Testing Rev 1 thru3 microcontroller board

Rev. 1/12/07

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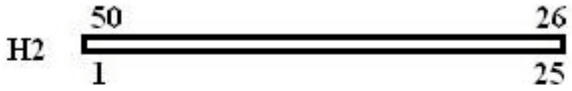
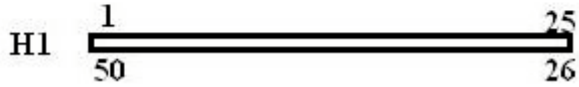
NOTES:

All references to modular jack pin numbers are as seen on the left looking into the cavity of the jack. A 6 pin connector is numbered the same from left to right.



And references to pins on the Adapt9S12 processor are numbered as on the right looking down on the board.



Ground tests

With a Volt/ohm meter, verify ground connections to the following using continuity check or very low resistance. Use the negative power input to the card as one end of the circuit.

Each module jack ground connection on pin 1.
Black wire of Adapt9S12 power jumper.

Power tests:

Remove Processor card, USB chip, rate gyro card and accelerometer card.

Apply 12 vdc (between 11 vdc and 14 vdc) to board power input.

With a voltmeter, measure voltage from ground to:

Red wire of Adapt9S12 power jumper. Should be 7.75 to 8.25 volts _____vdc

6 vdc bus (either hole to the side of the "+6" just above the 7806 regulator.)
Should be 5.75 to 6.25 volts. _____vdc

Power pin (4) on each RC module jack configured for RC servos (usually RC 4,5,6)
Should be 5.75 to 6.25 volts, same as 6 vdc bus.

Power pin (4) on each RC module jack configured for sonar use (usually RC0,1,2,3)
Should be 7.75 to 8.25 vdc same as 8 vdc bus.

Power pin for all other module jacks (except for Encoder jacks and motor jacks which have no power pin). Note that the 6P6C jacks use pin 6 as power, rather than pin 4.
Should be 7. 75 to 8.25 vdc, same as 8 vdc bus.

Pin 1 of rate gyro socket. Should be 4.75 to 5.25 volts. _____vdc
(note, if using 7 pin header for gyro, this is the end just below pin 1 of the 20 in dip socket)

Remove 12 vdc power.

Install Processor card, USB chip, rate gyro card and accelerometer card.

Apply 12 vdc power. The green light on the Adapt9S12 card should come on.

Measure voltage on pin 4 of Encoder module jacks ENC0,1,2.
Should be 4.75 to 5.25 volts. _____vdc

Signal tests:

The following tests are designed to test the wiring of the board. They do not generally test functionality. The tests are run using a program in the processor and a terminal hooked up to the processor RS232 serial port.

Many tests work by generating squarewave signals which can be measured at the modular jacks with either an oscilloscope or a voltmeter. The squarewaves are usually at 0.5 hz to make them testable with digital VOMs which may take awhile to settle on 0 or 5 vdc. The square waves are usually out of phase on adjacent pins to ensure that two adjacent wires are not shorted together.

Loading test software:

Connect serial cable to connector on side of Adapt9S12 board.

Apply 12 vdc power to the board.

Connect to a PC or laptop with a terminal emulator (e.g. HyperTerminal) and set up as follows:
Set to appropriate COM port
Set baud rate to 9600.
Data bits 8
Parity none
Stop bits: 1
Flow Control: hardware

Note: the following instructions demonstrate how to use hyperterminal to load software. You may use any other favorite terminal or the terminal included with the Imagecraft ICC12 compiler. Be sure to use a standard serial cable rather than a Null Modem cable.

Move the RUN/PROG switch to the PROG position. (handle to the right)

Press the reset button.

You should get the following on your terminal:
D-Bug12 Bootloader v1.0.0
(a) Erase flash
(b) Program Flash
(c) set baud rate
(d) erase EEPROM
?

Note: if you get the D-Bug monitor instead of the bootloader, you probably have the two Mode Select jumpers on the processor in the “0” position rather than the “1” position.

Note: Don’t try any of these options yet if you want to play with the D-Bug monitor which comes installed in the Adapt9S12. If so, now is your chance. You can see it by moving the switch to the Run position and hitting reset. When you install your robot code, it will overwrite the monitor. The monitor can be reinstalled later if you want. The manual for the monitor can be downloaded from Motorola’s website.

On the other hand, I don't use the monitor. Before going on to the rest of the testing, you will have to install the latest version of the microcontroller wiring test code.

Installing microcontroller code:

With the bootloader menu displayed,
Hit "a" (make sure the cursor is on the terminal)
After a few seconds (less than 5), the menu will be printed again.
Hit "b"
Go to Transfer on the top menu, select "Send text file".
Set the "Files of type" window to "All files".
Browse to find the Wiring test .s19 file.
Hit "Open" to download the .s19 file.

Hyperterminal seems to do this quite slowly. About 8 minutes compared to 1 1/2 minutes for the Imagecraft terminal. You may find some better settings.

There will be about 10 1/2 lines of asterisks and then the menu will be written again.

This completes programming.

Change the baud rate on your terminal to 115K.

You may have to create a new connection for 115K. I did, but then I'm no expert on hyperterminal.

Move the RUN/PROG switch to the run position and hit reset.

You should get a new menu labeled "Robot Controller Wiring Test Program" with 8 selectable tests. Just press a number key to get a test. Then when done, hit Esc to return to the menu.

Test analog inputs:

Note: this test is easier if you prepare a simple test tool which will verify the power, ground and signal on each analog input. (see picture at end)

Install a 4P4C (handset) modular plug onto a 6 inch piece of cable. The "standard" cable has the black wire in the pin # 1 position
Strip the wiring on the other end back about 1.5 inches.
Hook two 10K resistors together by twisting their leads together at one end.
Solder the common twisted end to the red modular wire.
Solder one resistor end to the yellow wire, and the other to the black wire.
(this forms a voltage divider which applies about 4 vdc to the analog input pin)

Press "1" on the keyboard to select the "Analog input values" test.

A set of 8 values should print across the screen every 0.5 seconds. These are the readings of the ATD converter representing the inputs from IR0 – IR7. The numbers will be random with no input signals applied.

Insert the test tool into each of IR0 to IR7. The screen display for that input should go to a fixed value which will probably be in the range of 800 to 1000. As you move the test tool to each input, the value should come out the same (+/- 1). In each position, check that that none of the other readings changes to the same value indicating a short. Record the values below for each jack as it is tested:

IR0	IR1	IR2	IR3	IR4	IR5	IR6	IR7
_____	_____	_____	_____	_____	_____	_____	_____

Note: A relatively low resistance path between two adjacent signal inputs may cause an adjacent readout to go to the same value. If this occurs, place a 10K resistor from the adjacent signal input to ground. If the two inputs now read properly (the 10K should go close to zero), your board should be OK. Or, you could clean up the solder flux in the area and see if it helps.

When done, hit “Esc” to return to menu.

(note: the test tool supplies about 4 volts and the ATD reads 0 to 5 volts reporting data of 0 to 1023. Hence a perfect 4 volts should read 818. However, my tool supplies 3.95 volts and the ATD reads 916. So that’s why we have to calibrate signals. Interestingly, both boards I have build read 916, so it appears that the ATD range is really up to about 4.5 vdc.)

Test Yaw Rate Gyro

This is a test that reads the rate gyro output.
Press 2 on the menu page to select.
With the board still, a value of around 1800 should be printed (value non-critical) _____

Pick up the board holding it leveland rotate it counterclockwise at about 20 degrees/second for a few seconds.

A lower value should be printed. _____

Rotate the board clockwise for several seconds. A higher value should be printed. _____

When done, hit “Esc” to return to menu.

Test Motor outputs and encoders:

Note: remove jumpers for RC motor selection (if installed).

From test menu, hit “3” for Motor test.

For MOT0, 1 and 2, measure the voltage on pins 2,3 and 4. Each should be cycling between 0 and 5 vdc at about a 0.5 hz rate.

For ENC0, 1 and 2, measure the voltage on pins 2 and 3. Each should be cycling between 0 and 5 vdc at about a 0.5 hz rate. EXCEPT for pin 3 on ENC2 which can’t be driven up and down; it should be at about 5 vdc.

When done, hit “Esc” to return to menu.

Accelerometer:

From test menu, hit “4” for Accelerometer test.

With board level on table, the two values printed should be between 5000 and 8000. _____

Tilt the board forward 90 degrees until the “bottom” of the board is pointed straight up.
The second reading should decrease by about 1500 counts. (exact value is not critical, maybe +/- 20%)

Return the board to level.

Tilt the board to the right 90 degrees until the “left” side of the board is pointed straight up.
The first reading should decrease by about 1500 counts.

Return the board to level.

When done, hit “Esc” to return to menu.

Sonar/RC servo ports

The sonar/RC ports use two signal wires. Normally, one is an input and one is an output. This test outputs a cycling signal to each output wire. While the signals may look similar on a scope, they are out of phase such that shorts are likely to cause an observable problem.

The test is performed by applying a short between the two signal wires at each module jack. This can be done by making a simple test tool, like the one for analog inputs, except with just the red and green wires twisted together. (see picture at end) Or just use test probes to make the short; but if you do, don't short the output pin to the power (+5) pin!

The screen will display 6 columns of data representing the port RC0 to RC6 input wires. The data is updating at 61 hz. With a module port empty, the data will generally be 0, although you might see exceptions since an open wire may pick up noise

Applying the short to each jack should give results as follow:

RC0 cycles between values of 0 and 8 (at about 1 1 hz rate)
RC1 cycles between values of 0 and 16
RC2 cycles between values of 0 and 32
RC3 cycles between values of 0 and 64
RC4 cycles between values of 0 and 1
RC5 cycles between values of 0 and 2
RC6 cycles between values of 0 and 4

With the short applied to RC6, measure that the pad beside H2 pin 48 is NOT cycling. Note that pin 48 is the LEFTMOST pad, not the third from the left.

DIO ports

This test places the DIO pins all in output mode and cycles them at about a 1 hz rate.

You can build a test tool using a 6pin modular plug and a header strip (similar to that suggested by Gary Malolepsy below), or just measure directly to pins 2 through 5 of the jack.

Measure the voltage to each of the 12 (pins 2 – 5 on DIO 0,1,2) and verify they are transitioning up and down.
Check pin 2 of the I2C port to verify it is NOT transitioning.
Check pin 2 of the IR7 port to verify it is NOT transitioning.
Check pin 2 of the RC4 port to verify it is NOT transitioning.

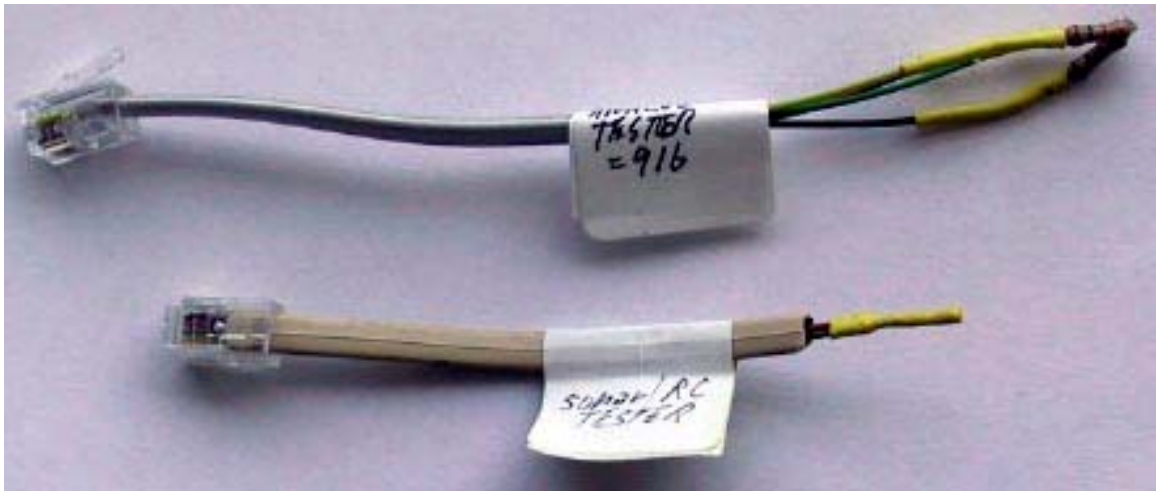
SPI and I2C ports

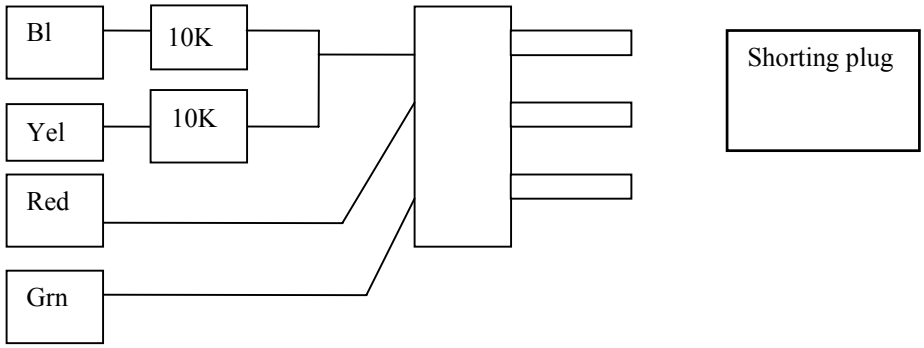
Same as above, the 4 SPI pins and the two I2C pins (pins 2 and 3) should be cycling at 1 hz.

External Reset Header and RUN/PROG switch

Set terminal baud rate to 9600 and the RUN/PROG switch to the program position.
Short the two reset header pins together momentarily. The boot loader program should appear each time.
Set the terminal baud rate to 115K and the RUN/PROG switch to the run position.
Short the two reset header pins together momentarily. The "processor is running" message should be printed each time.

Test Tools:





Gary Malolepsy suggests making a single test tool like the above which can be converted from an Analog tester to an RC/sonar tester just by moving a jumper.