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G30 SoC Datasheet

Where Hardware Meets Software

1 Contents

2 Introduction

The G30 SoC is a powerful, low-cost, surface-mount LQFP64 System on Chip (SoC) running Microsoft's .NET Micro Framework. The .NET Micro Framework enables the SoC to be programmed from Microsoft Visual Studio using a USB or serial cable. Programming in a modern managed language, such as C# or Visual Basic, allows developers to accomplish more work in less time by taking advantage of the extensive built-in libraries for networking, file systems, graphical interfaces, and more.

A simple two-layer circuit board with a power source and a few connectors can utilize the G30 SoC to bring the latest technologies to any product. There are no additional licensing or other fees and all the development tools are provided freely.

Throughout this document, the G30 SoC will be referred to as the G30.

For more information and support, please see https://www.ghielectronics.com/support/netmf and the product catalog entry. For advanced electrical characteristics and details on the underlying STM32F401RET6 processor, please consult the processor's datasheet.

2.1 Key Features

- .NET Micro Framework
- RoHS Lead Free
- 84 MHz ARM Cortex-M4 STM32F401RET6
- 68 Kbytes available RAM
- 128 Kbytes available flash
- 49 GPIO
- 16 interrupt capable GPIO
- 2 SPI
- 1 I2C
- 2 UART
- 15 PWM
- 16 12-bit analog input
- 4-bit SD/MMC memory card interface
- Low power modes
- -40°C to +85°C operational
- LQFP64 10 x 10 mm
- RTC
- Watchdog
- Threading
- USB client
- File System
  - Full .NET file interface
  - SD cards
- Native extensions
  - Device register access
- Signal controls
  - Generation
  - Capture
  - Pulse measurement

2.2 Example Applications

- Vending machines
- POS Terminals
- Measurement tools and testers
- Networked sensors
- Robotics
- Central alarm system
- Smart appliances
- Industrial automation devices

3 The .NET Micro Framework

Inspired by the full .NET Framework, Microsoft developed a lightweight version called .NET Micro Framework (NETMF). NETMF focuses on the specific requirements of resource-constrained embedded systems. Development, debugging, and deployment are all conveniently performed using Microsoft's powerful Visual Studio through a standard USB or serial cable.

Programming is done in C# or Visual Basic with libraries that cover sockets, memory management with garbage collection, advanced file system support, multitasking services, and many others. In addition to supporting many standard .NET features, NETMF has additional embedded extensions supporting microcontroller specific needs such as PWM outputs and analog inputs.

3.1 GHI Electronics and NETMF

Since signing the partnership agreement with Microsoft in 2008, GHI Electronics has become the leading Microsoft partner on NETMF through its work on integrating and extending the NETMF core. GHI Electronics's NETMF products are extended with important features extending the NETMF libraries such as databases, USB Host, Wi-Fi, and native programming.

4 Pinout Table

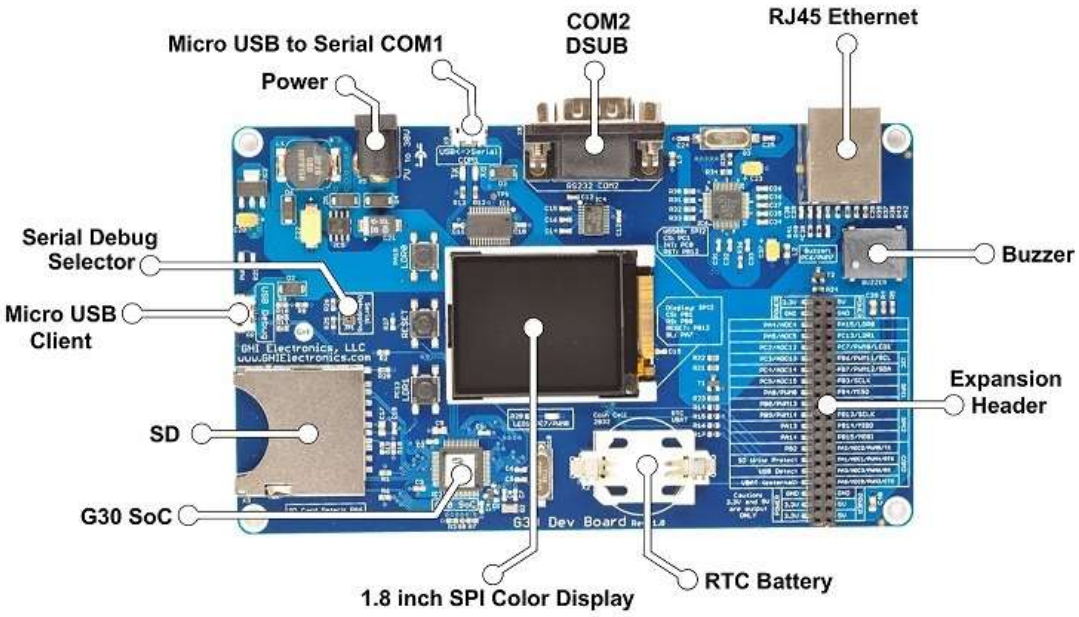
Many signals on the G30 are multiplexed to offer multiple functions on a single pin. Developers can decide on the pin functionality to be used through the provided libraries. Any pin with no name, function, or note must be left unconnected.

1		VBAT			23	PA7	ADC7		45	PA12	USBC D+
2[5]	PC13	LDR1			24	PC4	ADC14		46	PA13	
3[5]	PC14	RTC XTAL IN			25	PC5	ADC15		47		GND
4[5]	PC15	RTC XTAL OUT			26	PB0	ADC8		48		3.3 V
5		SYS XTAL IN			27	PB1	ADC9		49	PA14	
6		SYS XTAL OUT			28[1]	PB2			50	PA15	LDR0
7		RESET			29	PB10	MODE		51	PC10	SD D2
8	PC0	ADC10			30[2]				52[3]	PC11	SD D3
9	PC1	ADC11			31		GND		53	PC12	SD CLK
10	PC2	ADC12			32		3.3 V		54	PD2	SD CMD
11	PC3	ADC13			33	PB12			55	PB3	SPI1 SCK
12[6]		GND			34	PB13	SPI2 SCK		56	PB4	SPI1 MISO
13[6]		3.3 V			35	PB14	SPI2 MISO		57[3]	PB5	SPI1 MOSI
14	PA0	ADC0	COM2 CTS	PWM3	36	PB15	SPI2 MOSI		58[4]	PB6	I2C SCL	PWM11
15	PA1	ADC1	COM2 RTS	PWM4	37	PC6	PWM7		59[4]	PB7	I2C SDA	PWM12
16	PA2	ADC2	COM2 TX	PWM5	38	PC7	PWM8		60[1]			
17	PA3	ADC3	COM2 RX	PWM6	39	PC8	PWM9	SD D0	61	PB8	PWM13	
18		GND			40	PC9	PWM10	SD D1	62	PB9	PWM14	
19		3.3 V			41	PA8	PWM0		63		GND	
20	PA4	ADC4			42	PA9	COM1 TX	PWM1	64		3.3 V	
21	PA5	ADC5			43[3]	PA10	COM1 RX	PWM2				
22	PA6	ADC6			44	PA11	USBC D-					

[1]Requires a 10 kΩ pull-down resistor
[2]Requires a 4.7 µF capacitor to GND
[3]Requires a 10 kΩ pull-up resistor
[4]Open drain requiring a 2.2 kΩ pull-up resistor
[5]Can sink 3 mA, cannot source
[6]Used for the analog system

5 Reference Design

The G30 Dev Board is an excellent starting point and reference design for anyone interested in evaluating and developing with the G30. See the product catalog entry for more information and additional resources.



6 Device Startup

The G30 is held in reset when the reset pin is low. Releasing it will begin the system startup process.

There are three different components of the device firmware:

1. GHI Bootloader: initializes the system, updates TinyCLR when needed, and executes TinyCLR.
2. TinyCLR: loads, debugs, and executes the managed application.
3. Managed application: the program developed by the customer.

Which components get executed on startup can be control by manipulating the LDR0 pin. It is pulled high on startup. When low, the device waits in the GHI Bootloader. Otherwise, the managed application is executed. LDR1 is reserved for future use.

Additionally, the communications interface between the host PC and the G30 is selected on startup through the MODE pin, which is pulled high on startup. The USB interface is selected when MODE is high and COM1 is selected when MODE is low.

The above discussed functions of LDR0, LDR1, and MODE are only during startup. After startup, they return to the default GPIO state and are available to use as GPIO in the user application.

7 Libraries

Similar to the full .NET Framework, NETMF includes many built in libraries to help in modern application development with additional libraries to support embedded systems.

Please see https://www.ghielectronics.com/support/netmf for more information.

7.1 General Purpose Input and Output (GPIO)

GPIOs can read and write logical high and low signals. Keep the following in mind:

- They default to inputs with internal weak pull-up resistors
- They operate on 3.3 V logic levels.
- They are 5 V tolerant when not in analog or crystal mode.
- They have controllable pull up and pull down resistors.
- Not all are interrupt capable at the same time. See design considerations.
- Most pins can source or sink up to 8 mA (see the processor's documentation for advanced information).

7.2 Analog Input

Analog inputs can read voltages from 0 V to 3.3 V with 12-bit resolution. The built in analog circuitry uses the source voltage as a reference which can cause some noise on the analog signal. High accuracy ADCs with a dedicated reference can be added externally.

7.3 Pulse Width Modulation (PWM)

PWM is used to create a waveform with a specified frequency and duty cycle. It uses built-in hardware so no processing resources are needed to keep it running. Frequencies can range from 1 Hz to 42 MHz.

Some PWM channels share the same source clock internally. Changing the frequency on a channel will affect other channels; however, they can have a separate duty cycle.

Channel	Timer
0 to 2	1
3 to 6	2
7 to 10	3
11 to 14	4

7.4 Signal Generator

Signal Generator is used to generate a waveform on any GPIO with varying frequency and duty cycle. The feature is software driven and can generate frequencies up to 200 kHz ±10%. More processing time is required for higher frequencies.

7.5 Signal Capture

Signal Capture monitors any GPIO and records the time from the last change. This feature is software driven and can measure frequencies up to 250 kHz ±10%. Lower frequencies have higher accuracy.

7.6 Pulse Feedback

Pulse Feedback is used for sensing capacitance on any input pin and measuring pulses from ultrasonic distance and other sensors. When used for sensing capacitance, a 100 pF capacitor and 1 MΩ resistor between the pad and ground are recommended.

7.7 Universal Asynchronous Receiver Transmitter (UART)

UART is a common, full duplex, communications interface. Baud rates from 2,400 to 921,600 are supported. Handshaking is supported on COM2 only. Data bits of 8 and 9 are supported. Stop bits of 1 and 2 are supported. Even and odd parities are supported.

7.8 Serial Peripheral Interface (SPI)

SPI is a common three or four wire serial interface. The G30 can act as a SPI bus master only. The maximum supported clock is 42 MHz and all four SPI modes are supported. The SPI bus is designed to interface with multiple SPI slave devices. The active slave is selected by asserting the chip select line on the slave device.

7.9 Inter-Integrated Circuit (I2C)

I2C is a two-wire addressable serial interface. The G30 can act as an I2C bus master only with 7-bit slave addresses. It can connect to one or more slave devices over the same connection with a maximum clock of 400 kHz. The I2C bus interface requires pull up resistors to be added on both the SCL and SDA pins, usually 2.2 kΩ.

It is possible to simulate an independent I2C bus on any two GPIO pins with the appropriate resistors though the software I2C class, but performance will be lower.

7.10 1-Wire

Through 1-Wire, a master can communicate with multiple 1-Wire slaves using any GPIO.

7.11 Graphics

The G30 does not include any graphics libraries. However, the user application can render graphics on SPI displays manually or use character displays.

7.12 USB Client

The USB client interface is typically used as the G30 debug interface and for application deployment through Visual Studio. However, it is controllable and may be used to simulate other USB devices such as mice, keyboards, and Communications Device Class (CDC) interfaces using low level access instead of the debug interface.

7.13 File System

The G30 supports accessing files on SD cards formatted as FAT16 or FAT32. It uses a true 4-bit interface and MMC/SD/SDHC/SDXC cards in full, mini, and micro formats are supported. Access speeds are dependent on many different factors and can be up to 500 Kbyte/s.

7.14 Networking

7.14.1 Ethernet

There is no internal support for Ethernet. However, any Ethernet module with a built-in TCP/IP stack can be used.

7.14.2 Wi-Fi

There is no internal support for Wi-Fi. However, any Wi-Fi module with a built-in TCP/IP stack can be used.

7.15 Configuration

Access to the configuration sector of the device is provided for storage of small, infrequently changing, entries. The data will be lost if the configuration is reflashed. Space is limited and varies based on other information stored in the configuration.

7.16 Real Time Clock

The real time clock (RTC) is used to keep time while the processor is off, drawing its power from a backup battery or super capacitor providing 1.65 V to 3.6 V. An appropriate 32,768 Hz crystal and its associated circuitry must be connected to the G30 for the RTC to function.

7.17 Watchdog

Watchdog is used to reset the system if it enters an erroneous state. The G30 supports timeouts between 1 ms and 32,768 ms. Watchdog support is included through the GHI Electronics libraries replacing the built in NETMF version.

7.18 Power Control

The G30 supports entering sleep, deep sleep, and off modes in order to reduce power usage. It can consume as little as 17 mA in sleep, 5 mA in deep sleep, and 4 mA in off. It may be woken from an RTC alarm or a GPIO interrupt. Sleep pauses execution of the program. Deep sleep pauses execution of the program and shuts down many internal functions. Off shuts down all internal functions and can only be woken by the RTC alarm or a system reset. The system will be automatically reset when exiting off mode.

7.19 Direct Memory Access

Low level device registers and memory can be accessed to further configure the G30's underlying processor. Not all functionality of the processor is available as some functions may be used or configured internally for use in NETMF.

7.20 Battery RAM

Battery-backed RAM is provided as part of the internal RTC. This memory retains its contents when the power is lost as long as there is a backup battery. There are 80 bytes of battery backed RAM available. Consult the processor's documentation for details on use.

8 Design Considerations

8.1 Required Pins

Exposing the following pins is required in every design to enable device programming, updates, and recovery:

- LDR0
- LDR1
- Desired debug interface(s)
- MODE if required to select a debug interface

8.2 Power Supply

A typical clean power source, suited for digital circuitry, is needed to power the G30. Voltages should be within at least 10% of the needed voltage. Decoupling capacitors of 0.1 µF are needed near every power pin. Additionally, a large capacitor, typically 47 µF, should be near the G30 if the power supply is more than few inches away.

8.3 Crystals

The G30 requires an external 12 MHz crystal and associated circuitry to function. For the RTC to function, a 32,768 Hz crystal and circuitry are required. Please see the processor's documentation for advanced information.

8.4 Interrupt Pins

Interrupts are only available on 16 pins at any given time. Of those 16 pins, the pin number must be unique. For example: PA1 and PB1 cannot both be used as interrupts at the same time, but PA1 and PB2 can.

8.5 Reset

The reset pin is not pulled in any direction. Designs must be sure to use an appropriate pull-up resistor.

8.6 Direct Memory Access

Most of the core processor's resources are used by NETMF. Some resources are permanently used, like the main system timer while others are used when specific features, like the timers for PWM, are enabled. Used resources can change from one firmware version to another so care must be taken when using these resources through RLP or other direct memory access methods.

When absolutely required, applications can use resources in conjunction with NETMF. For example, creating a special baud rate, utilizing the timer capture feature, and making use of many other features supported by the processor. Please contact GHI Electronics's consulting services to determine exactly what resources are available and if the G30 can fulfill the specific requirements.

9 Legal Notice

9.1 Licensing

The G30 SoC, with all its built-in software components, is licensed for commercial and non-commercial use. No additional fee or licensing is required. Software, firmware, and libraries provided for the G30 SoC are licensed to be used on the G30 SoC only.

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10 Revision History

Revision	Date	Change
1.0	2015-11-12	Initial release.

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