Butterfly Real-Time Tester

1. Table of Contents

1. AVR Butterfly evaluation kit

The AVR Butterfly Evaluation Kit is a small device that can be seen in Figure 1. It has a LCD screen, 5-direction joystick etc. It has a programmable ATmega169 µC that controls the different resources on the device.

AVR Butterfly user guide: http://www.atmel.com/dyn/resources/prod_documents/doc4271.pdf.

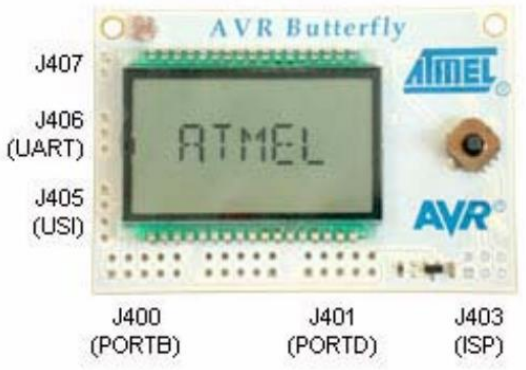


Figure 1: AVR Butterfly

2. Introduction to Butterfly Real-time tester

The Butterfly Real-Time Tester (BRTT) has been developed for the student exercises of TTK4147 in NTNU, Norway. The tester uses the small and inexpensive AVR Butterfly kit, and can test different aspects of the real-time properties of a target computer system. The BRTT is connected to its target using general 5V digital I/O channels.

All the tests done by the BRTT are through I/O. It doesn't only measure the internal delays in the target but also the delays from the I/O. This makes the results good indications for how the actions of the target system are perceived from the *real world*.

3. Reaction test

The reaction test is used to find how fast a target system can react to I/O signals. This is an important property for real-time system as they are often required to react quickly to events in the real world.

A test consists of a number of subtests. During a subtest the BRTT sends between one and three signals at the same time. After the target has responded to all the test signals sent by the BRTT, it will send the results on a serial connection to a computer. This is described in 0.

3.1. Parameters

There are three different parameters for a reaction test. These can be selected using the menu system described in 4.4.

Type:

The type parameter decides which signals are sent during one subtest, for more information about the signals see 4.1. The different types of tests are like follows:

Test type	Test signals sent by the BRTT	Response signals sent from the target
A	Test A	Response A
A+B	Test A and Test B	Response A and Response B
A+B+C	Test A, Test B and Test C	Response A, Response B and Response C

The test signals are simultaneously sent from the BRTT. The target should listen for each of these signals, and when it receives a test A signal it should answer with a response A signal, and the same for B and C. The target should ONLY send the response signal responding to the test signal it receives, or there is no point using multiple signals.

Number:

The number parameter decides how many subtests that should be done during a test. The more subtests the longer it will take to perform the test, but the results will be a bigger dataset useful for further analysis.

4. Using the Butterfly Real-Time Tester

4.1. Connecting it

Port B on the Butterfly is used during real-time tests. This is a 5x2 header connector that is described in Figure 2. Depending on the type of test to perform some of these must be connected to the I/O device on the target system.

Test signals:

The test signal pins should be connected to the targets digital inputs. They are used to send a test signal to the target during a reaction test. Depending on the type of test a signal will be sent on either A, A and B or all. The test signals will be sent at the same time.

The voltage level on this signal is normally high, and is pulled low by the BRTT when sending the signal.

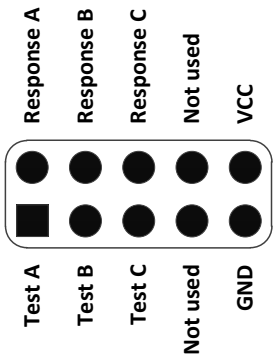


Figure 2: Connector to BRTT (Port B)

Response signals:

The response signal pins should be connected to the targets digital outputs. During a reaction test the target should return any test signals with the same response signal. During a timer test the target should send response A signals periodically.

The voltage level on this signal is normally high, and the target should pull it low when responding to a test signal. The BRTT reacts to a falling flank.

GND:

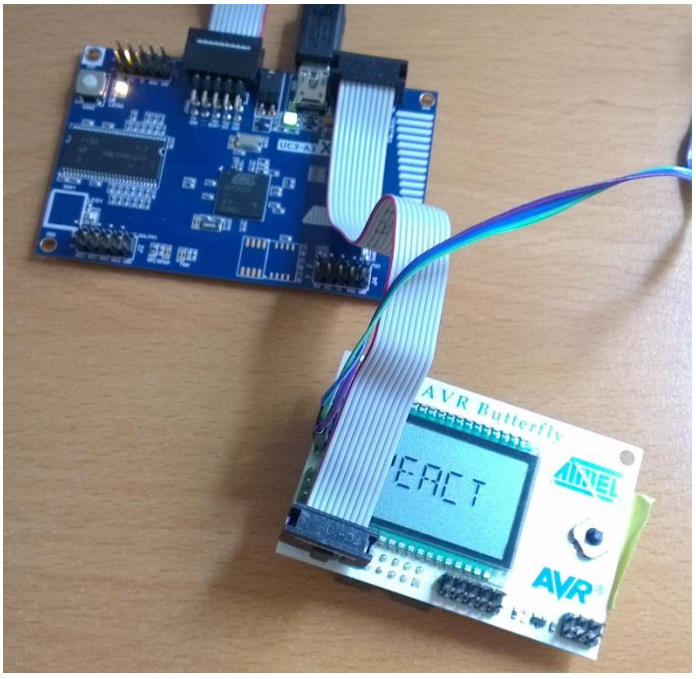
To work the GND must be connected to the signal ground of the target.

VCC:

The Butterfly can be powered through this pin if connected to a 3V – 5V power source. The Butterfly uses very little current, so almost any source should suffice. If the Butterfly is powered from another source, then this pin should not be connected.

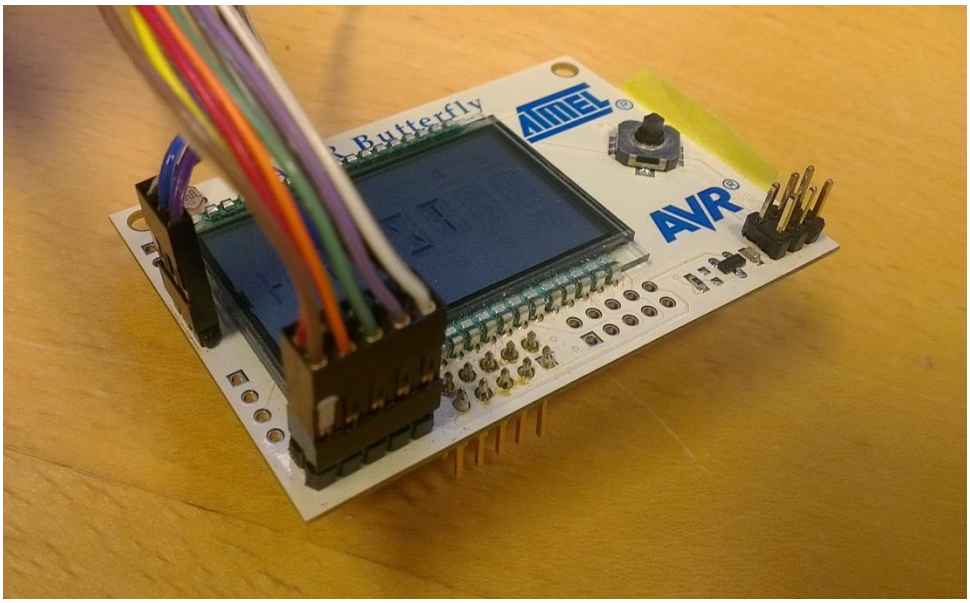
4.2. Connecting it to AVR32 UC3-A3 xplained card

The BRTT is connected to the AVR32 UC3 card as follows:



4.3. Connecting it to the real-time lab computers IO card

The BRTT is connected to the real-time lab computer as shown in the image below. Notice the position of the white dot of the header.



4.4. Using the menu System

To select parameters and start tests the BRTT has a simple menu system. The user can navigate between the different parameters and tests by moving the joystick up or down. To change a parameter, move the joystick right or left until the desired parameter value is shown in the display. The new value is automatically saved when the joystick is moved up or down to another parameter.

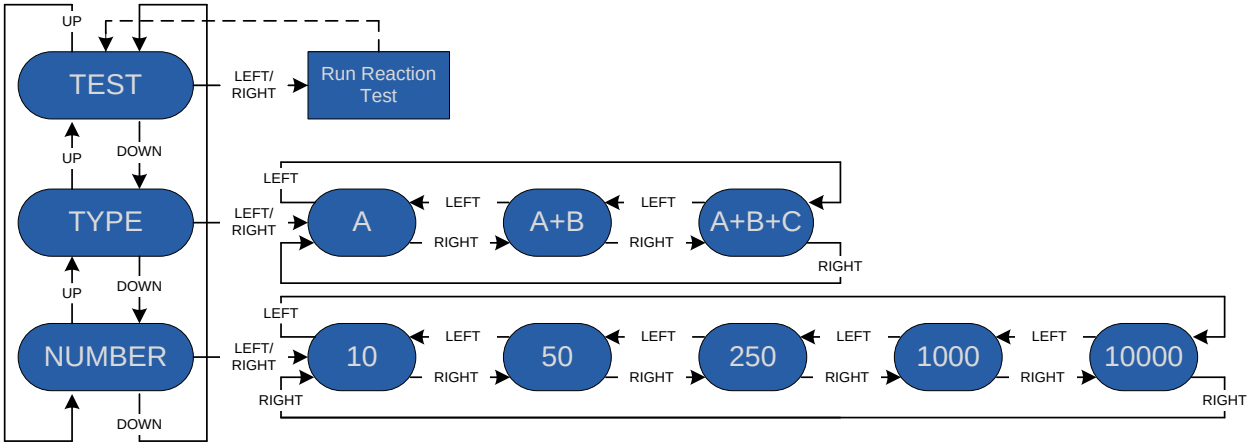


Figure 3: Menu structure

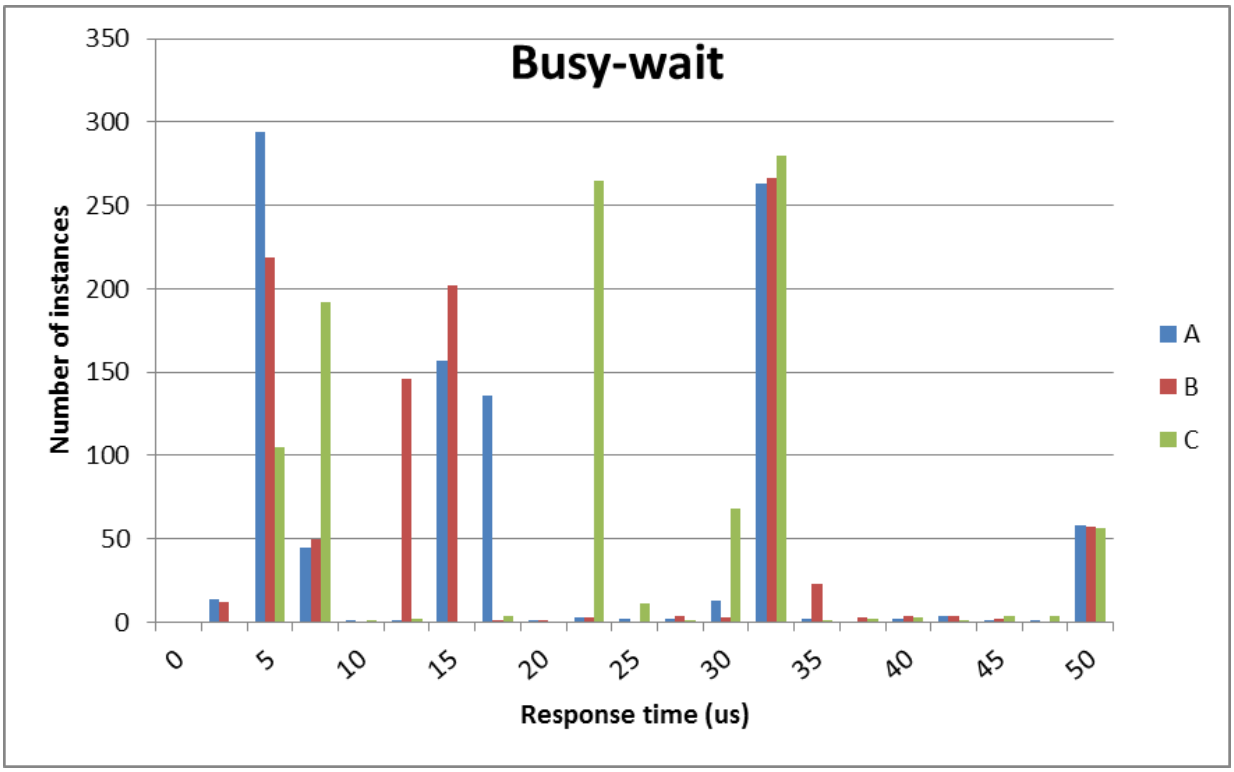
When the LCD is displaying “TEST” the reaction test will be started if the joystick is moved left or right. For the duration of the test the LCD will display “------“, to indicate that the menu is unavailable.

In Figure 3 the whole menu structure is shown and how to navigate in it.

4.5. Getting results

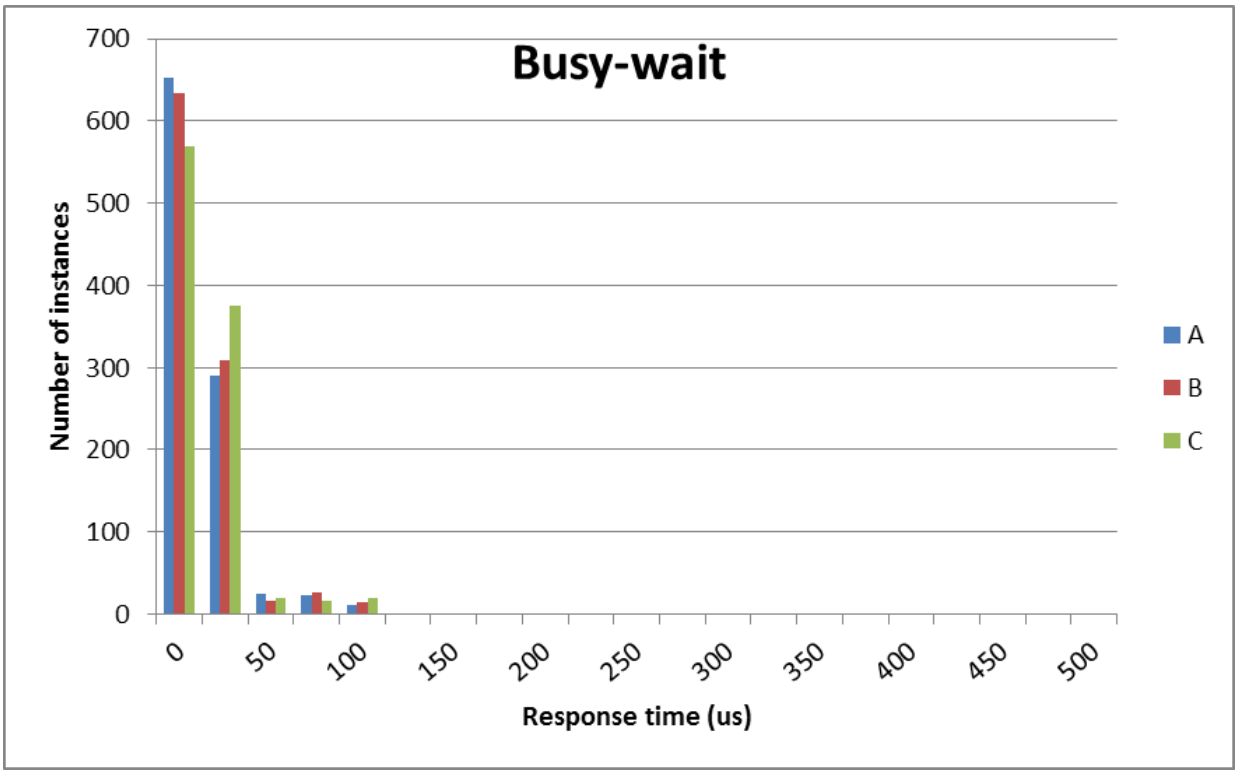
To get the results of a test the BRTT must be connected to a computer with a serial connection (RS-232). Since the Butterfly does not have a dsub-9 connector, so a special cable that connects to the UART pins on the Butterfly must be used.

The computer must have a serial console to view the log. The results can be viewed directly in the serial console or it can be copy-pasted into the BRTT result spreadsheet. It will then show a graph like the one below:



Here we can see the results from an A+B+C test. The bars are showing the distribution of the response time of the different tests. We can see from this graph that the response time varies quite a lot. Often the system responded within 10 us, but there are also many around 30-35 us.

The quite high bar at 50 us indicates that these results all have higher than 50 us response time. Using the select scale function on the spreadsheet, we can find out that these results have response times up to above 100 us. The same results with another scale are shown below.



4.6. Troubleshooting the BRTT

If your butterfly is giving strange results, it can be difficult to tell whether it is due to a problem with the butterfly itself, or the code you are using. If you are experiencing problems that you suspect is because of the butterfly, you can test it with the `brtt_tester` tool provided on it's learning. You must connect the BRTT to the computer (shown in 4.3), boot Ubuntu and run the program. The results should be in the range between 0 and 5 ms. If your butterfly does not work with this test, ask the student assistants for a replacement.