iC227

DUAL 11 GHz SAMPLING OSCILLOSCOPE

preliminary

FEATURES

Dual 11 GHz DC coupled inputs
50 Ω inputs
Optically isolated full speed USB interface
Intuitive graphical PC software interface
Low cost

APPLICATIONS

High-Speed Sampling
Oscilloscope for periodic signals

BLOCK DIAGRAM

DESCRIPTION

The iC227 is an 11 GHz bandwidth Sequential Sampling Oscilloscope.

The 4 SMA inputs and 2 SMA outputs all have 50 Ω impedance and are DC coupled.

The small, portable hardware package connects to a PC via an optically isolated full speed USB interface for PC protection and eliminates effects of noise from the USB bus and PC ground.

All device control and monitoring is managed via an intuitive graphical PC software interface. The use of small package high speed ECL components allows extremely wide bandwidth and highly accurate self calibrated time base with 1 ps resolution.

This low cost, easy to use device is a perfect solution for engineers and technicians alike who need to measure amplitude, rise time, fall time, propagation delay and much more in high speed analog and digital circuit.

iC227 will work with repetitive signals only, since it requires multiple signal repetitions to complete the conversion.

When 2 channels are used, there must be some fixed timing correlation between these channels in order for sampling to be an accurate representation of the real event.

If the frequency on 2 channels is different but there is a clear timing correlation or synchronization, then the channel with the lower frequency should be used as trigger source.

ELECTRICAL CHARACTERISTICS

After calibration. Designed and tested for laboratory environment with temperature 20 to 25 °C. Aluminum enclosure is used as heat sink and will warm to about 10 °C above ambient temperature.

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
General							
101	BW(IN)	Bandwidth at CH1 and CH2	SMA 50 Ω 18 GHz, DC coupled		11		GHz
102	BW(SPL)	Bandwidth when internal power splitter is used	SMA 50 Ω 18 GHz, DC coupled		4		GHz
103	BW(TR)	Trigger input bandwidth	SMA 50 Ω 18 GHz, DC coupled		2		GHz
104	f(TR)min	Min. trigger frequency			10		kHz
105	TB	Time base range	in 1-2-5 sequence	25 p		100 µ	s
106	TBacc	Time base accuracy			0.5 %FS +/-10 ps		
107	ResV	Vertical resolution			12		Bit
108	AccV	Vertical accuracy with direct CH1/CH2 Inp			3		%FS
109	DivV	Vertical divisions	in 1-2-5 sequence	10		1000	mV
110	Vin_{max}	Maximum input voltage	Sampler Trigger			2 4	Vpp Vpp
Case							
201	Dim	Enclosure size			102 x 56 x 123		mm
202	F	Weight			0.31		kg
203	P	Power consumption	9...16 VDC, regulated adapter 100-240 VAC		5 W +/-10 %		

BLOCK DIAGRAM AND THEORY OF OPERATION

iC227 is a simple yet very fast and accurate oscilloscope, consisting of a micro-controller and high speed ECL differential circuitry.

The micro-controller receives commands and responds via an isolated USB interface running in full speed mode at 12 Mbit/s.

The sequential scope works by inserting incremental delays between trigger and sample circuit.

ADC conversion can not start without a trigger event.

Once the trigger has been fired, a high-speed flip flop is set and the programmable delay lines starts counting time in 10 ps increments.

A fine tuning voltage adjusts final time delay with one picoseconds resolution using DAC calibration data from micro-controller flash memory.

A Sample is taken on both channels simultaneously after delay line counting is completed.

It is important to note, that each ADC conversion requires multiple trigger events, limiting the scope usage to repetitive signals only.

Achieving highly accurate and repeatable time base is done using proprietary self calibration and fine tuning techniques.

The device time base is calibrated after assembly and users have the option to run auto time base calibration. Time base calibration takes long time, since time base is scanned with 1 ps intervals and multiple cycles are repeated, compared to time generated by the crystal and stored in a flash calibration look up table.

There is no need for frequent time base calibration since the ECL logic is stable over temperature.

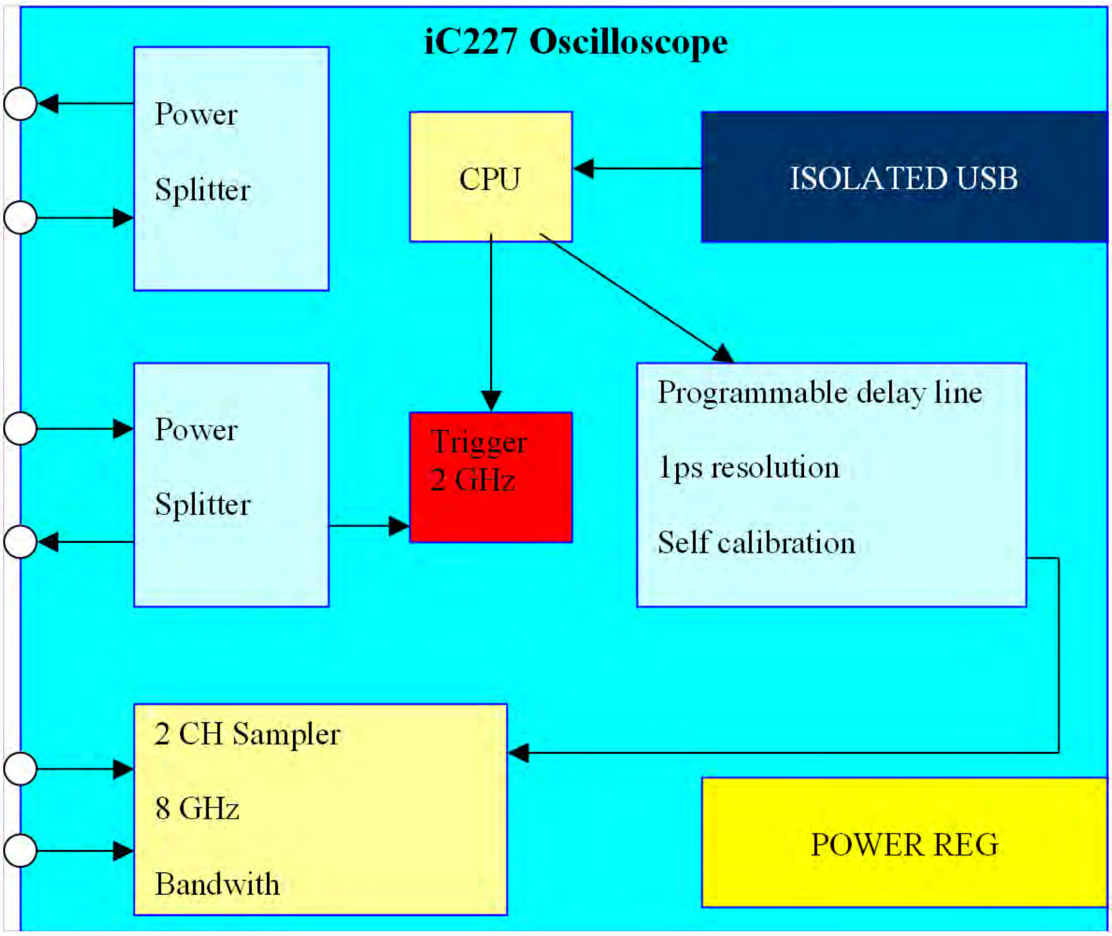


Figure 1: Block Diagram

CONNECTION BLOCK DIAGRAM 11 GHz

If full bandwidth is required, the input signal must be connected directly to CH1 and/or CH2. In this case the trigger needs to be supplied via a separate cable directly to the trigger input. The power splitter output must always be terminated with 50 Ohm.

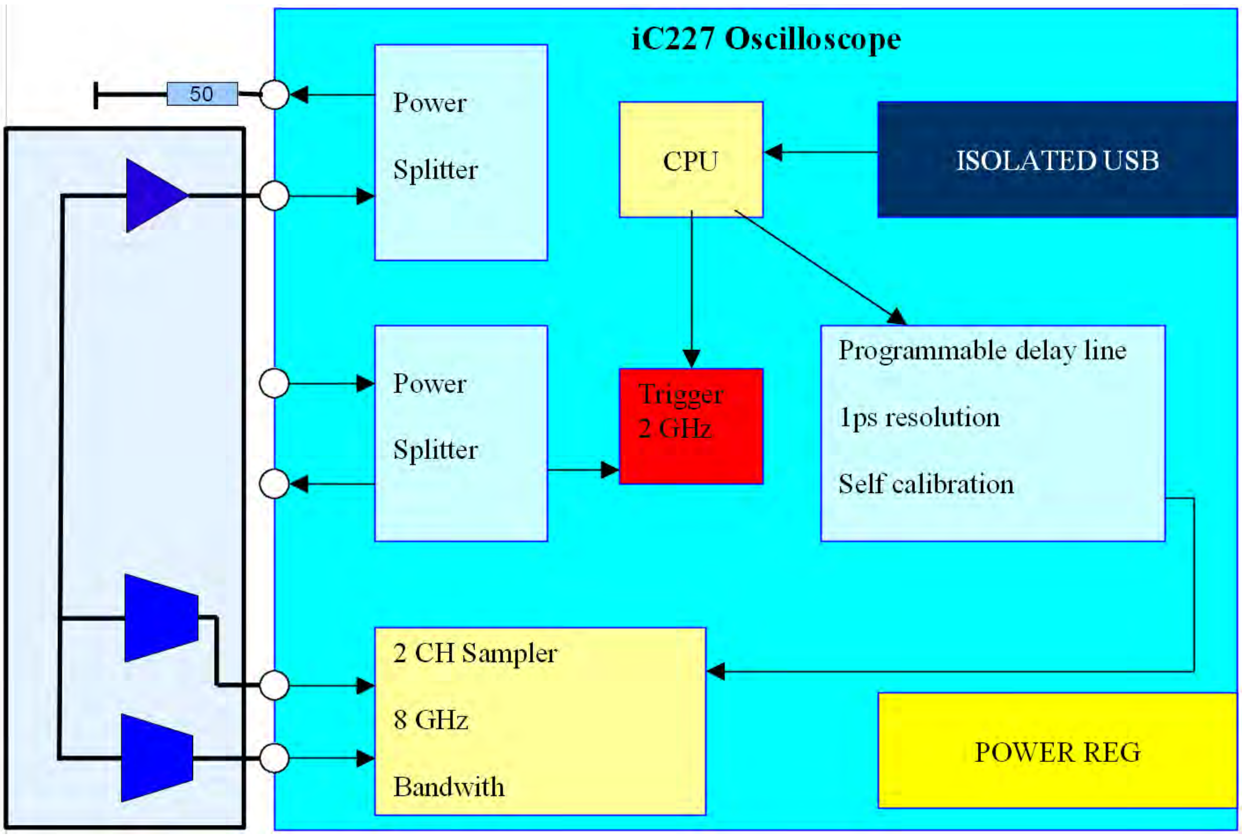


Figure 2: Full Bandwidth Setup

CONNECTION BLOCK DIAGRAM 4 GHz

If the required bandwidth is not exceeding 4 GHz, the input connection can be simplified by using the trigger input power splitter. In this case the input signal is divided by 2 and pre-trigger samples are available, if a 150 cm or longer external coax cable is used as delay line between the trigger power splitter output and the sampler input.

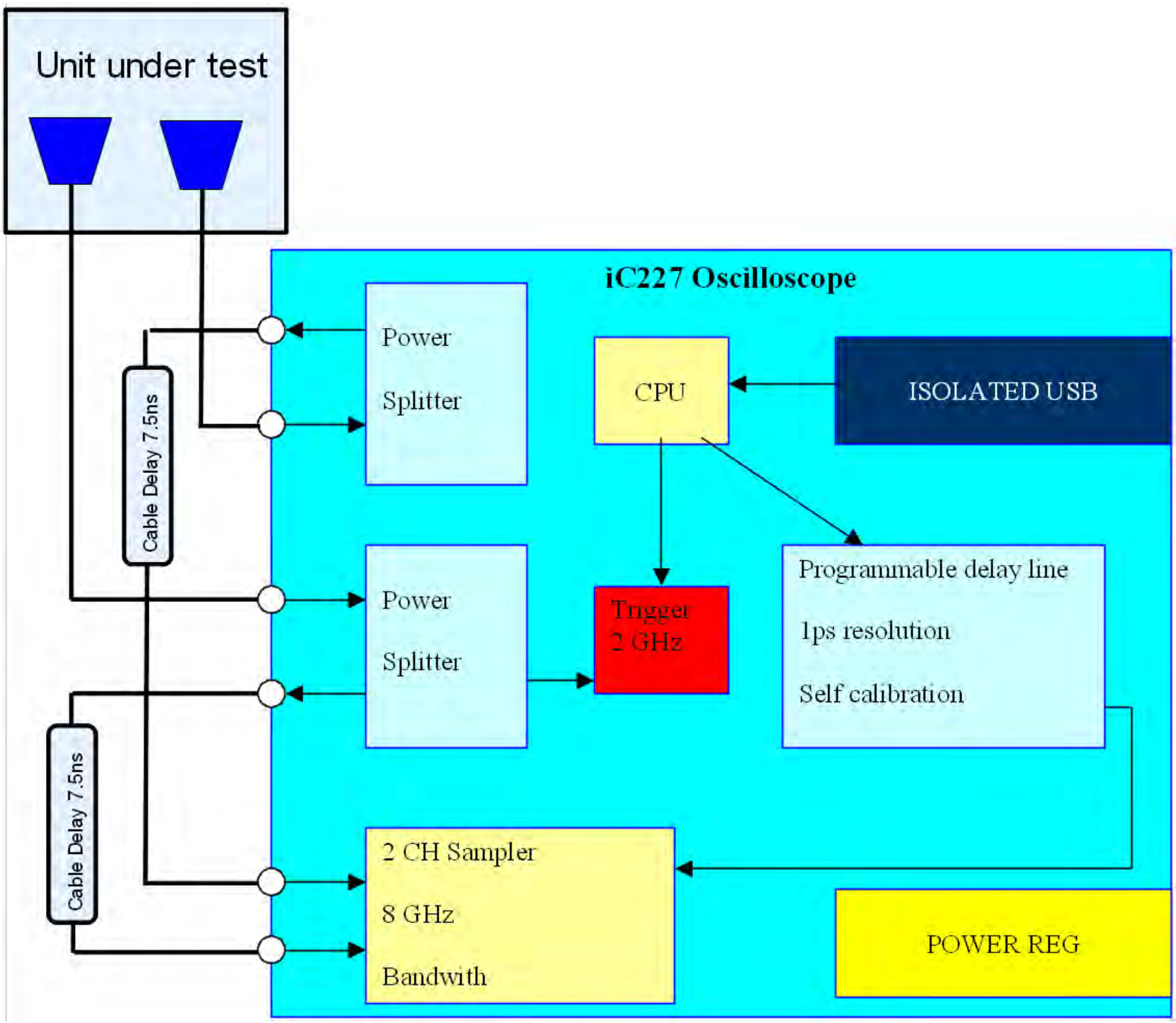


Figure 3: 4 GHz Setup

SOFTWARE

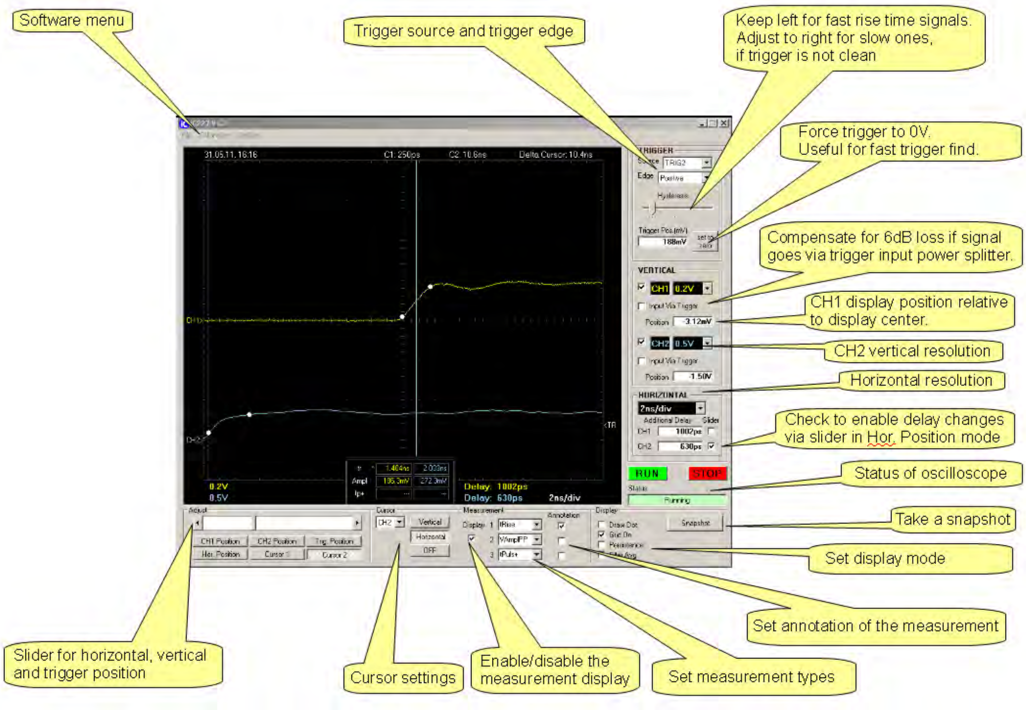


Figure 4: Settings

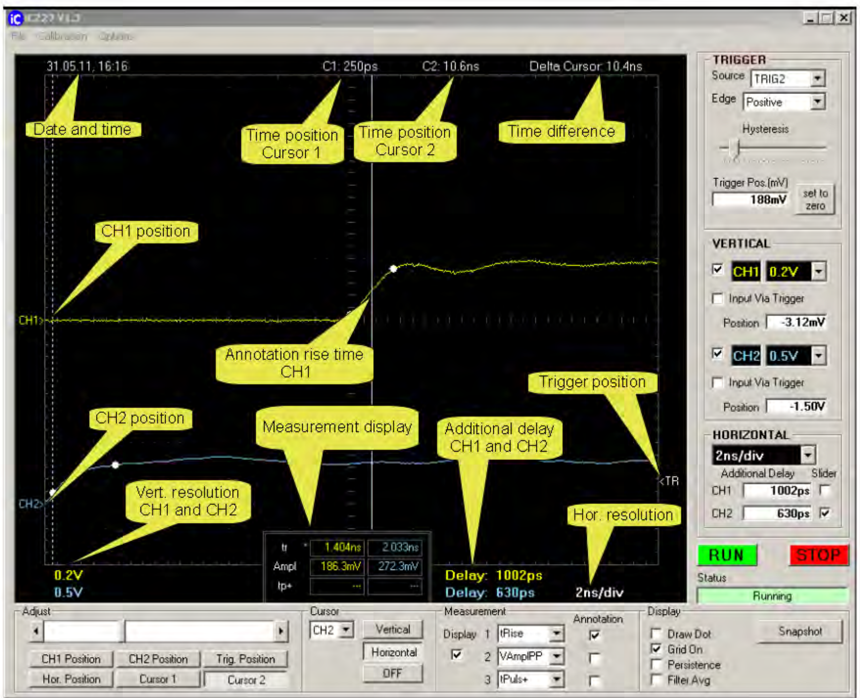
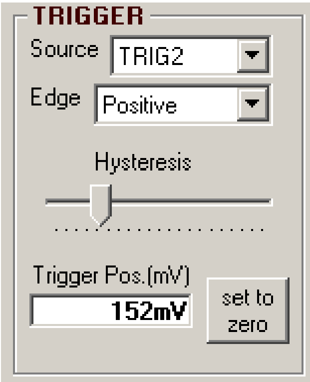


Figure 5: Readings



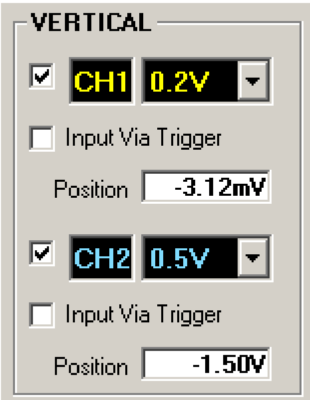
Source: TRIG1, TRIG2

Edge: Positive, Negative

Hysteresis: 0mV ... 200 mV

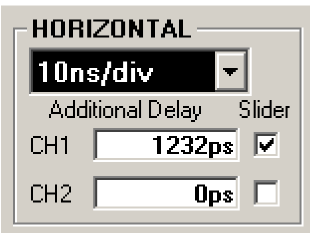
Trigger Position: -2048 mV ... +2048 mV
(Input Via Trigger unchecked)

Figure 6: Trigger



Display Trace: checked, unchecked
Vertical Resolution: 1V, 0.5V, 0.2V, 100mV, 50mV, 20mV, 10mV
Input Via Trigger: checked, unchecked
Position: full vertical screen

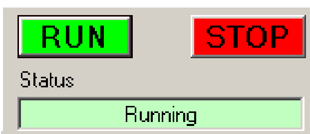
Figure 7: Vertical



Horizontal Resolution: 100us, 50us, 20us, 10us, 5us, 2us, 1us, 0.5us, 0.2us, 100ns, 50ns, 20ns, 10ns, 5ns, 2ns, 1ns, 0.5ns, 0.2ns, 100ps, 50ps, 25ps

Hor. Position Slider CH1/CH2: checked, unchecked
Additional Delay: 0 ... 2048 ps

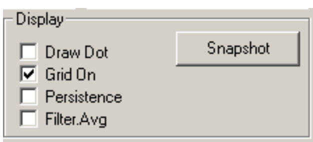
Figure 8: Horizontal



RUN, STOP button

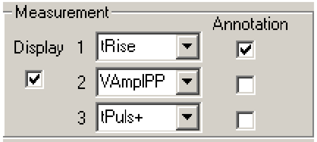
Status: Running, Waiting For TRIGGER, Stopped

Figure 9: Status



Snapshot button
Options: Draw Dot, Grid On, Persistence, Filter AVG

Figure 10: Display



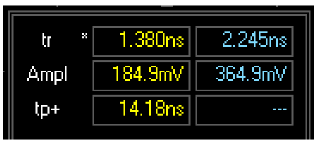
Display Measurement Annotation

Figure 11: Measurement

3 types of measurement at a time, 15 different types of measurement in total

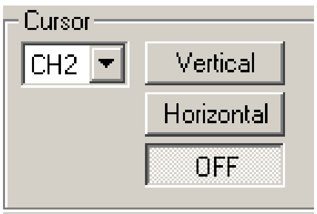
Vmax : max. spike value
Vmin : min. spike value
Vpp : peak to peak amplitude value
Vampl+ : max. amplitude ignoring spikes
Vampl- : min. amplitude ignoring spikes
VRMS : root mean square value
VMEAN : mean value

tRise : rise time
tFall : fall time
tPuls+ : positive pulse width
tPuls- : negative pulse width



3 types of measurement for CH1 and CH2
--- : no measurement possible
* : annotation button checked for this measurement

Figure 12: Display measurement



Cursor: CH1, CH2

Cursor button: Vertical, Horizontal

Cursor: ON, OFF

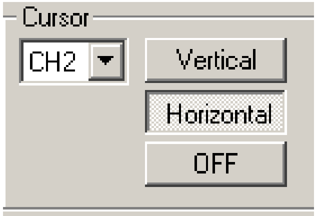
Figure 13: Cursor off

Slider for adjustment purpose

CH1/CH2 Position button, Trig. Position button (vertical)

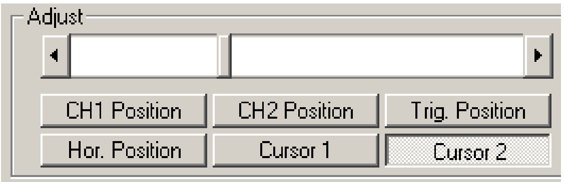
Hor. Position button, slider box must be checked

Figure 14: Adjust cursor off



Cursor CH2 Horizontal active

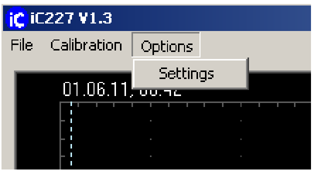
Figure 15: Cursor on



Cursor 1 button unhidden
Cursor 2 button unhidden and active

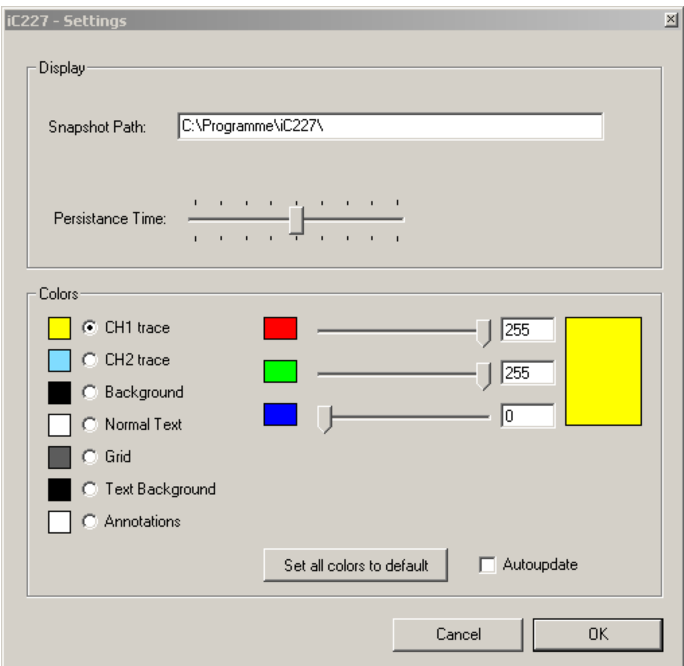
Figure 16: Adjust cursor on

SOFTWARE MENU BAR



Menu - Options - Settings

Figure 17: Options settings



Display:

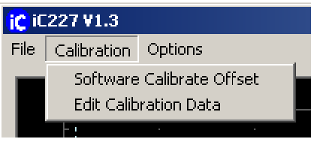
Snapshot Path

Persistence Time
1...9 overlays

Colors:
CH1/CH2 (fitting to cable colors)

Autoupdate checkbox:
live change of color settings

Figure 18: Options

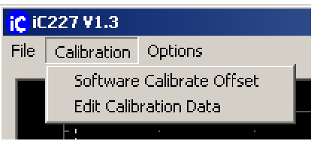


Menu - Calibration - Software Calibrate Offset

Figure 19: Software calibrate offset

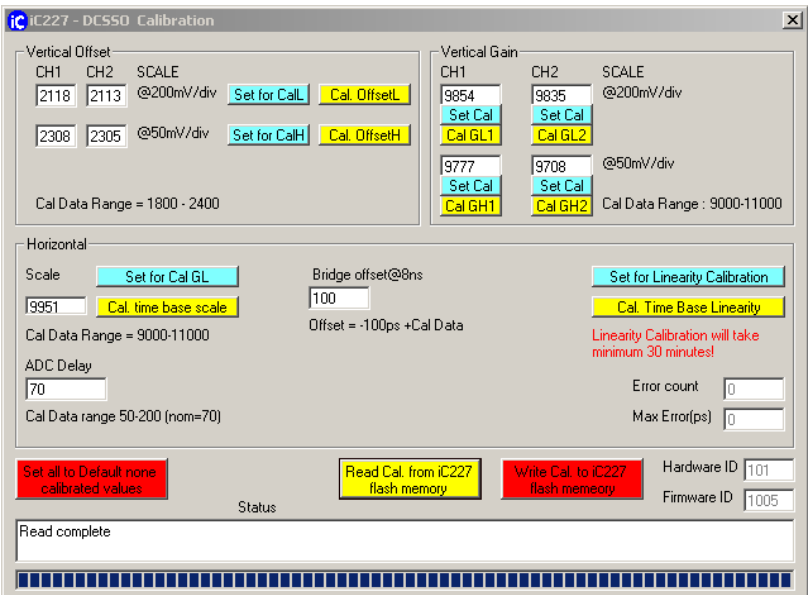
After pressing the OK button the offset of CH1 and CH2 are set to zero.

Figure 20: Offset calibration



Menu - Calibration - Edit Calibration Data

Figure 21: Edit calibration data



Vertical Offset
Vertical Gain

Horizontal

Read / Write
Calibration data
Message Window
Status Bar

Figure 22: Edit calibration

Menu - File:

Load Setup
Save Setup to a simple text file e.g. config.txt

Exit Program

Figure 23: File menu

CALIBRATION

The scope iC227 does not have a certificate of calibration, but this device has software and hardware designed for auto time base calibration and calibration of vertical gains and offsets on both channels. There is also a software feature which allows manual calibration of the time base in case that the accuracy of the internal crystal and auto calibration are not sufficient.

If the device is to be used in production where certified calibration is required, then there must be done periodically calibration against a known calibrated source.

Vertical offset

The "Vertical Offset" calibration process allows writing 4 offset calibration variables to the device flash memory. This will adjust the channel trace to be at the level of the channel pointer "CH1>" and "CH2>" seen on the left side of the screen when the input voltage is 0.00 V. There are 2 calibration registers for each channel: 500 mV/div and 50 mV/div. The first one is responsible for the vertical resolutions 1 V-0.5 V-0.2 V, while the second represents 100 mV-50 mV-20 mV-10 mV.

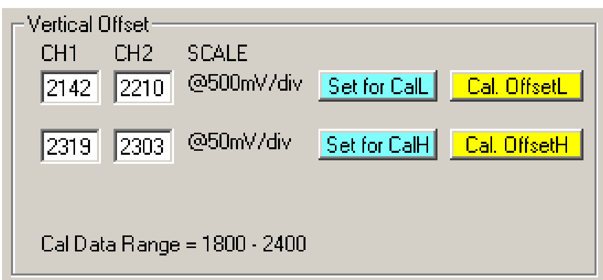


Figure 24: Vertical offset

Vertical offset calibration steps

1. Make sure that scope was powered on for minimum 10 minutes
2. Open Calibration - Edit Calibration Data
3. Press the "Set for Cal L" button and follow the instructions

Figure 25: Vertical calibration

4. Press the "Cal. Offset L" button
5. Press "Write Cal. to iC227 flash memory" button

Figure 26: Write calibration data

6. Press the "Set for Cal H" button and follow the instructions
7. Press the "Cal. Offset H" button
8. Press "Write Cal. to iC227 flash memory" button

Vertical gain
The ”Vertical Gain” calibration process allows writing 4 gain calibration variables to the device flash memory. The Vpp measurement utility is used to acquire the correct gain setting.

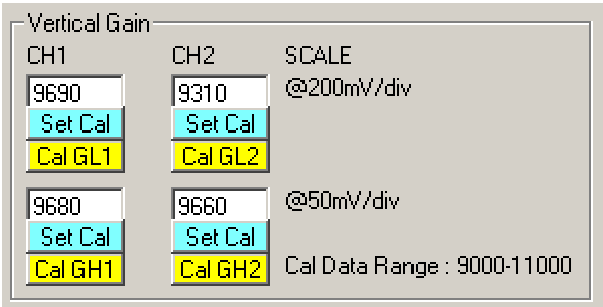


Figure 27: Vertical gain

Vertical gain calibration steps

1. Make sure that scope was powered on for minimum 10 minutes
2. Open Calibration - Edit Calibration Data
3. Press the scale @200 mV/div ”Set for Cal” button and follow the instructions.

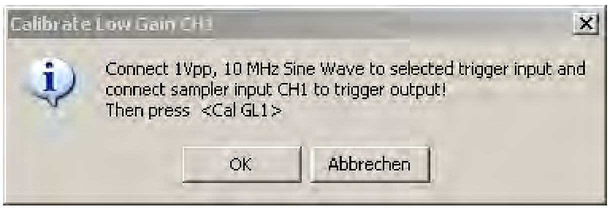


Figure 28: Amplitude calibration

4. Press the ”Cal. GL1” button
5. Press ”Write Cal. to iC227 flash memory” button

Figure 29: Write calibration data

6. Press the scale @50 mV/div ”Set for Cal” button and follow the instructions.

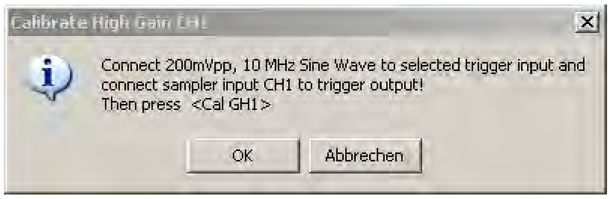


Figure 30: Amplitude calibration

7. Press the ”Cal. GH 1” button
8. Press ”Write Cal. To iC227 flash memory” button

Horizontal Calibration
The ”Horizontal” calibration process allows writing 2 calibration variables to the device flash memory.

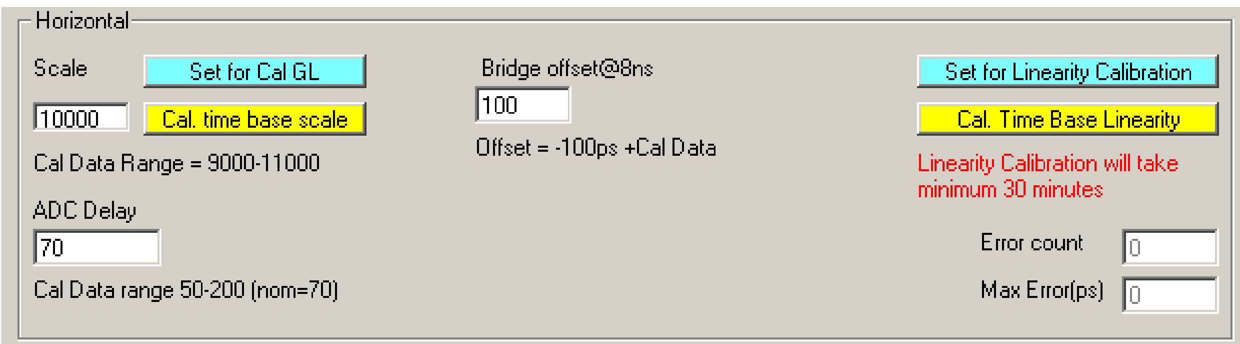


Figure 31: Horizontal calibration

Time base scale calibration steps

1. Make sure that scope was powered on for minimum 10 minutes
2. Open Calibration - Edit Calibration Data
3. Press the "Set for Cal GL" button and follow the instructions

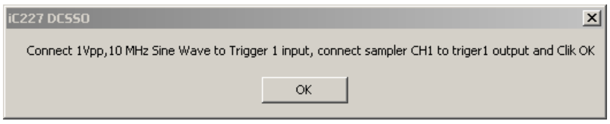


Figure 32: Time base calibration

4. Press the "Cal. Time base scale" button
5. Press "Write Cal. To iC227 flash memory" button

Figure 33: Write calibration data

Time base linearity calibration steps

1. Make sure that scope was powered on for minimum 10 minutes
2. Open Calibration - Edit Calibration Data

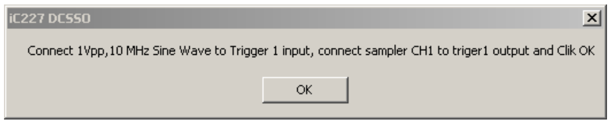


Figure 34: Time base calibration

3. Press the "Set for Linearity Calibration" button and follow the instructions. The status of the calibration is shown inside the message window.

Figure 35: Calibration status

EXAMPLES

4 GHz Measuring Example using iC212, iC149 and NZN-Eval-Board

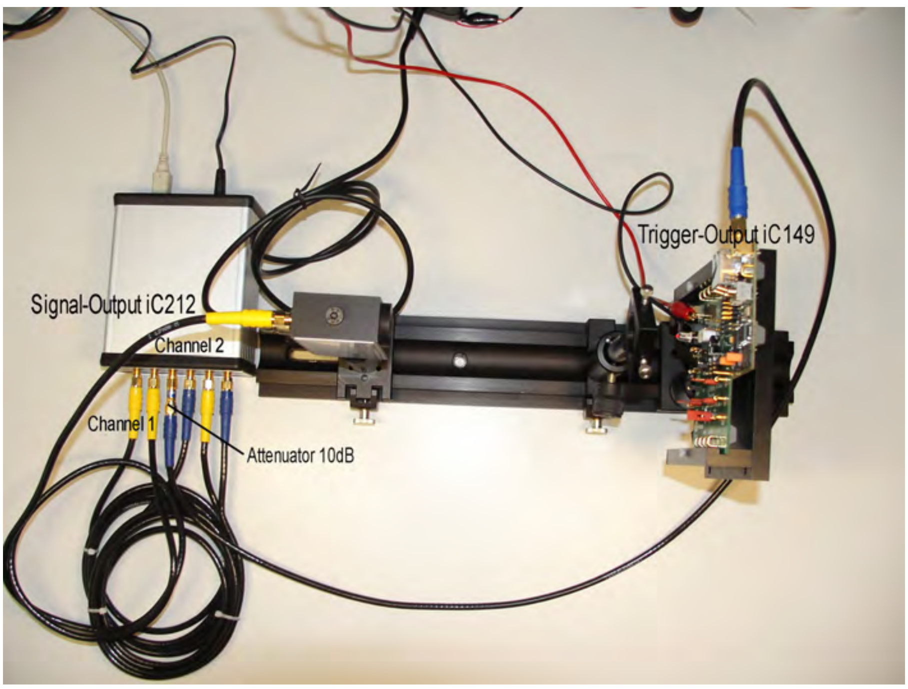


Figure 36: Set-up

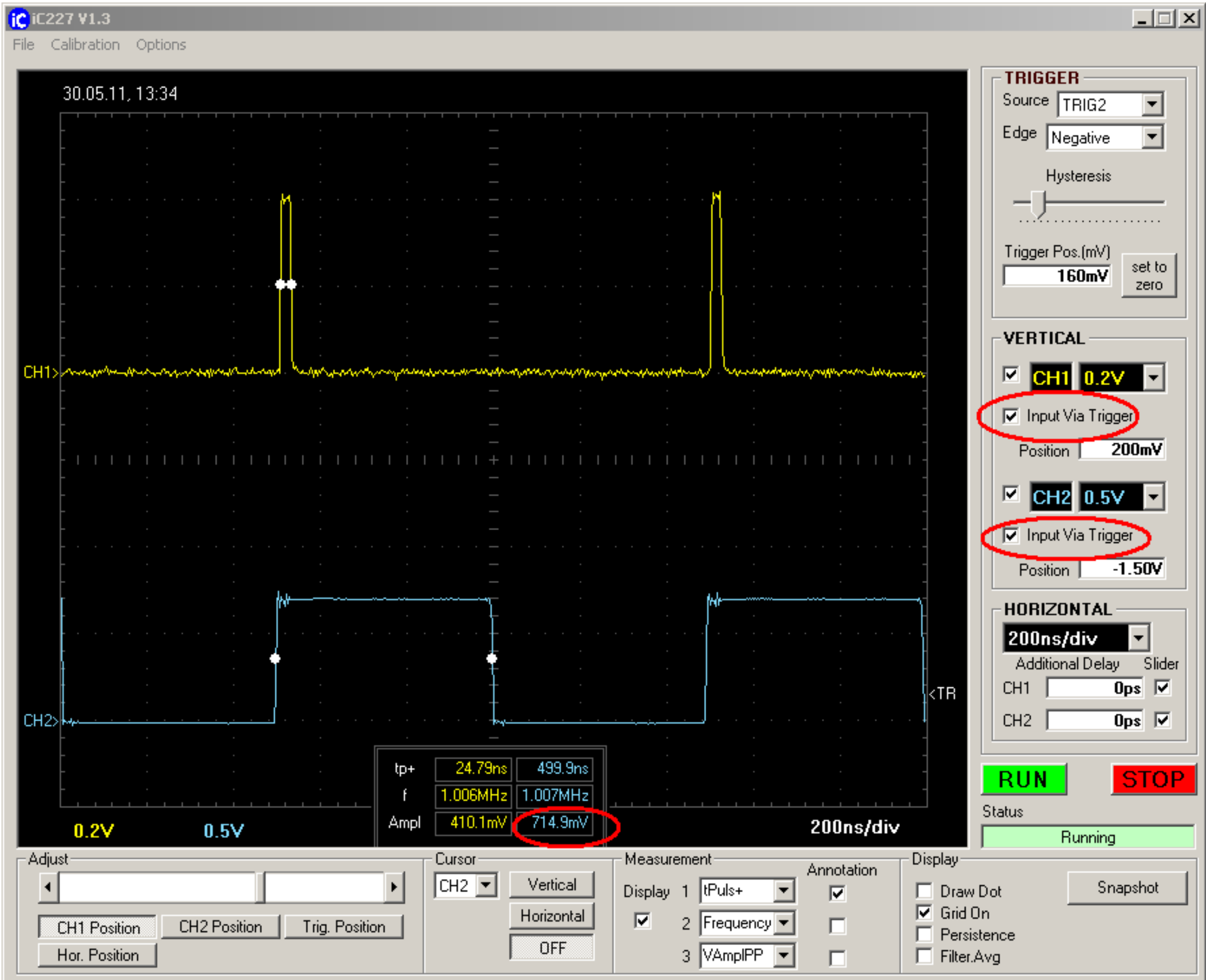


Figure 37: Measurement

The output of the iC212 Photoreceiver is connected to "TRIGGER IN". "SPLITTER OU1" is connected to "SAMPLER IN1". The trigger-output of the iC149 module (5 V, Rout = 50 Ω → 2.5 V) is a little bit too high for feeding it directly to the iC227 Oscilloscope. When using the 10 dB attenuator, the level is reduced to

$$2.5\,V * 10^{-\frac{10\,dB}{20\,dB}} = 2.5\,V * 0.31 \approx 0.77\,V$$

far below the maximum input of 2 V.

The amplitude measurement setup of the iC227 is reading a value of 0.714 V in good correlation to the above done estimation. To get the correct amplitude values the "Input Via Trigger" boxes must be checked.

First 11 GHz Measuring Example using iC212, iC149 and NZN-Eval-Board

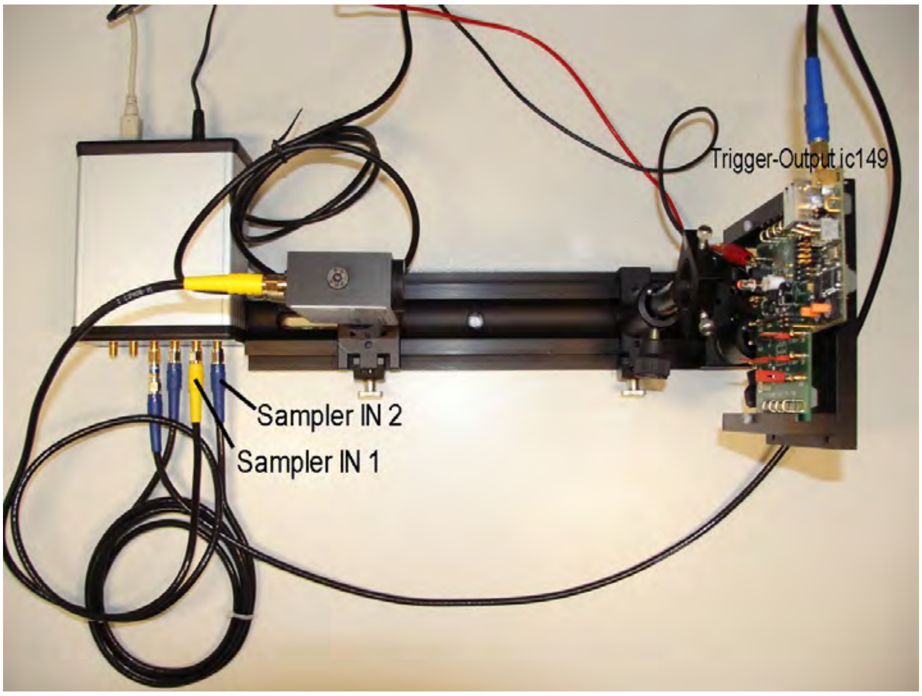


Figure 38: Set-up

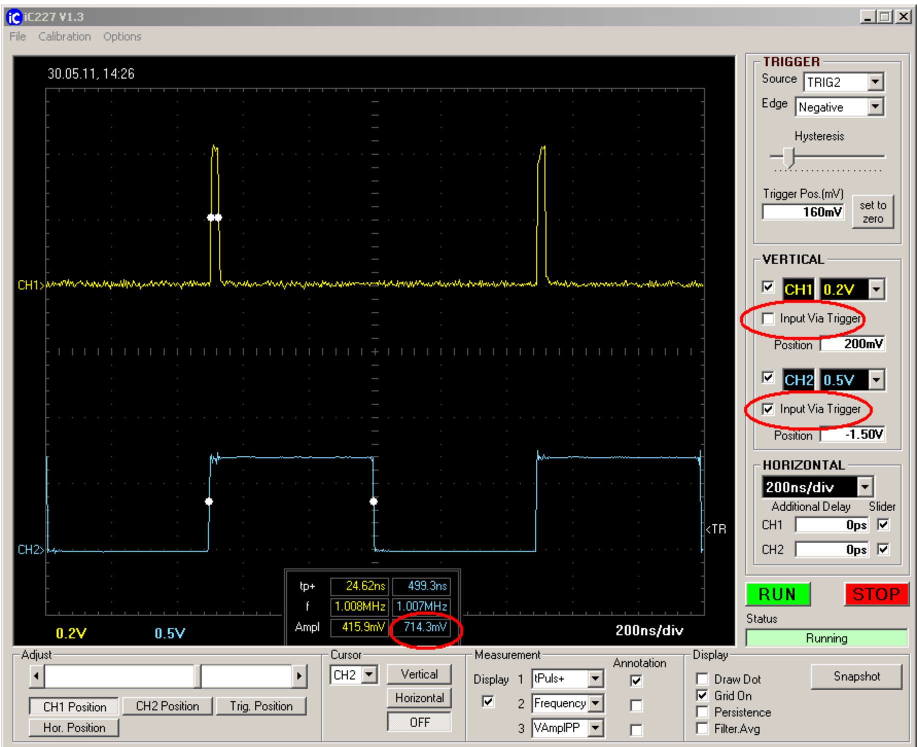


Figure 39: Measurement

The output of the iC212 Photoreceiver is connected directly to "SAMPLER IN1".The "Input Via Trigger" box of channel 1 must be unchecked. The connection of the iC149 trigger-output is the same compared to the 4 GHz setup.

Second 11 GHz Measuring Example using iC212, iC149 and NZN-Eval-Board

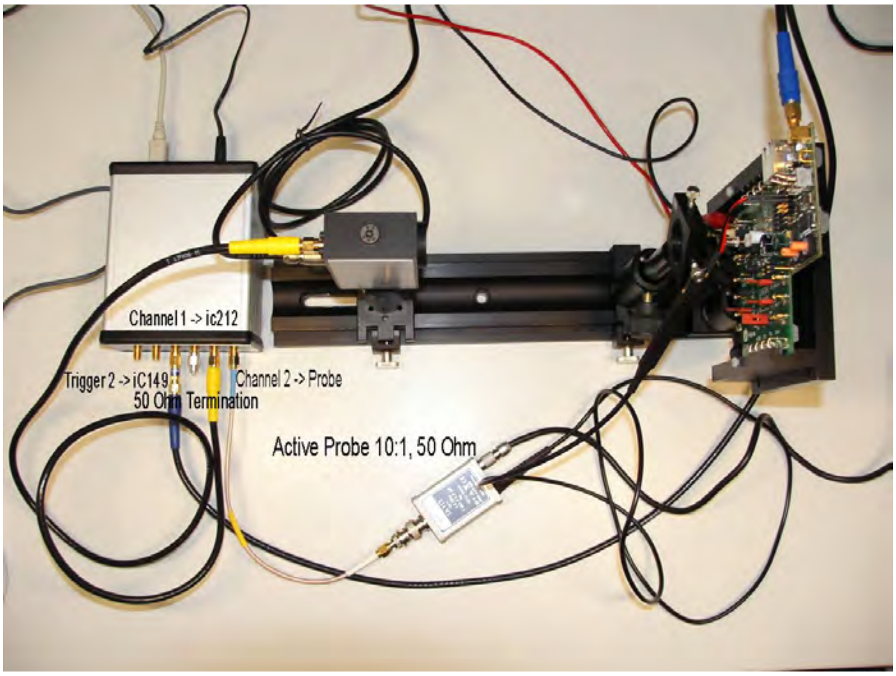


Figure 40: Set-up

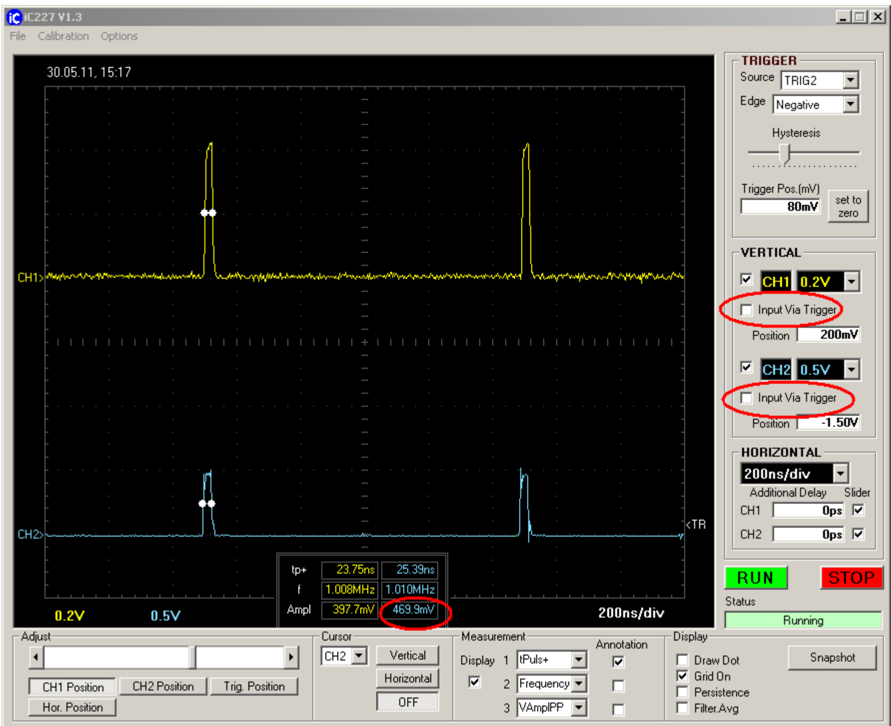


Figure 41: Measurement

The trigger-output of iC149 is connected to "TRIGGER IN 2" while "SPLITTER OUT 2" is terminated via 50 Ω. "SAMPLER IN 1" is still connected to the iC212 Photoreceiver. "SAMPLER IN 1" can now be used for other purposes, in this special case an "Active Probe" is attached to measure the CMOS-Trigger signal. The amplitude reads 0.469 V (divided by 10), resulting in 4.7 V.

4 GHz Measuring Example using iC213

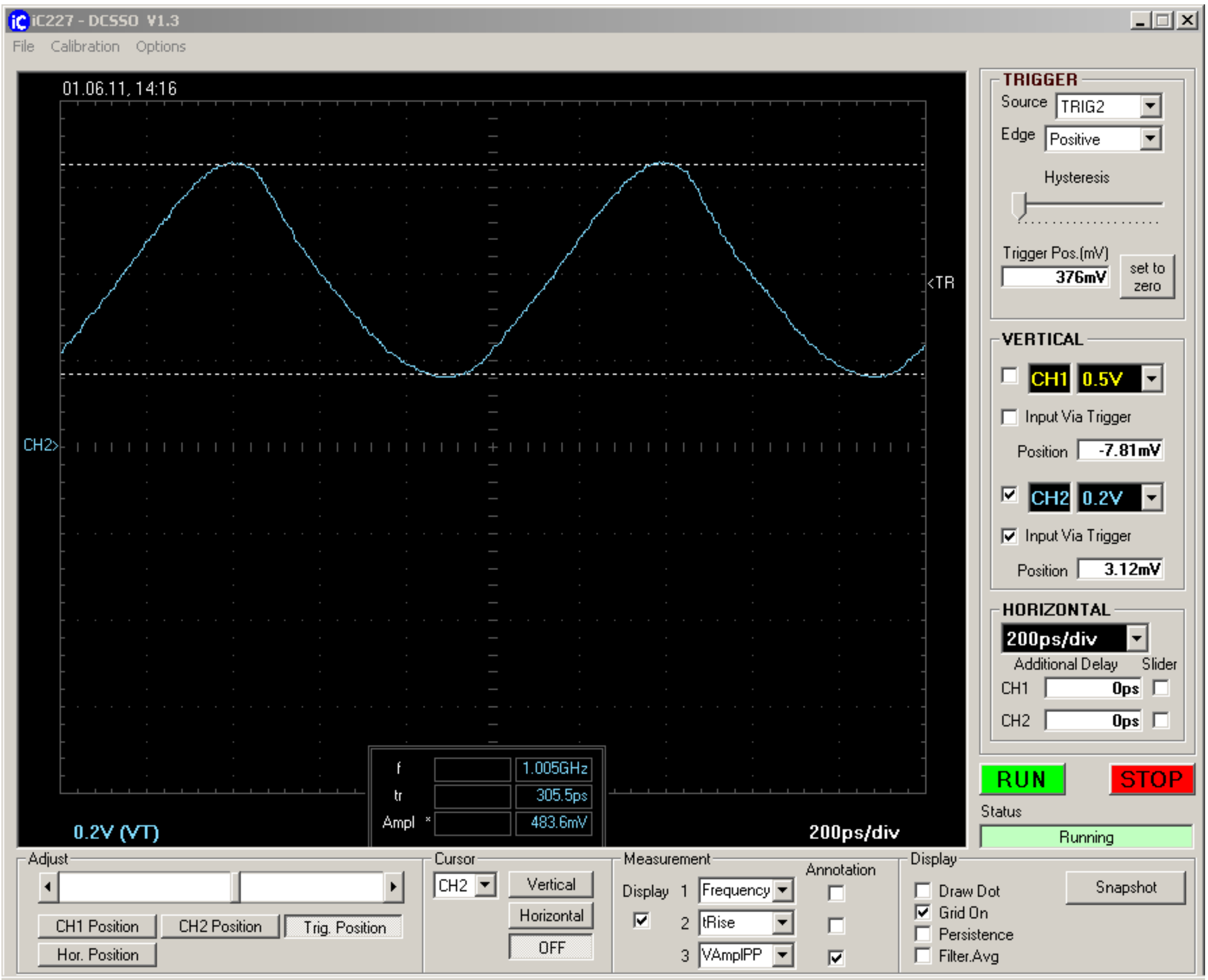


Figure 42: Measurement

In this configuration only CH2 is used. The iC213 device is set to the highest frequency, 1 GHz. At the trigger output you get a signal with nearly 500 mVpp and an offset of 200 mV.

11 GHz Measuring Example using Windfreak Tech RF Signal Generator

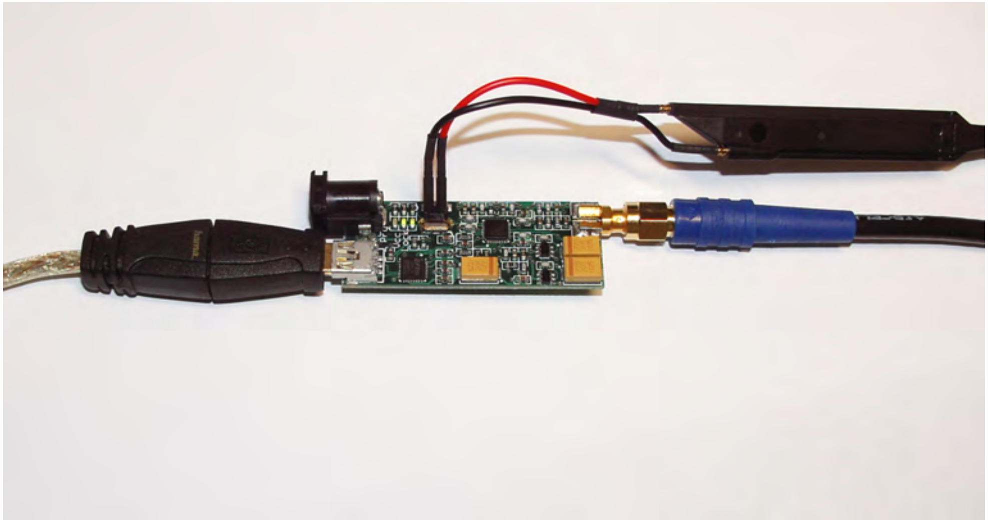


Figure 43: RF generator

The 10 MHz reference oscillator is connected to ”TRIGGER IN”. ”SPLITTER OUT 1” is then connected via 150 cm delay cable to ”SAMPLER IN 1” (4 GHz bandwidth). The output of the RF generator is directly connected to ”Sampler IN 2” (11 GHz bandwidth).

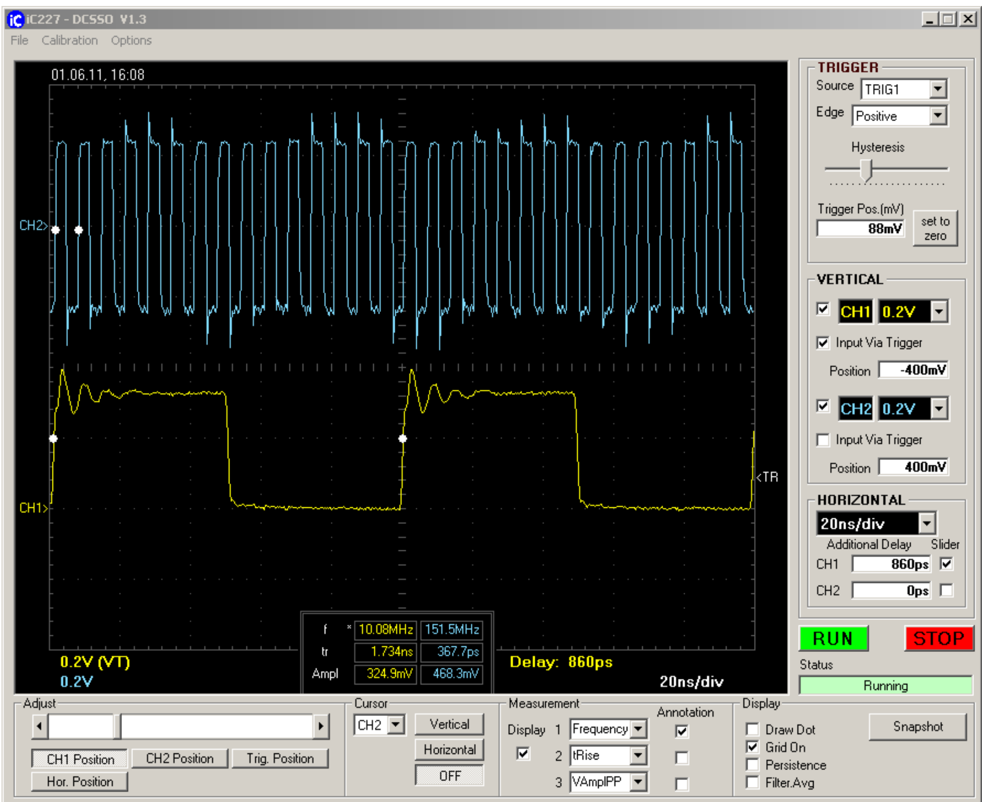


Figure 44: RF generator output frequency 150 MHz

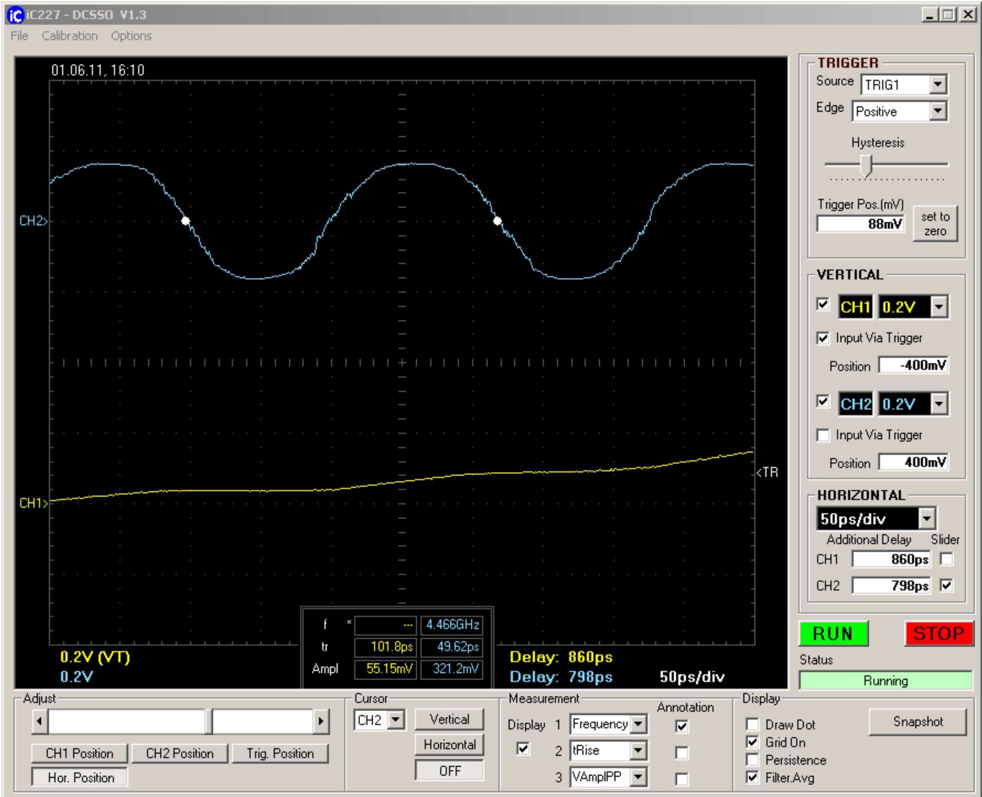


Figure 45: RF generator output frequency 4.4 GHz - the maximum possible value

Figure 46: RF generator

PACKING LIST

Figure 47: Attenuators

Figure 48: Terminator

Figure 49: Cable

Figure 50: Delay lines

2 attenuators 50 Ω, 10 dB, 2 W, 11 GHz

1 terminator 50 Ω

2 cables Aircel® low loss, 1.0 m, 0.22 dB/m @1 GHz (yellow CH1, blue CH2)

2 delay lines Aircel® low loss, 1.5 m, 0.22 dB/m @1 GHz, ΔT = 7.5 nsec fixed (yellow CH1, blue CH2, used as delay lines for pre-trigger samples)

1 USB Cable

1 wall power adaptor

1 aluminium housed oscilloscope

1 transportation case

Figure 51: Contents

ORDERING INFORMATION

Type	Package	Order Designation
iC227		iC227

For technical support, information about prices and terms of delivery please contact:

iC-Haus GmbH
Am Kuemmerling 18
D-55294 Bodenheim
GERMANY

Tel.: +49 (61 35) 92 92-0
Fax: +49 (61 35) 92 92-192
Web: http://www.ichaus.com
E-Mail: sales@ichaus.com

Appointed local distributors: http://www.ichaus.com/sales_partners