internal registers.

10. ChipworkX Design Consideration

10.1. Hardware

The following peripherals are recommended to be exposed from the module in any design, possibly hidden from the end user:

- Up, Down and Select button pins.
- USB Device (Client).

IMPORTANT NOTE: The ChipworkX™ module uses SPI-based flash for bootstrap. This flash is connected to SPI1 bus, SPI2 is completely free. A SPI bus master (ChipworkX™) is designed to work with multiple slaves. For example, the ChipworkX™ Development System uses SPI1 for flash, touch screen controller and MP3 decoder chip. Our WiFi module uses SPI1 as well by default. They all work in sync because only one slave is selected at any time. This is accomplished by passing the Chip Select pin along with SPI configurations so the pin is selected only when data is being sent and then it is automatically deselected.

If you are not sure of how SPI works or your slave cannot be deselected (doesn't have Chip Select pin, SSEL) then you must use SPI2, which is completely free.

This applies to all SPI1 bus pins. Those are SPI1-MOSI, SPI1-MISO, SPI1-SCK.

Ideally, SPI1 can only be used when a developer has already used all pins and must use SPI1; otherwise, SPI1 pins should be left unused by the developer.

10.2. Software

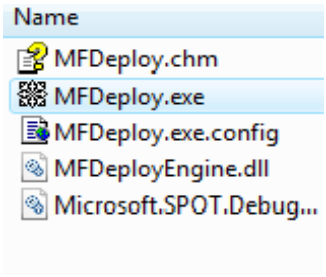
The ChipworkX™ firmware is only licensed to work on ChipworkX™ MINI9261I modules provided by GHI Electronics, LLC. Please consult GHI Electronics for customized firmware for other hardware designs.

10.3. ChipworkX Placement

The ChipworkX™ Module MINI9261I mounting is a standard SO-DIMM 200-pin.

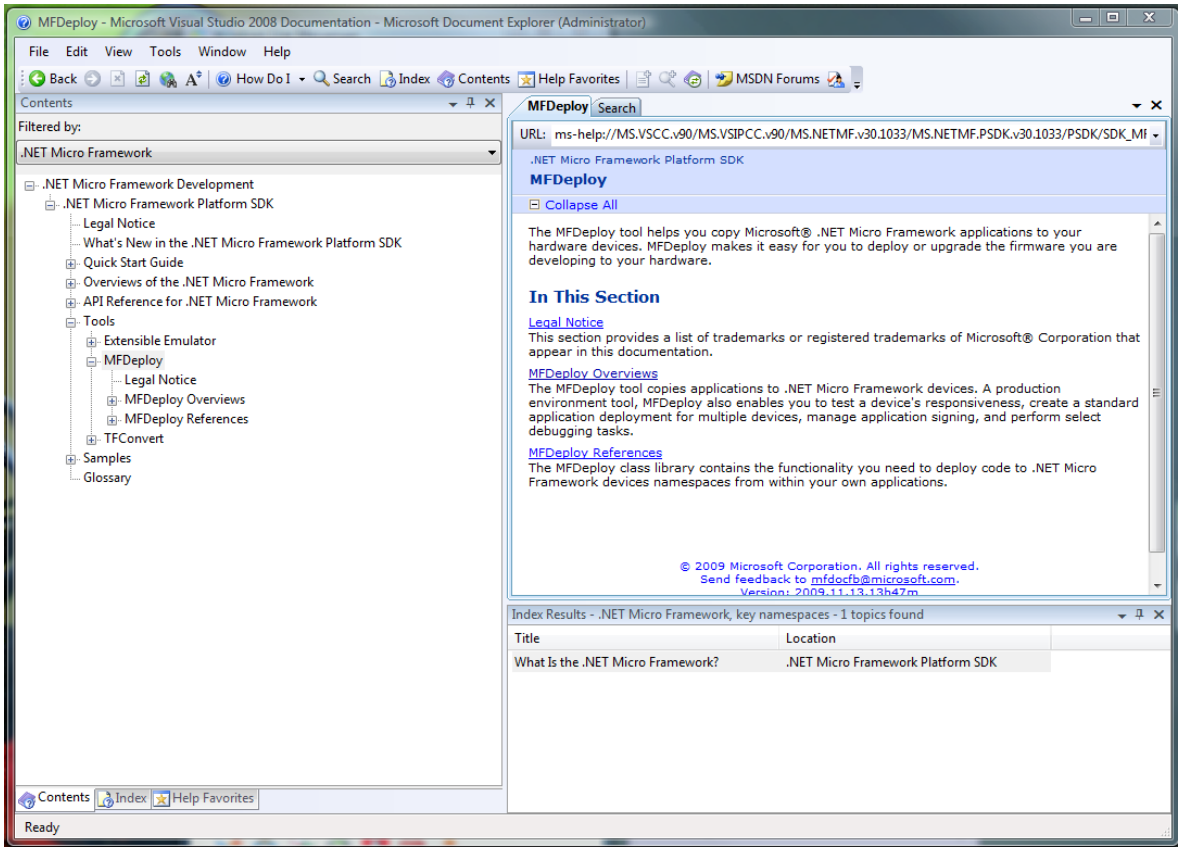
A compatible SO-DIMM 200-pin connector is 1565917-4 from AMP.

Appendix A: MFDeploy Tool



MFDeploy is a free tool from Microsoft that helps you deploy Microsoft's .NET Micro Framework applications to your hardware devices. MFDeploy makes it easy for you to download the firmware you are developing to your hardware. MFDeploy is available in NETMF SDK. *%Microsoft .NET Micro Framework\vx.0 folder%*\Tools\MFDeploy.exe

Detailed documentation about MFDeploy is available under the .NET Micro Framework Help.



One of the great features of MFDeploy is authenticating loaded files. MFDeploy uses public/private keys to verify files. This is a good feature for companies who want to make sure they are the only ones who can load applications on the system. MFDeploy documentation explains this feature in details.

Legal Notice

Licensing

The ChipworkX™ Module is fully licensed for commercial use. The Module price covers the commercial use of the ChipworkX™ Module with the .NET Micro Framework.

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