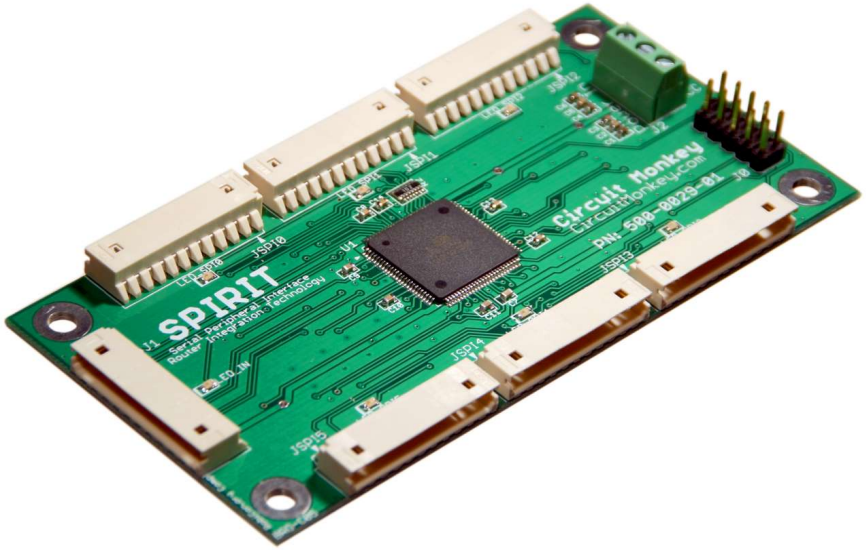
Circuit Monkey

500-0029-01

SPIRIT™

CPLD Based
SPI Networking Board
Rev. A

User Guide



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Illustrations and photographs by Mark J Koch and Nyles Nettleton
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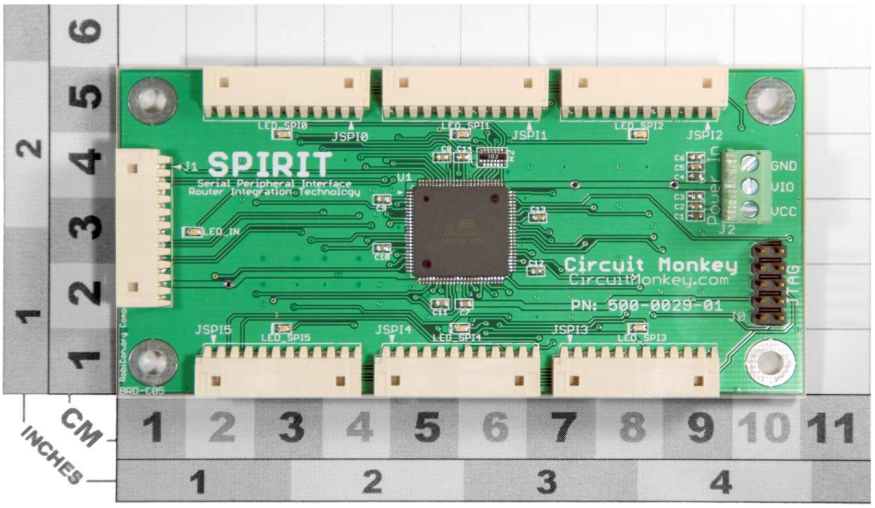
Overview

Circuit Monkey [http://circuitmonkey.com] presents part number ***500-0029-01***, a SPI networking board that allows a single SPI master port to control many SPI slaves without the overhead of many select lines or decode logic. Individual, group and full broadcast modes of communication are available, with the ability to connect multiple SPIRIT boards in a hierarchical network to provide additional connectivity. Each slave port includes an interrupt/attention pin to allow timely communications with the SPI master.

The Input/Output signals on SPIRIT are connected using the *Molex 53015 (MicroBlade)* series for reliable and vibration resistant connections. These connectors are *RobiCon.org* compliant. The board is 100mm x 50mm and features four mounting holes placed on a 90mm x 40mm mounting grid. The holes are plated and connected to logic ground and accept screws of size M3 or less *(M3, 6-32, M2.5, 4-40, etc.)*.

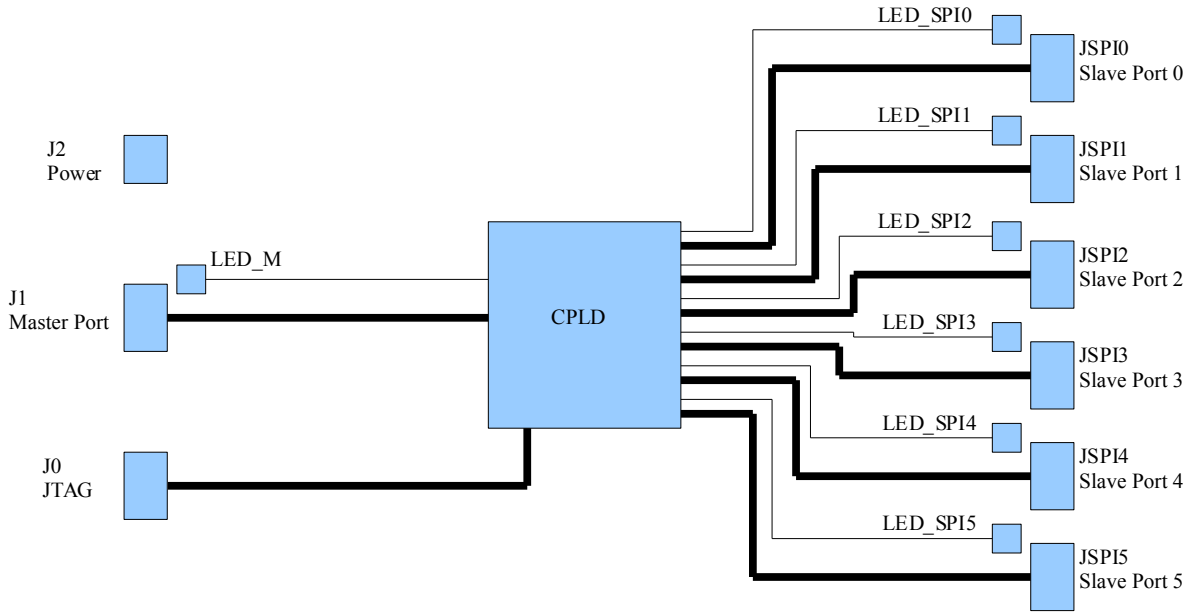


Features

- One master SPI port.
- Six slave SPI ports.
- Cascade-able networking.
- Indicator LED per port.
- Core supply voltage: VCCint = 5V +- 5%.
- I/O supply voltage: VCCio = 3.0-5V.
- Operating Current: Icc=110mA(avg) / 180mA (max).
- Per I/O Pin Current: 32mA (max).
- Max Chip Current: VCC-GND: 250mA (max)
- RobiCon.org compliant (Molex MicroBlade) connectors for all I/O connections.
- High current terminal block for power connections.
- RobiCon.org compliant board outline and mounting.
- 100mm x 50mm (WxD).
- JTAG programmable, for the CPLD developer.

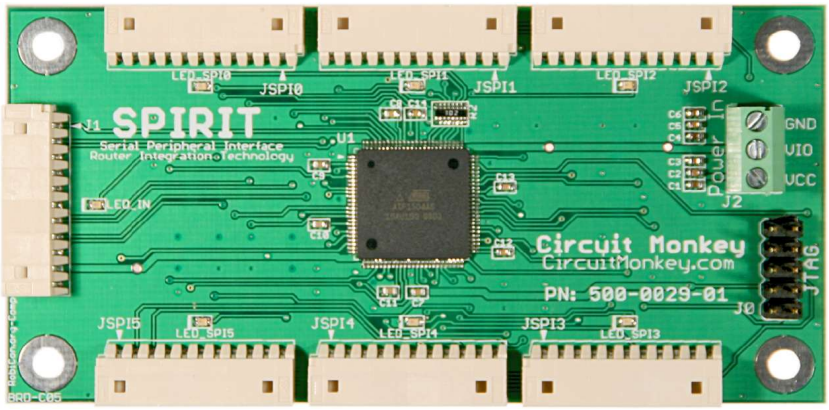
Block Diagram

A block diagram representing the SPIRIT board is shown below:



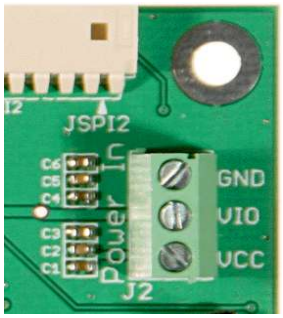
Connectors

The top view of SPIRIT is shown below:



From the upper left, clockwise are the connectors JSPI0, JSPI1, JSPI2, J2, J0, JSPI3, JSPI4, JSPI5 and J1.

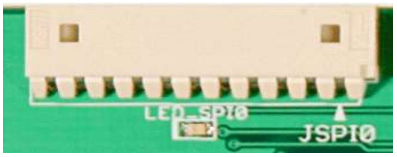
Power Connector (J2)



The power connector (J2) for SPIRIT utilizes screw terminals in order to provide at least 500mA to every SPI port, simplifying system power routing. The pinout for this connector is as follows:

Pin	Function
1	VCC: 5V
2	VCCio: 3-5V, normally jumpered to VCC
3	GND

SPI Port Connections (J1 and JSPI0~5)



There are seven SPIRIT SPI ports on the board, one master (J1) and six slaves (JSPI0-5). This allows a 1:1 pinout on cabling when connecting multiple levels of SPIRIT network hierarchy. The pinout of all these ports follows:

Pin	Function
1	INT: signalling from slave to master
2	M0: Mode 0
3	M1: Mode 1
4	n/c
5	GND
6	SS: negative true select
7	MOSI: Master Out, Slave In
8	MISO: Master In, Slave Out
9	SCK: Serial Clock
10	VCCio

11	GND

INT, M0 and M1 are additional protocol pins used for controlling SPIRIT, which will be described in a later section.

JTAG (J0)

The JTAG (J0) connector has a ByteBlaster compatible pinout that allows reprogramming of the CPLD in circuit. Instructions on how to set up an inexpensive programming interface will be put forth in an additional document.

Indicators

The SPIRIT board features seven LEDs, each placed next to an SPI port connector. They are individually controllable from the master SPI port. They are named LED_M, which is associated with the master port, and LED_SPI0-5 which are associated with the slave ports.

Port Functions

The SPIRIT SPI ports act as normal SPI ports with additional function bits INT, M0 and M1. This allows the SPI master to control a large number SPI ports with minimal hardware overhead on the control processor. The methods of operation for the SPIRIT ports follow.

SCK, MISO, MOSI

These are the core SPI pins, and are treated in the normal manner.

A very good introduction to SPI can be found at:

http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

SS

This negative true signal has additional meaning to SPIRIT beyond the normal SPI behavior; the trailing (rising) edge of *SS* causes register latching and state machine progression. It is recommended that the methods, tips and tricks described for port operation be adhered to closely. This is also true in dealing with many types of SPI slave devices; what works for one isn't any guarantee that it will work for the next.

Mode Bits

The two mode bits M0 and M1 define four operating modes for the master SPI port:

Mode	Function
0	Port select and downstream mode
1	LED data
2	INT probe
3	Passthrough to selected port(s)

Port Select and Downstream Mode

When mode bits, M1 and M0, are in any other mode than 00, the Mode 0 state machine is reset. This prepares it for operation for the next usage of Mode 0.

Setting Mode 0, followed by two bytes transmitted on MOSI, load the Select and Xmode registers (in that order). Each byte transmitted must have its own instance of SS in order for the Mode 0 state machine to operate properly. The contents of the two registers follow:

Bit	Select Function
0	Select slave port 0
1	Select slave port 1
2	Select slave port 2
3	Select slave port 3
4	Select slave port 4
5	Select slave port 5
Bit	**Xmode Function**
0	Slave port M0
1	Slave port M1

In the INT Probe and Passthrough modes, the select bits determine which slave port is active. Xmode data is always active, driving directly to all slave port mode bits.

LED Data

The LED Data mode operates in a simpler manner than Port Select, in that there is no internal state machine to reset.

While in Mode 1, bytes sent via SPI set the seven bit LED Data register. The bit definitions follow:

Bit	LED Data Function
0	LED_SPI0 (Slave Port 0)
1	LED_SPI1 (Slave Port 1)
2	LED_SPI2 (Slave Port 2)
3	LED_SPI3 (Slave Port 3)
4	LED_SPI4 (Slave Port 4)
5	LED_SPI5 (Slave Port 5)
6	LED_M (Master Port)

Setting a bit to 1 lights the corresponding LED on the SPIRIT board.

INT Probe

The INT Probe mode, when set (10), uses the mask bits in the associated INT Mask register to enable the passthrough of the INT signal to the master port. This enables the identification of the source without needing to directly query the source of the INT signal.

Since it is possible for multiple sources to be asserting the INT signal, it may be simplest to

simply walk a 1 across the 6 select bits. Knowing which ports can or can not assert INT can also shorten the query cycle.

The INT Mask register is set when a byte is sent via SPI during INT Probe mode. The bit definitions follow:

Bit	INT Mask
0	Enable passthrough of INT on port 0
1	Enable passthrough of INT on port 1
2	Enable passthrough of INT on port 2
3	Enable passthrough of INT on port 3
4	Enable passthrough of INT on port 4
5	Enable passthrough of INT on port 5

Passthrough to Selected Ports

In Passthrough mode (11), SPI operations are passed through to the selected port(s). Note that return data is ORed, so reading data from multiple sources simultaneously will result in garbage data. Selecting multiple ports is likely to be mostly useful in transmit-only type operations, such as synchronizing the operation of multiple slave devices.

INT

The INT signalling system is a mechanism enabling slave devices on the SPIRIT network to assert asynchronous, real-time notification to the master port. The associated mask registers both enable the master to selectively enable only the ports of interest, but to rapidly probe the INT network to identify the source of the notification(s).

Ideally, the INT input to the host driving the master SPIRIT port is routed to an input that can be configured to generate an interrupt on assertion (negative true) of the line. This enables the most timely response to notifications, enhancing system performance in many situations.

Applications

Nymph UART SPI to SPIRIT Cable

The cable to connect a Circuit Monkey Nymph controller to SPIRIT uses 11 and 14 pin RobiCon connectors:

SPIRIT Connector Pin	Nymph Connector Pin	Color	Function
1	10	white	INT
2	6	yellow	M0
3	8	green	M1
4	n/c		
5	9	black	GND
6	5	white	SS
7	2	yellow	MOSI
8	1	green	MISO
9	7	blue	SCK
10	3	red	VCC
11	4	black	GND
12			
13			
14			

This cable connects Nymph J4 (14 pin) to the SPIRIT master port (J1). Note that power is connected between the two boards, so power can be supplied from either board.

Example Code

Setting Port Select and Slave Port Mode

```
SPIRIT_PORT &= SP_MODE_MASK;    // Mode 0 to top level SPIRIT
dbuf[0] = 1 << 2;      // Select slave port 2
dbuf[1] = 0;           // Slave mode 0
SPIRIT_Xmit(dbuf, 2);  // Send port select and slave mode
```

Setting the LEDs

```
SPIRIT_PORT &= SP_MODE_MASK;   // Clear mode bits to top level SPIRIT
SPIRIT_PORT != SP_MODE_LED;    // Mode 1 to top level SPIRIT
dbuf[0] = (1 << 4) | 1;    // Set LEDs for port 4 and 0
SPIRIT_Xmit(dbuf, 1);      // Send LED data
```

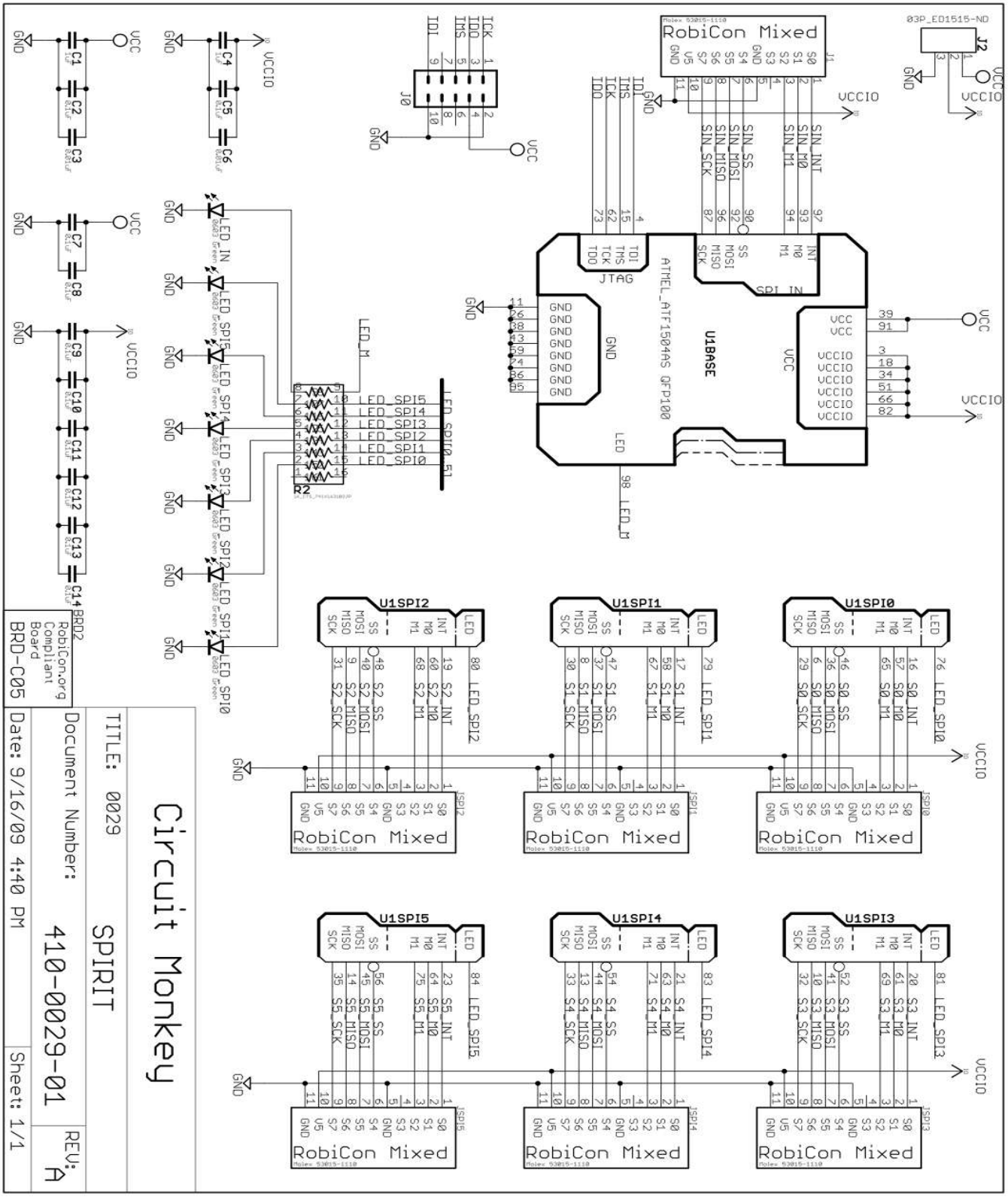
Setting the Interrupt Mask and Reading the INT State

```
SPIRIT_PORT &= SP_MODE_MASK;   // Clear mode bits to top level SPIRIT
SPIRIT_PORT != SP_MODE_INT;    // Mode 2 to top level SPIRIT
dbuf[0] = 1 << 3;        // Set INT mask to port 3
SPIRIT_Xmit(dbuf, 1);    // Send INT data

_delay_ms(0.001);           // Wait for the signal to propagate

int_state = !(SPIRIT_IPORT & SP_BIT_INT);
```

Setting Passthrough Mode and Sending Data to Slave Port

```
SPIRIT_PORT &= SP_MODE_MASK;   // Clear mode bits to top level SPIRIT
SPIRIT_PORT != SP_MODE_PASS;   // Mode 3 to top level SPIRIT
dbuf[0] = 0x32;          // Sending 0x32 to slave
SPIRIT_Xmit(dbuf, 1);    // Send INT data
```

Schematic


Circuit Monkey
TITLE: 0029 SPIRIT
Document Number: 410-0029-01
REV: A
Date: 9/16/09 4:40 PM
Sheet: 1/1
BRD-C05
RobiCon.org Compliant Board
U1BASE
ATMEL_ATF1504AS QFP100
JTAG
SPI_IN
LED_M
U1SPI0
U1SPI1
U1SPI2
U1SPI3
U1SPI4
U1SPI5
RobiCon Mixed
VCC
VCCIO
GND

Appendix A: References and Links

Downloads

Example Code

Example Code Download Links Go Here

Links

Circuit Monkey

http://www.circuitmonkey.com

RobiCon.org

A proposed open standard for Robotics Interconnect. Currently lead by the owner of Circuit Monkey.

http://www.robicon.org

Atmel

Manufacturers of the *AVR/ATmega* microcontroller and ATF1504AS CPLD chips.

http://atmel.com/dyn/products/product_card.asp?part_id=2126