Record Function combined with advanced Triggering on Rigol DS4000 Series Oscilloscopes

In the last years the automatically decoding of serial data busses has been established to a standard function which can (still) optionally be added to your oscilloscope. The times where each bit has to be read out manually from the Scope display and then the bus message has to be built up are, thanks to the bus decoding options, gone. Further on the triggering on the decoding level is now possible. There are a lot of different possibilities selectable. For example Triggering on the Packet data, on Addresses or on Errors can be done. This enables the user to have a look only into the specific events without the need to monitor or record masses of data packets. The combination of the 'Record-Function', a standard built in function, which adds intelligent memory management on Rigol Scopes, and the Triggering and Bus-Decoding the optimum usage of the resource memory.

What is behind the so called Record-Function and how could this function be used in an efficient way in your daily work also without the need of bus decoding?
In the following the basic principle of the record function should be explained and clarified with an example application. Subsequent to this the Bus analyzing function and the record function will be combined. This will also be shown with the help of an example.

Imagine a clock signal which contains from time to time an unwanted glitch. The error could be a Runt or maybe a spike. This unwanted behavior should be found and analyzed, for example how often this spike occurs and how high is the peak voltage and which pulse width it has. What is a convenient way to solve this task? There are more possibilities available how to act. The simplest but also the most time consuming way is to acquire a long time period and afterwards zoom into the signal and scroll manually thru the whole sequence and look after the disruption. The challenge is that if the error is only a short peak the sampling rate must be high enough to be able to catch the spike. But if you work with high sample rate you need to have a large memory depth to be able to acquire a long enough time period.
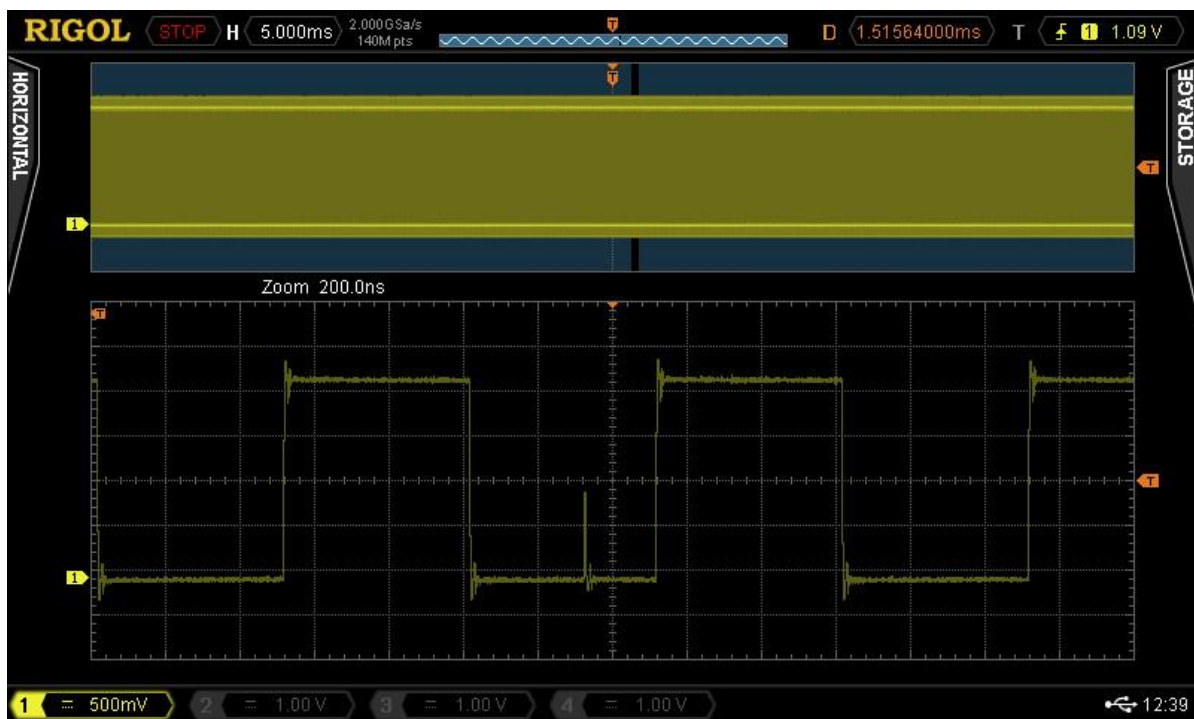
A different possibility is offered with the usage of the Record-Function which is built in the Rigol Scopes. This at least helps to save time by doing the error search automatically. With this method also a long time period is recorded. The difference is that no only one long „single" shot is taken, but multiple single shots with shorter time base and many details are saved subsequently. Now it is possible to define a „good"-mask and perform a pass/fail test throughout all recorded data. At the end all "fail" positions are marked red and can easily to accessed and analyzed. With the help of time stamps and the overall view it is possible to see how frequent the errors occur.
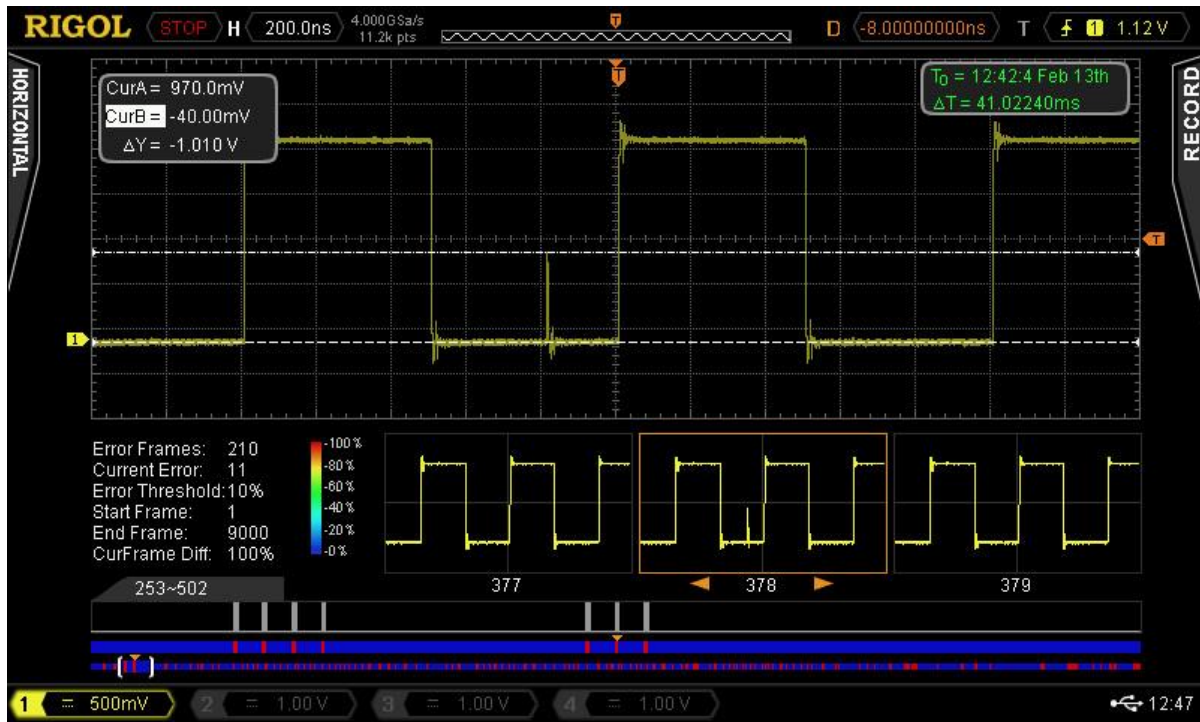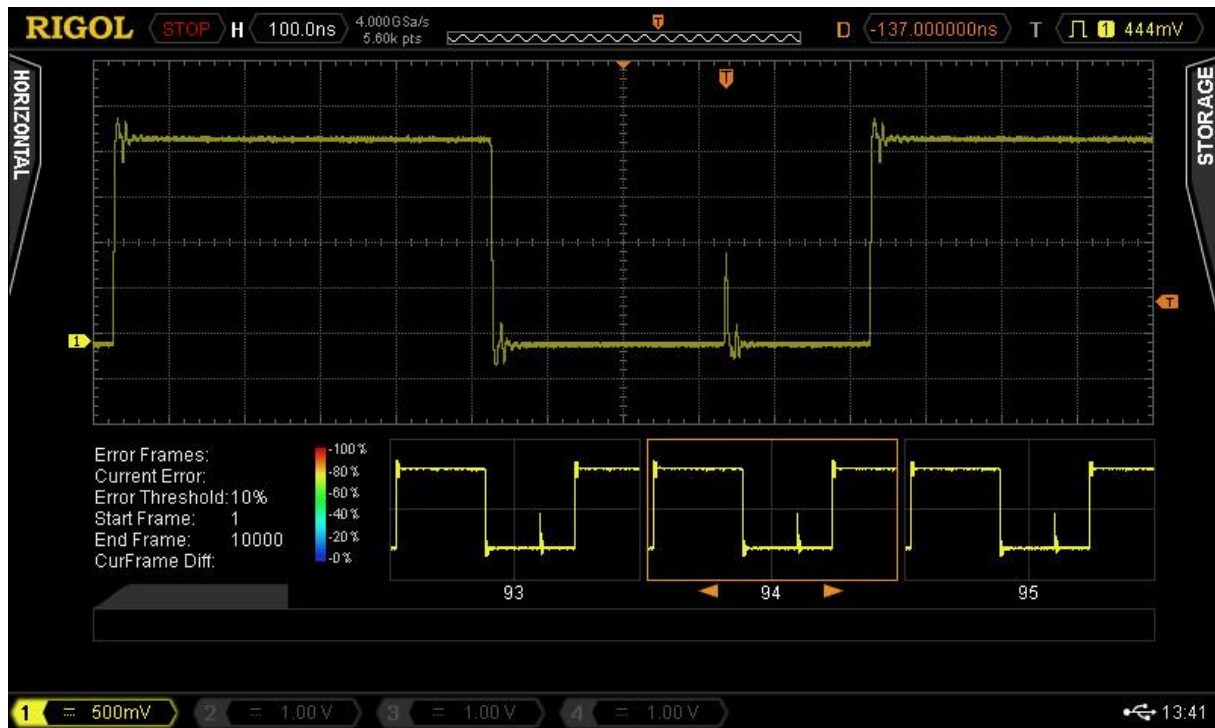
The third and most advanced alternative is the combined usage of the record function and the available trigger functions. The oscilloscope can be configured in that way, that only the error is recorded. Depending on the frequency of error occurrence and time base settings it is possible to monitor the signal and record the errors up to hours.

A small disadvantage is that the information how much time between errors is, will be lost. The main advantage is that the available memory is not wasted by saving signal parts without any anomaly. On the other hand the "interesting" signal parts are acquired with maximum sample rate. Offline analysis can be done directly on the scope. For example automatic measurements with measurement history can be added and displayed in play back mode. Of course the data also can be downloaded to and analyzed on the computer.

Also a very common application for oscilloscopes is the serial bus analysis. Nowadays serial busses can be found in almost every part of the technical world. The LIN/CAN or FlexRay Bus in the Automotive Industry, I2C in. A given task could be to analyze the traffic from the controller to a certain slave for example in the I^2C Bus. Example architecture could be like in the following schematic:
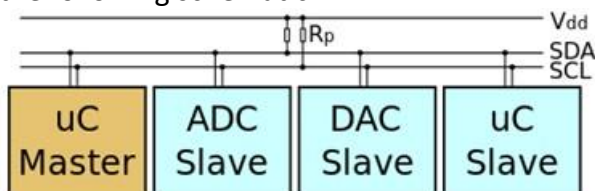
The member selection at I^2C Bus is realized with the existence of an address section which is transmitted in the data package, not as hardware selection line like at the SPI Bus (called Chip Select or Slave Select). To filter out and monitor only the messages of one specific

member it is necessary to have the possibility of doing something like a pre-selection. The „simplest" way is triggering on the address part of the data. In the meantime modern Oscilloscopes offer this functionality. Most Scopes have only to be equipped with the corresponding option. Rigol Oscilloscopes from the DS2000, DS4000 und DS6000 Series do already have the bus trigger option as standard included.

The following screenshot shows a message which was send to the member with the address 16 (in hexadecimal 0x10). There is also a possibility of choosing whether you would like to see only Read or only write or both data traffic directions.
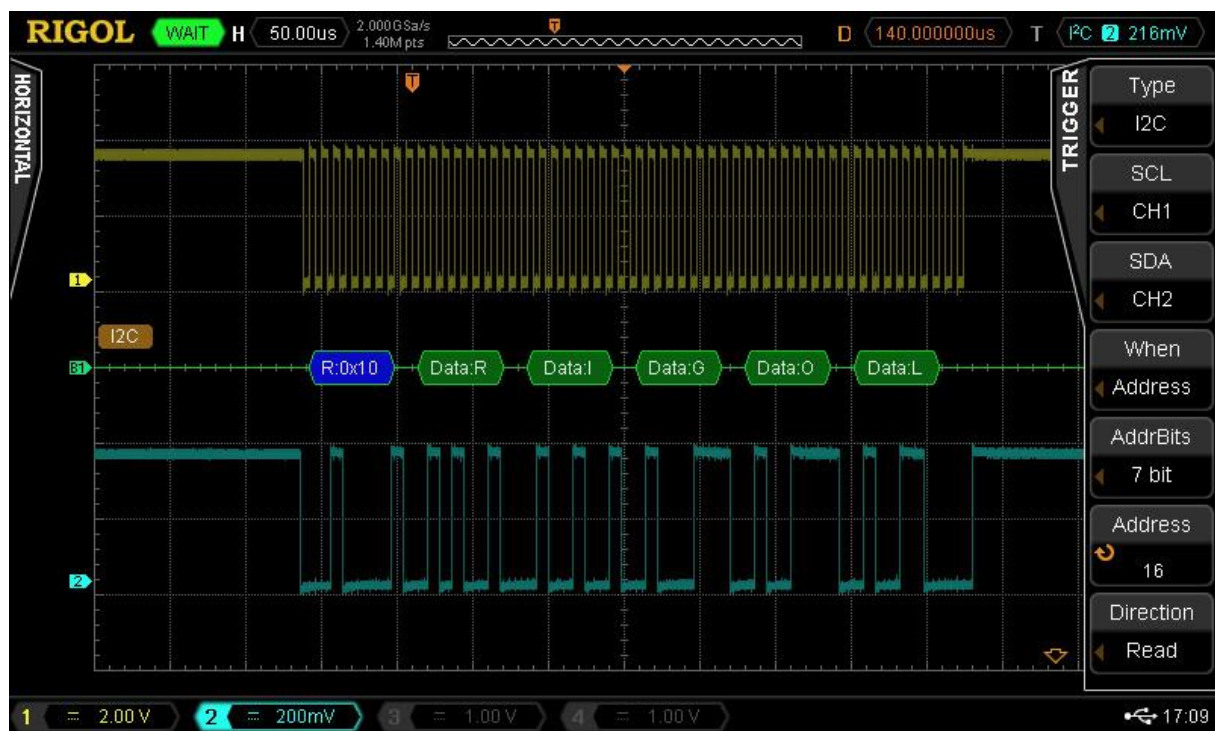
The screenshot above shows a single decoded message. The data traffic on the bus could be high so that the time between the messages between master and slave with address 16 could be very long. How can it now be achieved that the messages between Master and „Slave 16" are separated and being displayed in a compact manner, without the need of sorting out many of not wanted messages by hand?

The solution could again be the Rigol Record-Function. This offers a simple and effectiv way without adding extra costs.

As already explained and demonstrated above the bus trigger will be used. In addition to this setup, the Record-function will be activated. The trigger has to be set to Normal mode, because it has to be avoided that the trigger starts automatically, if a certain time no valid trigger event occur, as it will happen in Auto mode.

After the activation of the Record-Function only messages with the valid trigger event (address no. 16) will be recorded. Every message between master and slave is stored separately in the memory. When the memory is filled up or the acquisition is stopped it is possible to change to the Playback or the Analysis Mode. Within this you can scroll to all messages frame by frame and see the decoded data.
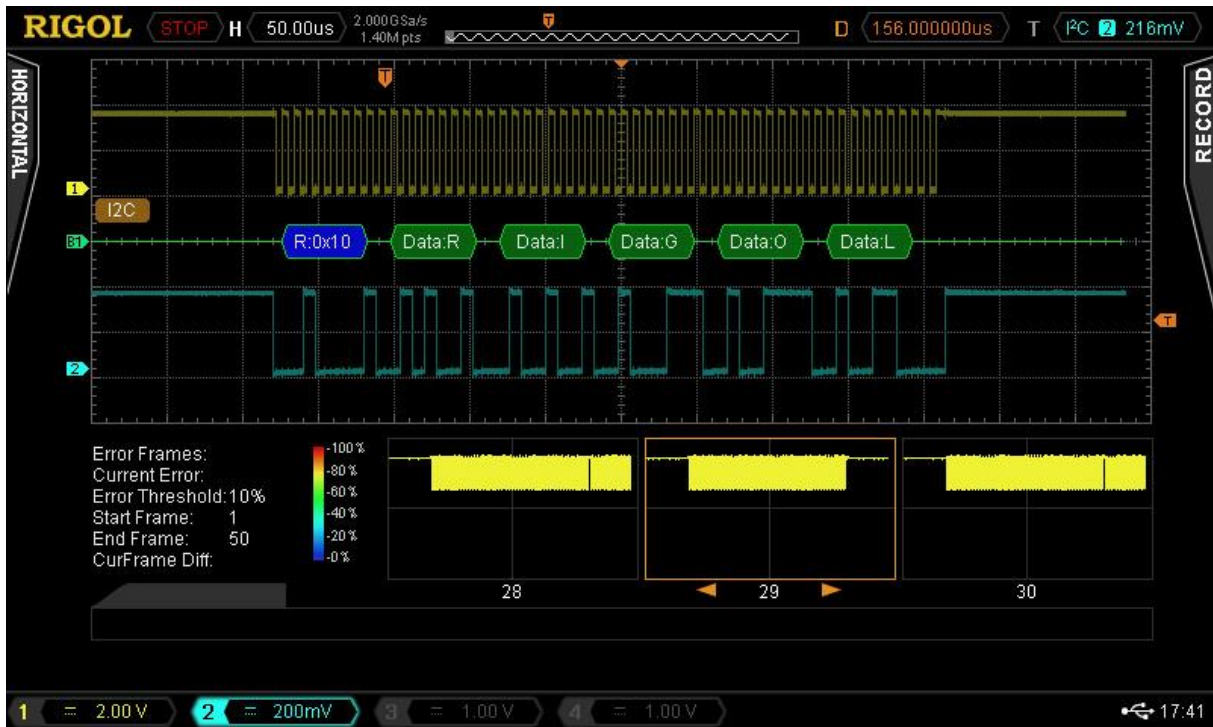
This function is not only usable to separate the data traffic on serial busses with addressing , it can also be used to locate errors in data transmissions. Depending on the bus it is also be possible to trigger directly on error frames and record the corresponding frame and analyze it afterwards and solve the issue.

The Record Function combined with the advanced trigger functions provide a huge number of analyzing possibilities and could help in different cases to make the work more easy or to find and solve errors more quickly.