iC227

DUAL 11 GHz SAMPLING OSCILLOSCOPE



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FEATURES

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

APPLICATIONS

High-Speed Sampling Oscilloscope for periodic signals

BLOCK DIAGRAM





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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.

| ltem | 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 | | |
| 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 | 5 | W +/-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.

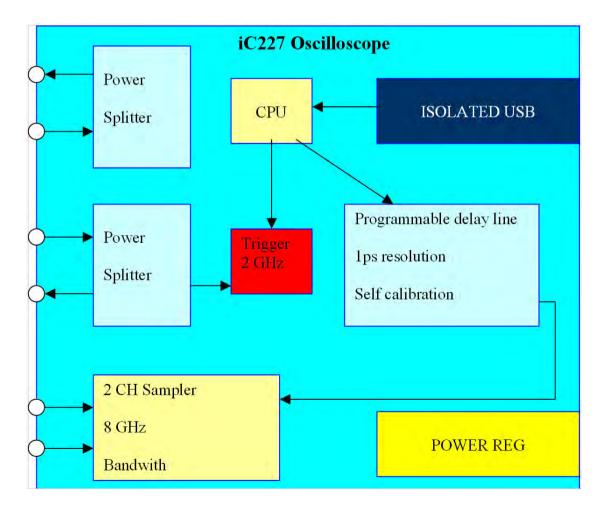


Figure 1: Block Diagram

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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.

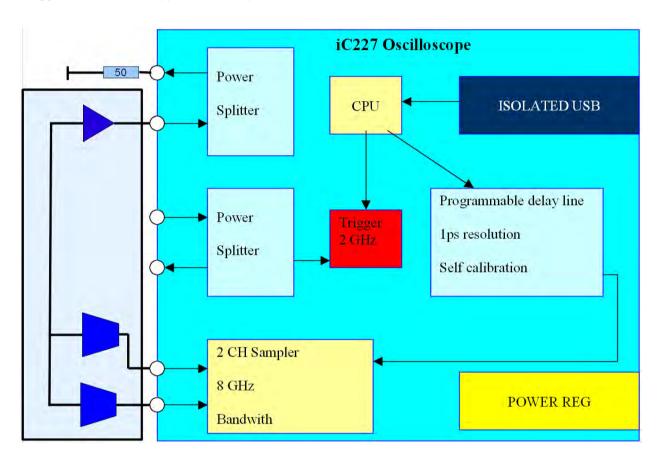


Figure 2: Full Bandwidth Setup

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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.

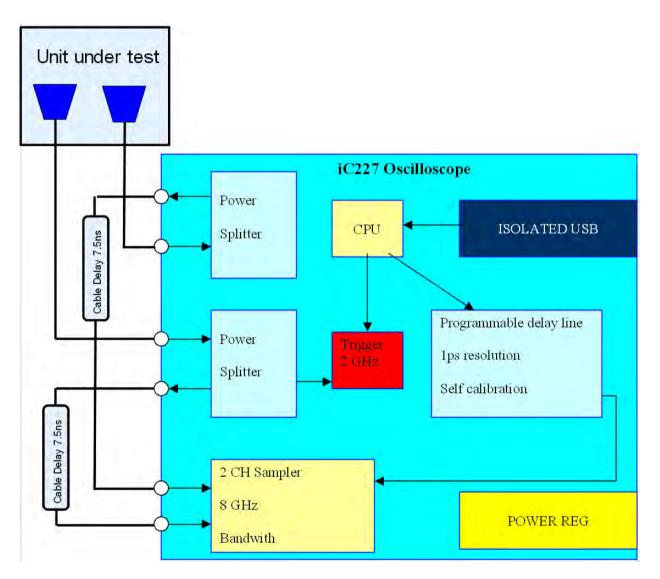


Figure 3: 4 GHz Setup

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SOFTWARE

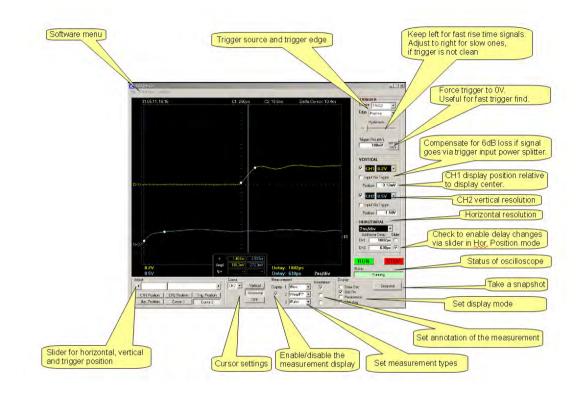


Figure 4: Settings

| 31.05.11.16:16 | C1: 250ps | C2: 10.6ns | Delta Cursor 10.4ns | TRIGGER Source TRIG2 • |
|-----------------------|----------------------|--------------------|---|------------------------------------|
| Date and time | | | Time difference | Edge Positive |
| | Cursor 1 Cu | rsor 2 | | Trigger Pos.(mV) |
| | | | | 188mV set t |
| CH1 position | | | | VERTICAL |
| | | | | ✓ CH1 0.2V - |
| | - | | | Input Via Trigger |
| 11 | | | | Position -3.12mV |
| | Annotation rise time | | | CH2 0.5V - |
| | CH1 | | Trigger position | Input Via Trigger |
| | - | | Higger position | Position -1.50V |
| CH2 position | Measurement displ | | | HORIZONTAL |
| | | CH1 and | CH2 | 2ns/div |
| | | | <t c<="" td=""><td>Additional Delay Sli CH1 1002ps</td></t> | Additional Delay Sli CH1 1002ps |
| Vert. reso CH1 and | | | Hor. resolution | |
| | | | Hor. resolution | Gra j Goops / |
| | | 133ns | | RUN STO |
| 0.2V | Ampl 186.3mV 272 | 3mV Delay: 10 | | Status |
| 0.5V djust | Cursor | Measurement | Ops 2ns/div | Running |
| ninzi | | ical Display 1 (Pi | Annotation | Draw Dot Snapshot |

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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

| ☑ CH1 0.2∨ ▼ | |
|---------------------|--|
| 🔲 Input Via Trigger | |
| Position -3.12mV | |
| ✓ CH2 0.5∨ ▼ | Display Trace: checked, unchecked |
| 🔲 Input Via Trigger | Vertical Resolution: 1V, 0.5V, 0.2V, 100mV, 50mV, 2 Input Via Trigger: checked, unchecked |
| Position -1.50V | Position: full vertical screen |

Figure 7: Vertical

| HORIZONTAL | | | | | | |
|------------|-------------------------|--|--|--|--|--|
| 10ns/div 🔽 | | | | | | |
| Ad | Additional Delay Slider | | | | | |
| CH1 | 1232ps 🔽 | | | | | |
| CH2 | Ops 🗆 | | | | | |

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

| – Display | |
|------------------------------------|----------|
| Draw Dot Grid On Persistence | Snapshot |

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

Figure 10: Display

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 | | | | | | |
|---------------|--------------|----------------|--|--|--|--|
| 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 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

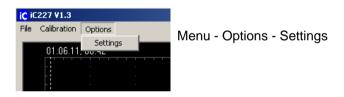


Figure 17: Options settings

| iC227 - Settings | |
|--|--|
| Display | Display: |
| Snapshot Path: C:\Programme\iC227\ | Snapshot Path |
| Persistance Time: | Persistence Time 19 overlays |
| Colors Colors CH1 trace CH2 trace CBackground CNormal Text CGrid C Text Background C Annotations | Colors: CH1/CH2 (fitting to cable colors) |
| Set all colors to default T Autoupdate Cancel OK | Autoupdate checkbox: live change of color settings |



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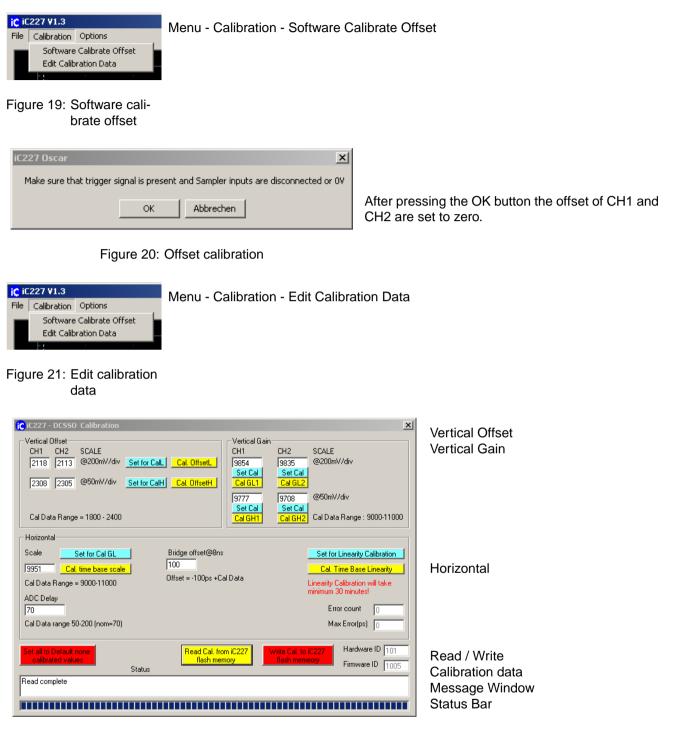


Figure 22: Edit calibration

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| F | c | iC227 | D | CSSO | ¥1.3 |
|---|----------|-------|---|------|------|
| | * | | - | | |

| File | Calibratio | n Options | Menu - File: |
|------|-----------------------|-----------|--|
| | ad Setup ave Setup | | Load Setup Save Setup to a simple text file e.g. config.txt |
| E> | cit | 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

| | e Ölfset - Low G | 2011 | | - |
|----|------------------------------------|------|-----------------------------------|---------------|
| į) | Make sure that Then press 'Cal. | | nt and sampler inputs are disconn | ectand or OV! |
| | | | | |

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.

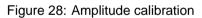
| ⊢ Vertical Gai | n | |
|----------------|---------|-----------------------------|
| CH1 | CH2 | SCALE |
| 9690 | 9310 | @200mV/div |
| Set Cal | Set Cal | |
| Cal GL1 | Cal GL2 | |
| 9680 | 9660 | @50mV/div |
| Set Cal | Set Cal | |
| Cal GH1 | Cal GH2 | Cal Data Range : 9000-11000 |

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
- 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.



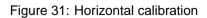
Figure 30: Amplitude calibration

- 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 | | minimum oo minutes |
| 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 | r 1 input, connect sampler CH1 to triger1 output 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 DC550 | x |
|---|---|
| Connect 1Vpp,10 MHz Sine Wave to Trigge | er 1 input, connect sampler CH1 to triger1 output and Clik OK |
| | ОК |

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.

| | | Status |
|-------------------------------------|----------------------------------|--------|
| Hardware ID 101 Firmware ID 1005 | Calibrating 3220 of 10500 points | |
| | | |

Figure 35: Calibration status

EXAMPLES

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

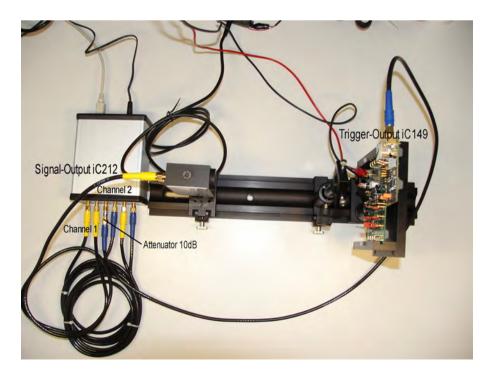


Figure 36: Set-up

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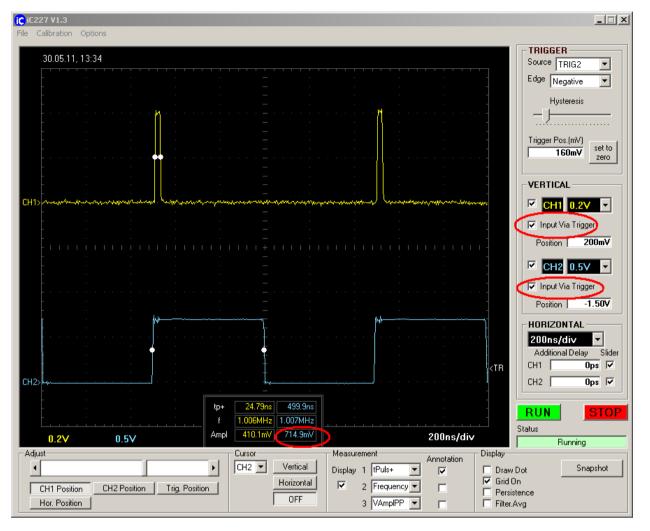


Figure 37: Measurement

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

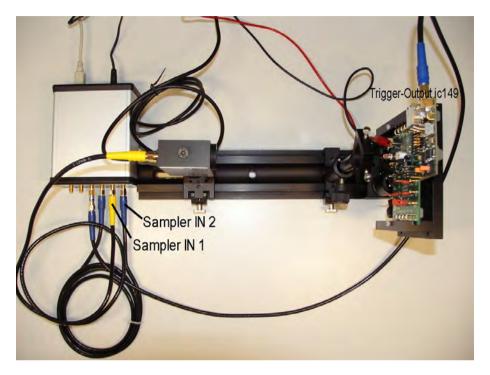


Figure 38: Set-up

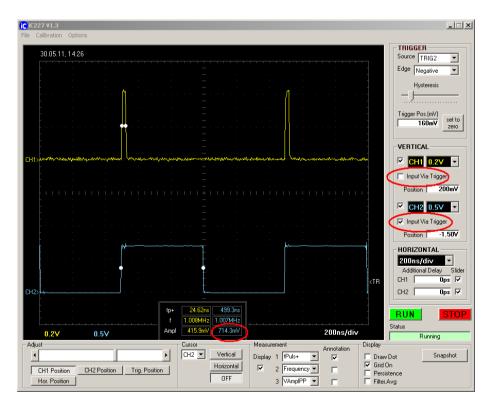


Figure 39: Measurement

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

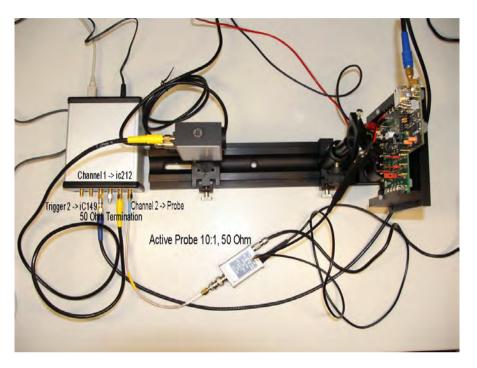


Figure 40: Set-up

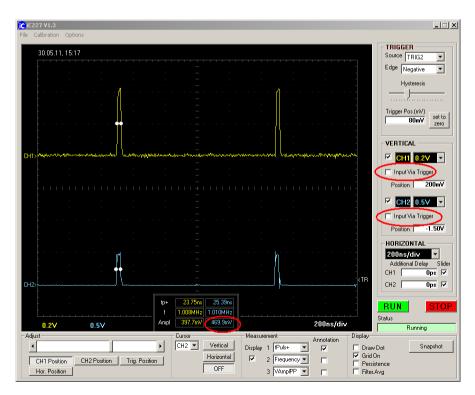


Figure 41: Measurement

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

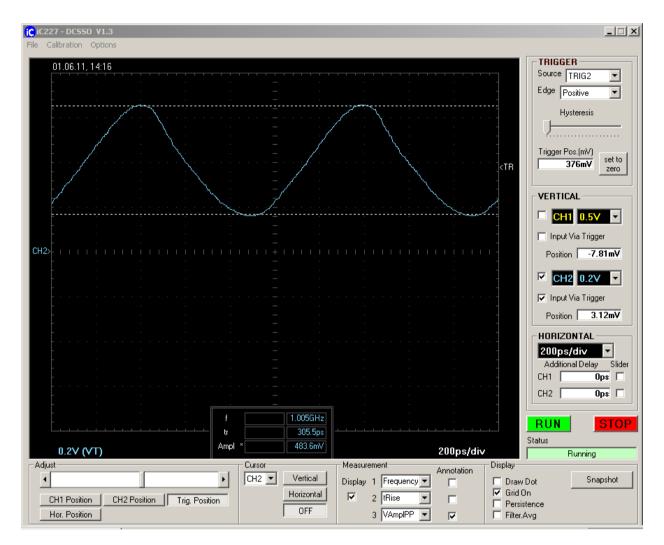


Figure 42: Measurement

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

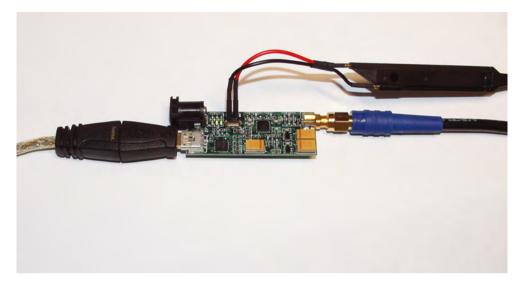


Figure 43: RF generator

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).

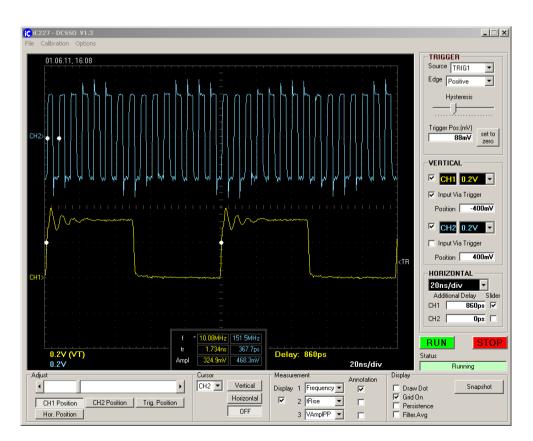


Figure 44: RF generator output frequency 150 MHz

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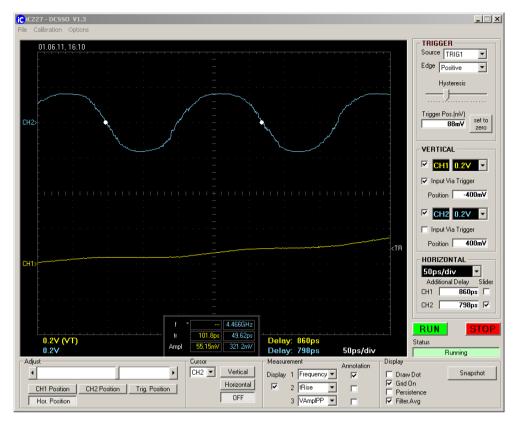


Figure 45: RF generator output frequency 4.4 GHz - the maximum possible value



Figure 46: RF generator

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PACKING LIST



Figure 49: Cable

Figure 50: Delay lines

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

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

1 wall power adaptor

1 aluminium housed oscilloscope

1 transportation case





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Figure 51: Contents

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ORDERING INFORMATION

| Туре | Package | Order Designation |
|-------|---------|-------------------|
| iC227 | | iC227 |

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

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