iC227

DUAL 11 GHz SAMPLING OSCILLOSCOPE



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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





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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	Symbol	Parameter	Conditions				Unit
No.	,			Min.	Тур.	Max.	
Gene	ral						
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	ТВ	Time base range	in 1-2-5 sequence	25 p		100 µ	s
106	TBacc	Time base accuracy		0.5	%FS +/-1	0 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		10	2 x 56 x ⁻	123	mm
202	F	Weight			0.31		kg
203	Р	Power consumption	916 VDC, regulated adapter 100-240 VAC	5W +/-10%		%	

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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.

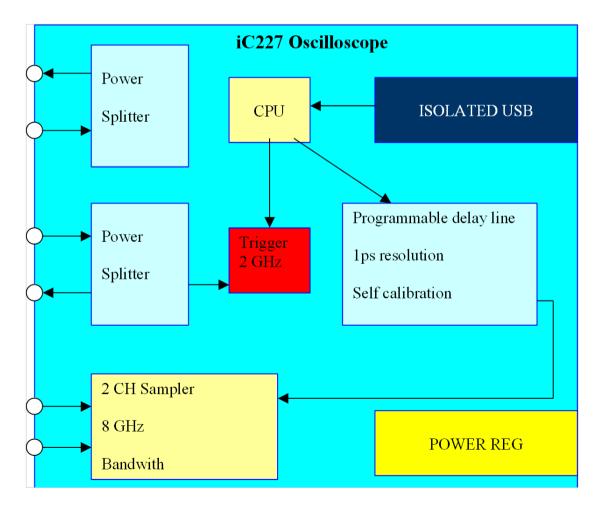


Figure 1: Block Diagram



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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.

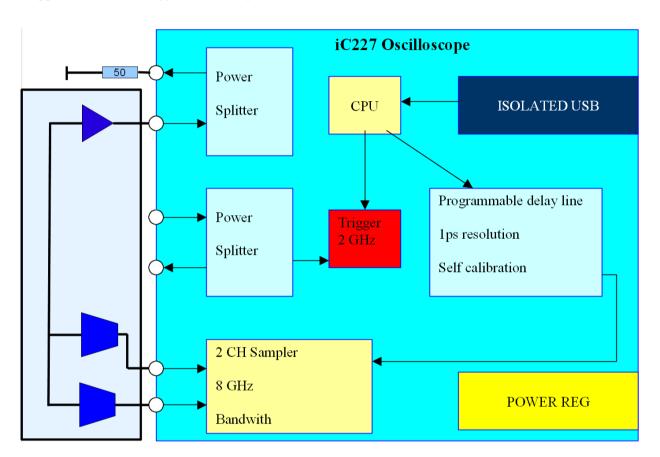


Figure 2: Full Bandwidth Setup

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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.

Ra

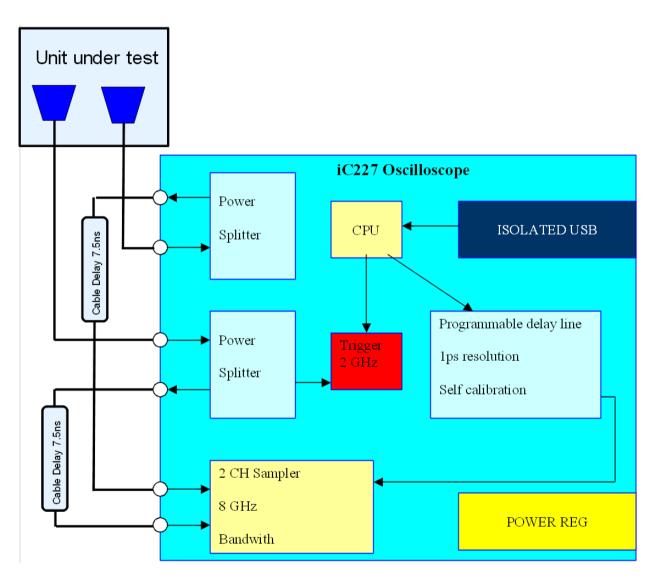


Figure 3: 4 GHz Setup

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SOFTWARE

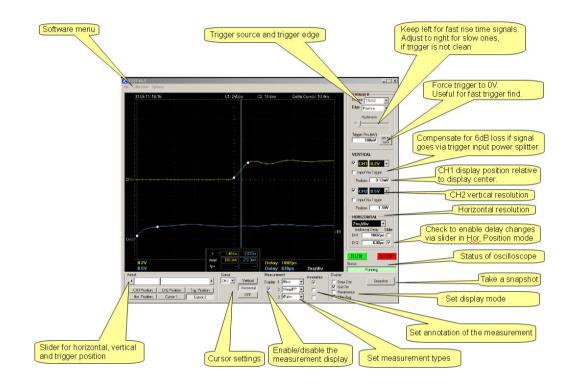


Figure 4: Settings

IC IC227 V1.3			×
File Calibration Options			
	C1: 250ps C me position Cursor 1		Source TRIG2 Edge Positive Hysteresis Trigger Pos.(nV)
	itation rise time CH1	Trigger pos	VERTICAL VERTICAL VERTICAL VERTICAL Input Via Trigger Position -3.12mV V CH2 0.5V V
CH2 Vert. resolution CH1 and CH2 0.5V	Measurement display	Delay: 1002ps Delay: 630ps 2ns/di	
Adjust	Cursor	Measurement Annotatio	
CH1 Position CH2 Position Trig. Posit Hor. Position Cursor 1 Cursor 1	000	Display 1 (Rise VAmpIPP 3 (Puls+	Draw Dot Snapshot Grid On Persistence Filter.Avg

Figure 5: Readings

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TRIGGER	
Source TRIG2	Source: TRIG1, TRIG2
Edge Positive	Edge: Positive, Negative
Hysteresis	
	Hysteresis: 0mV 200 mV
Trigger Pos.(mV) 152mV set to zero	Trigger Position: -2048 mV +2048 mV (Input Via Trigger unchecked)

Figure 6: Trigger

VERTICAL	
☑ CH1 0.2V ▼	
📄 Input Via Trigger	
Position -3.12mV	
✓ CH2 0.5∨ ▼	Display Trace: checked, unchecked
🔲 Input Via Trigger	Vertical Resolution: 1V, 0.5V, 0.2V, 100mV, 50 Input Via Trigger: checked, unchecked
Position -1.50V	Position: full vertical screen

Figure 7: Vertical

HORIZONTAL							
10r	10ns/div 🔽						
Ad	ditional Delay Slider						
CH1	1232ps 🔽						
CH2	Ops 🗆						

Figure 8: Horizontal



RUN, STOP button

Additional Delay: 0 ... 2048 ps

Status: Running, Waiting For TRIGGER, Stopped

Hor. Position Slider CH1/CH2: checked, unchecked

Figure 9: Status

- Display	
☐ Draw Dot ☑ Grid On ☐ Persistence ☐ Filter.Avg	Snapshot

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

Figure 10: Display

)mV, 20mV, 10mV

50ns, 20ns, 10ns, 5ns, 2ns, 1ns, 0.5ns, 0.2ns, 100ps, 50ps, 25ps

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

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– Measure	eme		Annotation	
Display	1	tRise	•	
	2	VAmpIPP	•	
	3	tPuls+	•	

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

Adjust		Þ
CH1 Position	CH2 Position	Trig. Position
Hor. Position		

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

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- Cursor		
CH2 💌	Vertical	С
	Horizontal	
	OFF	

Cursor CH2 Horizontal active

Figure 15: Cursor on

Adjust		Þ	
CH1 Position	CH2 Position	Trig. Position	
Hor. Position	Cursor 1	Cursor 2	

Cursor 1 button unhidden Cursor 2 button unhidden and active

Figure 16: Adjust cursor on

SOFTWARE MENU BAR

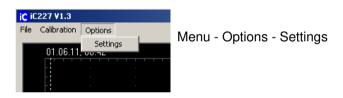


Figure 17: Options settings

iC227 - Settings 🛛	
Display	Display:
Snapshot Path: C:\Programme\iC227\	Snapshot Path
Persistance Time:	Persistence Time 19 overlays
Colors Image: Colors Image: Chll trace Image: Chll trace Image: Chll trace Image: Chll trace	Colors: CH1/CH2 (fitting to cable colors)
Set all colors to default Autoupdate	Autoupdate checkbox: live change of color settings
Cancel	



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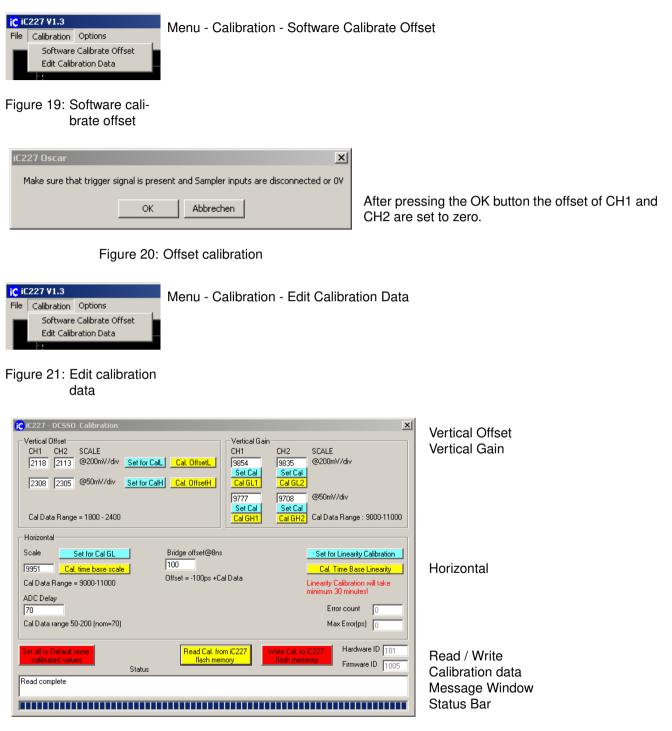


Figure 22: Edit calibration

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F	c	iC227	D	CSSO	¥1.3
	*		-		

File Calibration Options	Menu - File:
Load Setup Ctrl+L Save Setup Ctrl+S	Load Setup Save Setup to a simple text file e.g. config.txt
Exit Ctrl+X	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
- Press the "Set for Cal L" button and follow the instructions

Calibrat	e Offset - Low Gai	n		3	×
(į)	Make sure that Trigger is present and sampler inputs are disconnectand or 0V! Then press 'Cal. OffsetL'		!		
		ОК	Abbrechen		

Figure 25: Vertical calibration

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

Read Cal from iC227	Write Cal. to iC227	Hardware ID 101
flash memory	flash memeory	Firmware ID 1005

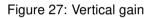
Figure 26: Write calibration data

- 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.

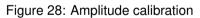
⊢ Vertical Gai	n	
CH1	CH2	SCALE
9690	9310	@200mV/div
Set Cal	Set Cal	
Cal GL1	Cal GL2	
9680	9660	@50mV/div
Set Cal	Set Cal	
Cal GH1	Cal GH2	Cal Data Range : 9000-11000



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.





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

Read Cal from iC227	Write Cal. to iC227	Hardware ID 101
flash memory	flash memeory	Firmware ID 1005

Figure 29: Write calibration data

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

Calibrate High Gain CH1				
į)	Connect 200mVpp, 10 MHz Sine Wave to selected trigger input a connect sampler input CH1 to trigger output! Then press <cal gh1=""></cal>			
		ОК	Abbrechen	

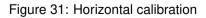
Figure 30: Amplitude calibration

- 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.

Horizontal		
Scale Set for Cal GL	Bridge offset@8ns	Set for Linearity Calibration
10000 Cal. time base scale		Cal. Time Base Linearity
Cal Data Range = 9000-11000	Offset = -100ps +Cal Data	Linearity Calibration will take minimum 30 minutes
ADC Delay		
70		Error count
Cal Data range 50-200 (nom=70)		Max Error(ps)



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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

iC227 DC550		x
Connect 1Vpp,10 MHz Sine Wave to Trigge	er 1 input, connect sampler CH1 to triger1 o	utput and Clik OK
	ОК	

Figure 32: Time base calibration

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

Read Cal from iC227	Write Cal. to iC227	Hardware ID 101
flash memory	flash memeory	Firmware ID 1005

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

iC227 DC 55 0	X
Connect 1Vpp,10 MHz Sine Wave to Trigge	er 1 input, connect sampler CH1 to triger1 output and Clik OK
	OK

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.

	. <u></u>	Status
11	Calibrating 3220 of 10500 points	
05		

Figure 35: Calibration status

EXAMPLES

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

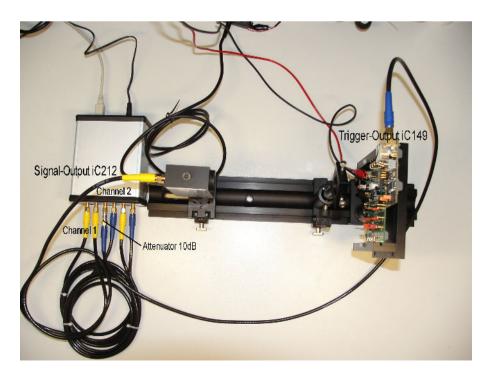


Figure 36: Set-up

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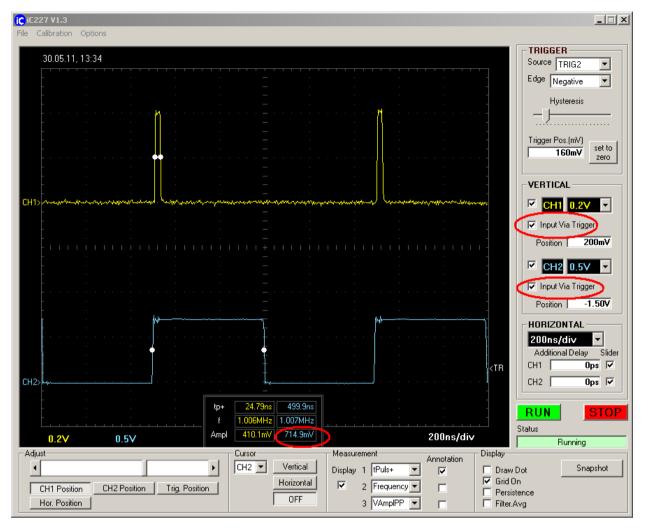


Figure 37: Measurement

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 = $50 \Omega \rightarrow 2.5 V$) 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

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.

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

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

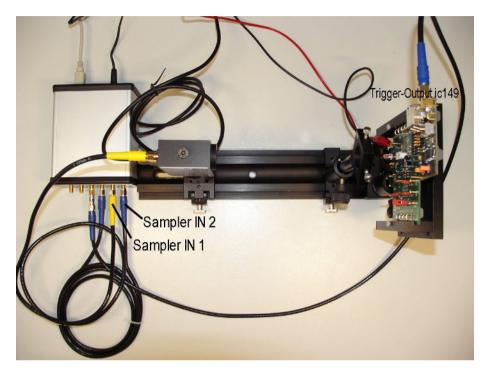


Figure 38: Set-up

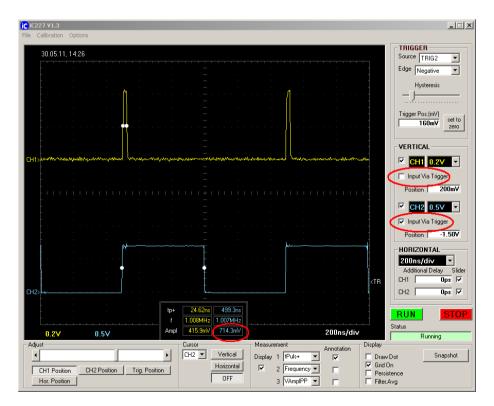


Figure 39: Measurement

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.

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

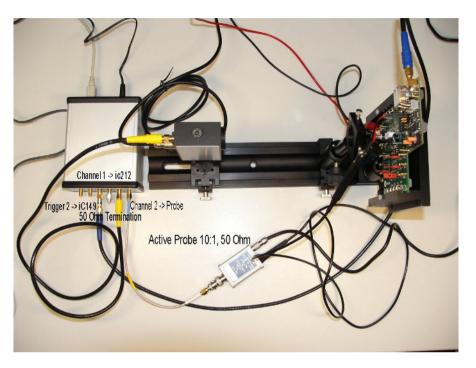


Figure 40: Set-up

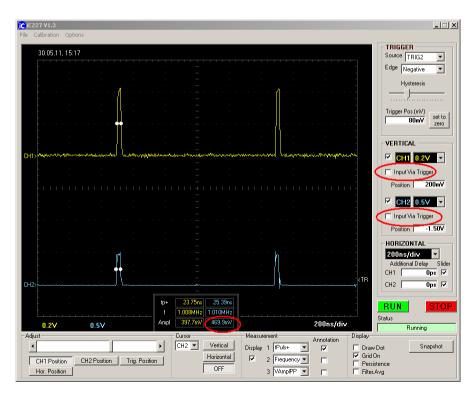


Figure 41: Measurement

The trigger-output of iC149 is connected to "TRIGGER IN 2" while "SPLITTER OUT 2" is terminated via 50Ω . "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.



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4 GHz Measuring Example using iC213

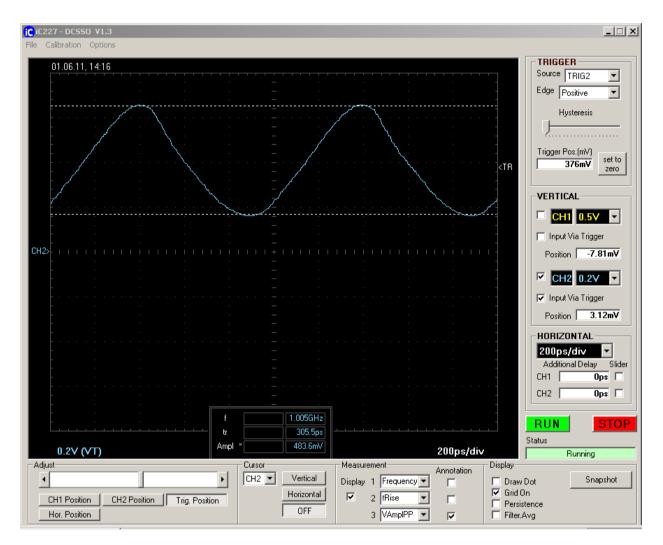


Figure 42: Measurement

In this configuration only CH2 is used. The iC213 device is set to the highest frequency, 1 GHz. At the trig-

ger output you get a signal with nearly 500 mVpp and an offset of 200 mV.



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11 GHz Measuring Example using Windfreak Tech RF Signal Generator

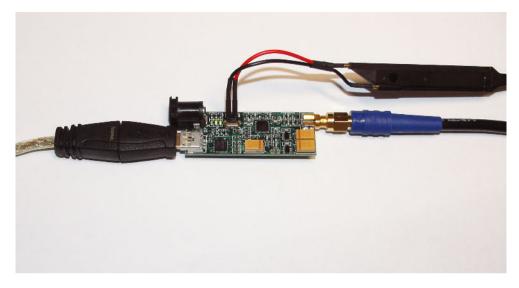


Figure 43: RF generator

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).

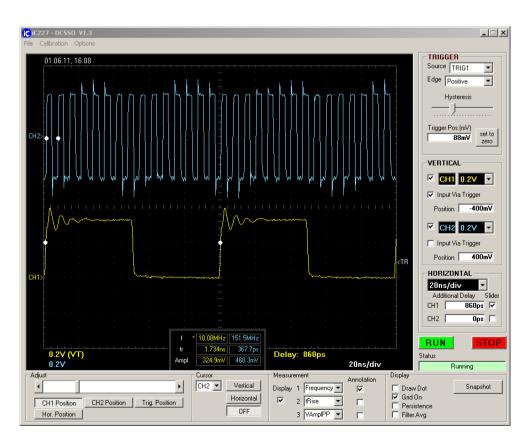


Figure 44: RF generator output frequency 150 MHz

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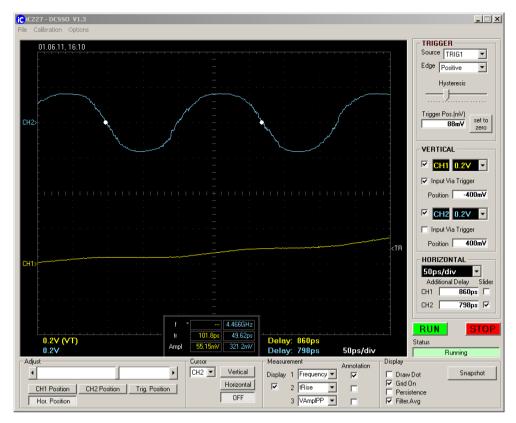


Figure 45: RF generator output frequency 4.4 GHz - the maximum possible value



Figure 46: RF generator

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PACKING LIST





Figure 50: Delay lines

2 attenuators 50 $\Omega,\,10\,\text{dB},\,2\,\text{W},\,11\,\text{GHz}$

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, $\Delta T = 7.5 \text{ nsec fixed (yellow CH1, blue CH2, used as delay lines for pre-trigger samples)$

1 USB Cable

1 wall power adaptor

1 aluminium housed oscilloscope

1 transportation case

Figure 49: Cable



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Figure 51: Contents

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iC227 CUAL 11 GHz SAMPLING OSCILLOSCOPE



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ORDERING INFORMATION

Туре	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