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# BCM-RF-E
# Beam Charge Monitor - RF receiver
# User's Manual

Rev. 1.1

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## Record of updates

| Version: | Release date: | Change: |
|---|---|---|
| 0.0 | Dec. 2012 | First review |
| 0.1 | Jan. 2013 | Connectors pins allocation : corrected & updated – Summary : cleaning – Sensitivity : small change |
| 0.2 | Mar. 2013 | DB9 Remote control section removed – Architecture : DB9 remote control removed - Pin allocations table updated – Summary updated |
| 0.3 | Jul. 2013 | USB update. |
| | | |
| 1.0 | Feb. 2014 | SENSITIVITY : Qcal and Ucal added, log10() instead of exp(). GUI section added, FIRMWARE section added. CALIBRATION section added. ARCHITECURE : DB9,6ADC.TRG.OUT added. |
| 1.1 | Dec. 2014 | General improvements and corrections |

## SUMMARY

## INITIAL INSPECTION, WARRANTY, ASSISTANCE

### INITIAL INSPECTION

It is recommended that the shipment be inspected immediately upon delivery. If it is damaged in any way, contact Bergoz Instrumentation or your distributor. The content of the shipment should be compared to the items listed on the invoice. Any discrepancy should be notified to Bergoz Instrumentation or its distributor immediately. Unless promptly notified, Bergoz Instrumentation will not be responsible for such discrepancies.

### WARRANTY

Bergoz Instrumentation warrants its beam monitors to operate within specifications under normal use for a period of 12 months from the date of shipment. Spares, repairs and replacement parts are warranted for 90 days. Products not manufactured by Bergoz Instrumentation are covered solely by the warranty of the original manufacturer. In exercising this warranty, Bergoz Instrumentation will repair, or at its option, replace any product returned to Bergoz Instrumentation or its distributor within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and that the defect has not been caused by misuse, neglect, accident or abnormal conditions or operations. Damages caused by ionizing radiations are specifically excluded from the warranty. Bergoz Instrumentation and its local distributors shall not be responsible for any consequential, incidental or special damages.

### ASSISTANCE

Assistance in installation, use or calibration of Bergoz Instrumentation beam monitors is available from Bergoz Instrumentation, 01630 Saint Genis Pouilly, France. It is recommended to send a detailed description of the problem by e-mail.

### SERVICE PROCEDURE

Products requiring maintenance should be returned to Bergoz Instrumentation or its distributor. Bergoz Instrumentation will repair or replace any product under warranty at no charge. The purchaser is only responsible for transportation charges.

For products in need of repair after the warranty period, the customer must provide a purchase order before repairs can be initiated. Bergoz Instrumentation can issue fixed price quotations for most repairs. However, depending on the damage, it may be necessary to return the equipment to Bergoz Instrumentation to assess the cost of repair.

### RETURN PROCEDURE

All products returned for repair should include a detailed description of the defect or failure and name of the user. Contact Bergoz Instrumentation or your local distributor to determine where to return the product. Returns must be notified by e-mail prior to shipment.

Return should be made prepaid. Bergoz Instrumentation will not accept freight-collect shipment. Shipment should be made via United Parcel Service, DHL or Federal Express. Within Europe, the transportation service offered by the Post Offices "EMS" (Chronopost, Datapost, etc.) can be used. The delivery charges or customs clearance charges arising from the use of other carriers will be charged to the customer.

## YOU JUST RECEIVED A BEAM CHARGE MONITOR ....

This manual applies only to BCM-RF revisions 204.2 and above

Its does NOT apply to either earlier BCM-RF revisions, BCM-IHR or BCM-CA.

The BCM-RF system includes:

Description Order code

- BCM-RF electronics module BCM-RF-E/XXXMHz
  Where XXXX is operating frequency

Accessories

- 19" chassis with power supply BCM-RFC/XX,
  Where XX = number of BCM stations

Note : BCM-RFC/XX RF-shielded chassis is compatible with BCM-IHR, BCM-CA.

Hence, BCM-RF, BCM-IHR and BCM-CA can be mixed in same BCM-RFC/XX chassis.

## Determine your BCM-RF operating mode (charge or current measurement)

- Sample & Hold mode (S&H) for bunch charge measurement.
- Track-Continuous mode (T-C) for CW or long macropulse beam current measurement.

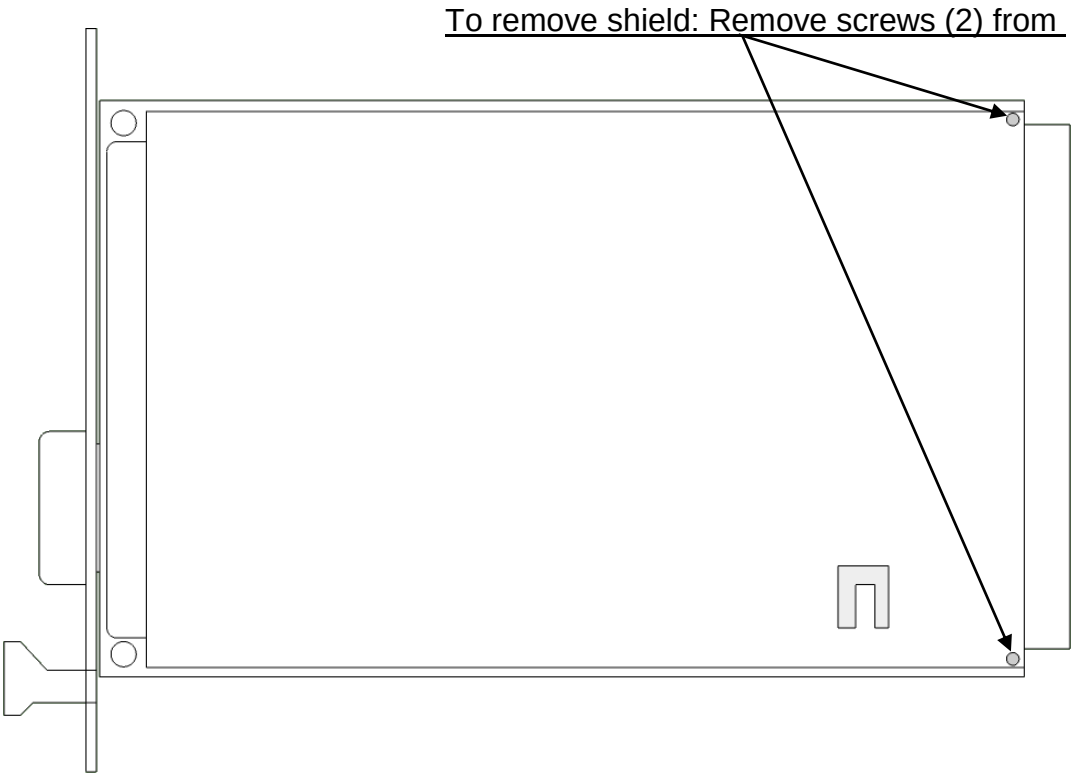
BCM-RF-E is factory configured either for beam charge measurement or beam current measurement. The operating mode can be selected with mechanical switches or by USB remote control (see OPERATING MODE SELECTION).

The ex-factory mode of operation is defined in the Test report and in the Certificate of Calibration.

**ACCESS to SWITCHES**

To access switches, remove the module shield:

Note: It is possible to remote control BCM-RF-E via the USB port (*) without removing module shield.



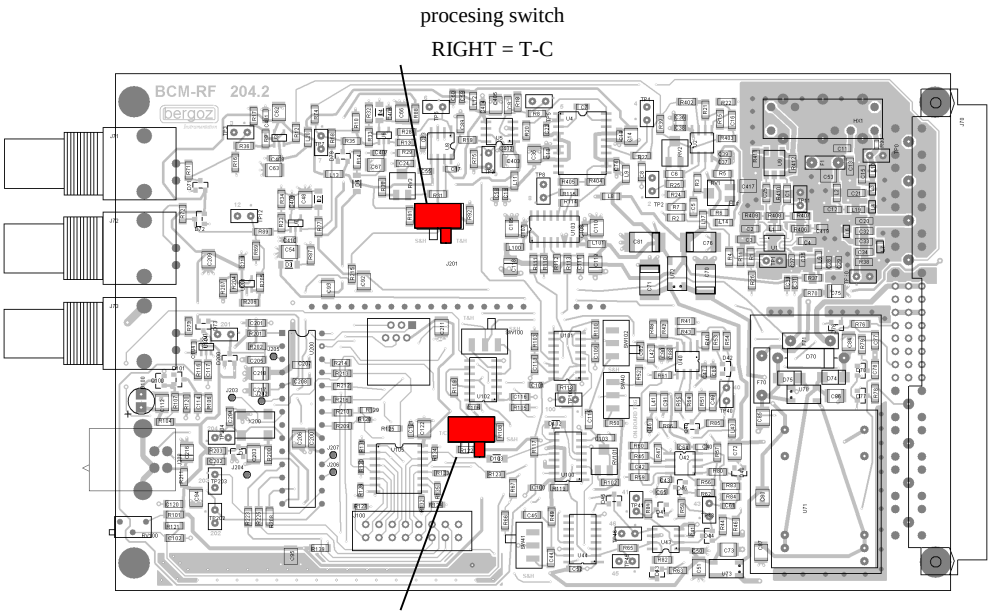

(*) Available only from #006 BCM-RF serial number. Firmware revision is written on the microcontroller.

## OPERATING MODE SELECTION

### By using on-board switches … (manual mode)

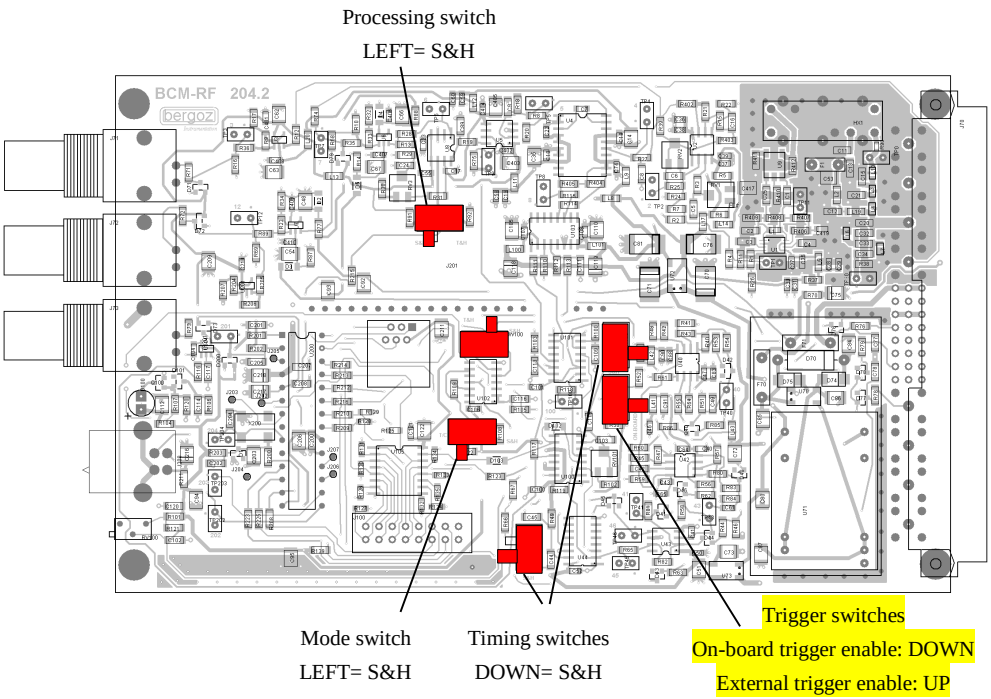
WARNING : the PIC microcontroller has the priority on switches control. To use the mechanical switches, please remove the microcontroller from its slot.

Track-Continuous mode (T-C)




*Note: others switches not used in this mode*

Sample and Hold mode (S&H)



## OPERATING MODE SELECTION (Cont'd)

### By remote control via USB port

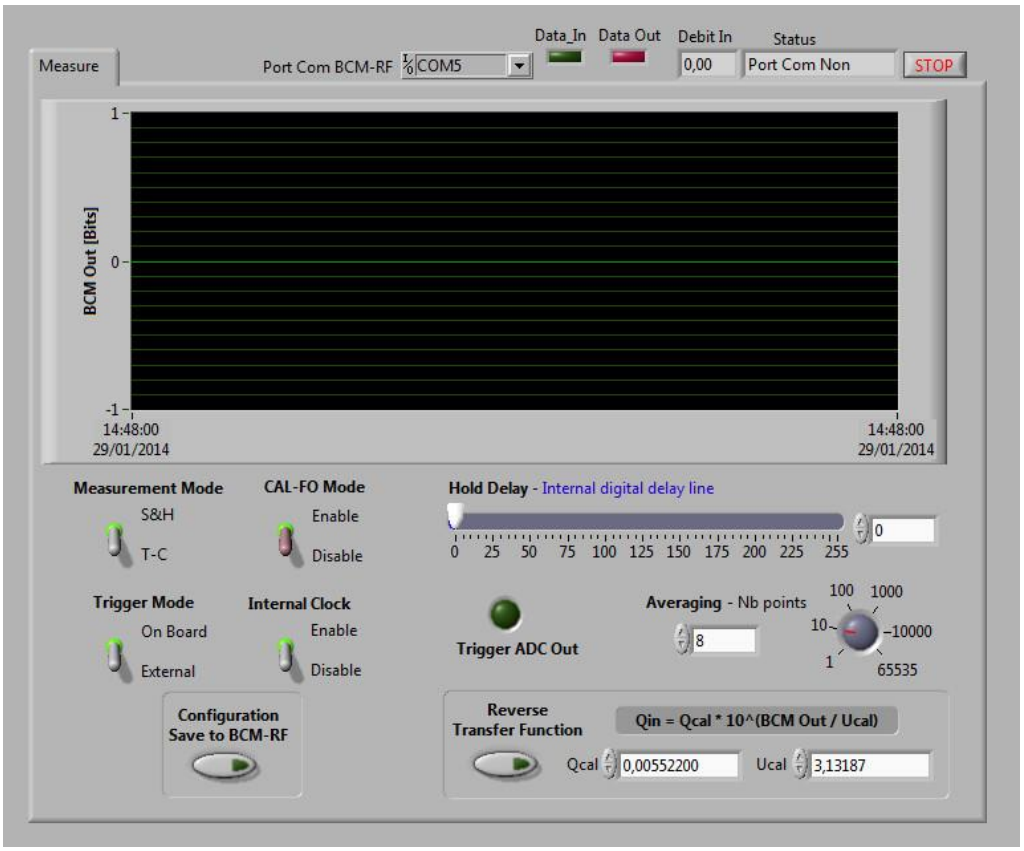
Available only from #006 BCM-RF-E serial number. Bergoz Instrumentation provides a Labview Graphical User Interface to control and read the BCM-RF-E. This software is available from our website. See GRAPHICAL USER INTERFACE section.

Name : BCM-RF-GUI-x.x

Extension : executable file (.EXE)

Requires : Labview Run Time Environment 7.1

Size : < 500 KB



## QUICK CHECK

You can check immediately that your BCM is working. This is what you need:

- BCM-RF-E (Beam Charge Monitor RF): at least one BCM-RF-E electronics module in…
- BCM-RFC/xx chassis
- Turbo-ICT (Turbo-Integrating Current Transformer)
- 4-channel oscilloscope with 500 MHz bandwidth or higher
- Fast pulse generator <200 ps fwhm, <200 pC, <2 MHz repetition rate or with external trigger
- Pulse generator used as trigger: >2 V pos. edge, Tw>100 ns, <2 MHz repetition rate
- Short (4…8 ns) BNC cables and SMA-BNC adapters.

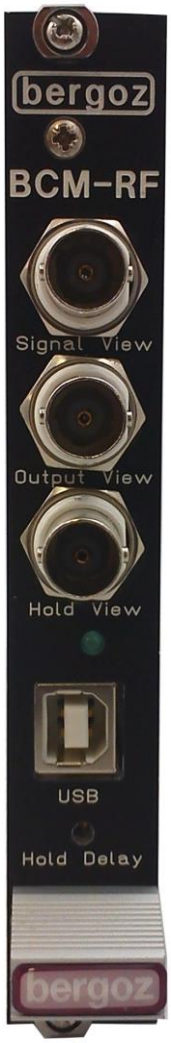
Verify that this manual corresponds to your BCM version

The modular Electronics "Beam Charge Monitor, RF" (BCM-RF-E) version is the object of this manual. Other User's Manuals cover other versions:  BCM-IHR-E and BCM-CA-E.

**QUICK CHECK ...**

**Front panel**

BCM-RF-E module




Signal View, Log signal envelope (1 Mohm or 50 ohm)

Output signal, proportional to the input charge logarithm (1 Mohm)

Hold View, rising edge indicates time when log value is held (50 ohm, only in S&H mode)

Front panel LED : blinks in S&H mode when an input signal or external trigger arrives.

USB connector type B : data readout and remote control

Hold Delay front panel trimmer used to fine adjust the hold time.
Do not change if Turbo-ICT-CAL-FO option is installed!

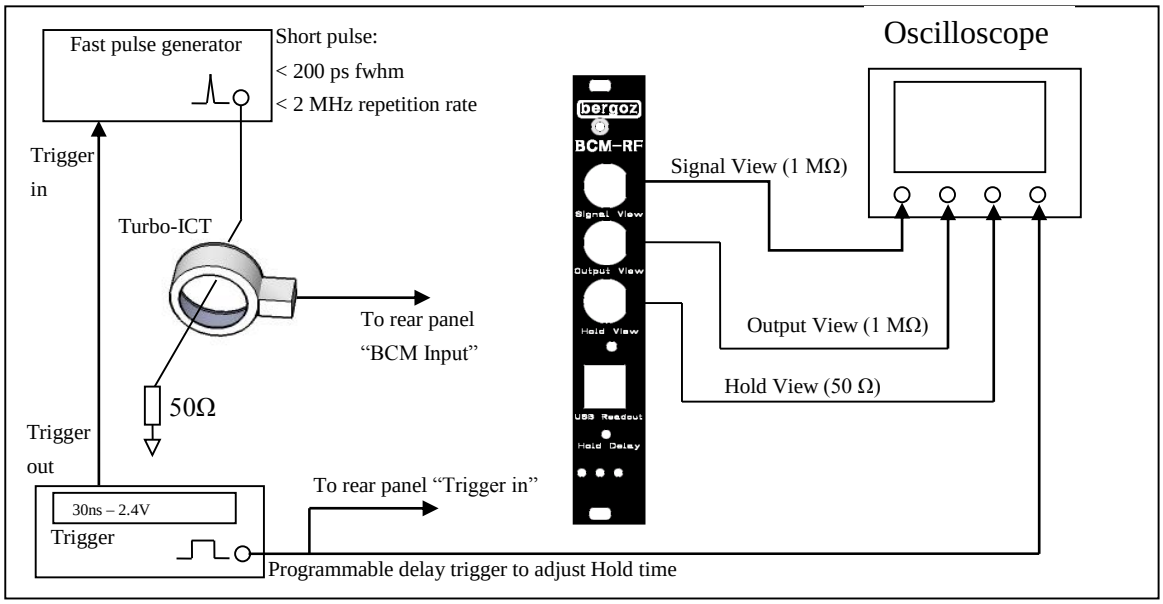
**WARNING: Jumpers configuration & Potentiometers settings**
Your BCM is in the "Ex-factory" configuration.
Jumper and timing adjustments (potentiometers) have been configured according to your order.
Do not change those settings until you are familiar with the Beam Charge Monitor.

**QUICK CHECK ....**

**Charge measurement, select Sample & Hold mode (S&H), to measure bunch charge**

See OPERATING MODE SELECTION

**SETUP**




Connect the Turbo-ICT to "BCM Input" SMA connector on chassis rear panel.

Make sure your AC mains voltage corresponds to BCM-RFC chassis mains voltage.

Note: A label with the set AC mains voltage is affixed to the power supply unit front panel

Connect BCM-RFC chassis AC input to the mains.

- Apply a 50 ohm fast pulse through the Turbo-ICT aperture:
- Pulse charge: <200 pC.
- Pulse polarity: any.
- Pulse fwhm <200 ps.
- Pulse repetition rate: < 2MHz (expected to be triggered by pulse generator below)
- Apply a 50 ohm pulse from generator to "Trigger in" SMA connector on BCM-RFC/XX chassis rear panel:
- Pulse width: >30 ns.
- Pulse polarity: rising edge.
- Pulse amplitude: >2.4 V in 50 ohm
- Pulse repetition rate: <2 MHz ( >500 ns).

Apply same pulse to oscilloscope trigger input.

## Charge measurement, Sample & Hold mode (cont'd)

### Waveforms

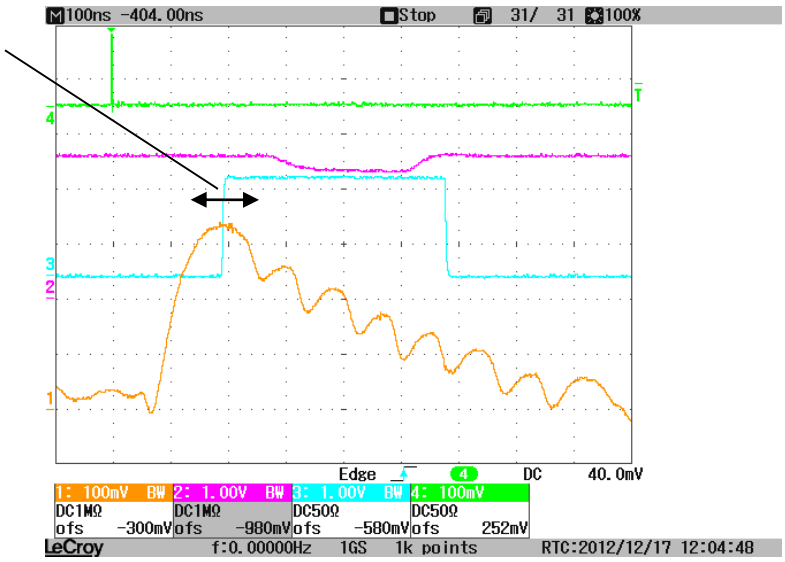
Adjust Hold time to get the maximum value on Output View using external trigger delay or internal delay line by USB.

Ch 4 - Input pulse
Fwhm = 200 ps T=20 ms

Ch 2 - Output View
(Log. of the input charge)

Ch 3 - Hold View
(Rising edge indicates time when log signal is held)

Ch 1 - Signal View
(Log. envelope of Turbo-ICT signal)




Channel 4 (green) shows the input short pulse which goes thru the Turbo-ICT aperture.

Channel 2 (pink) shows "BCM Out". This voltage is held constant for up to 100ms after the pulse.

Channel 3 (cyan) shows the "Hold View". The rising edge is an indication when the hold time occurs. But it is too imprecise to set up trigger timing.

Channel 1 (orange) shows the "Signal View". This is the logarithmic envelope of the signal from the Turbo-ICT. The voltage apex is proportional to the logarithm of the beam charge.

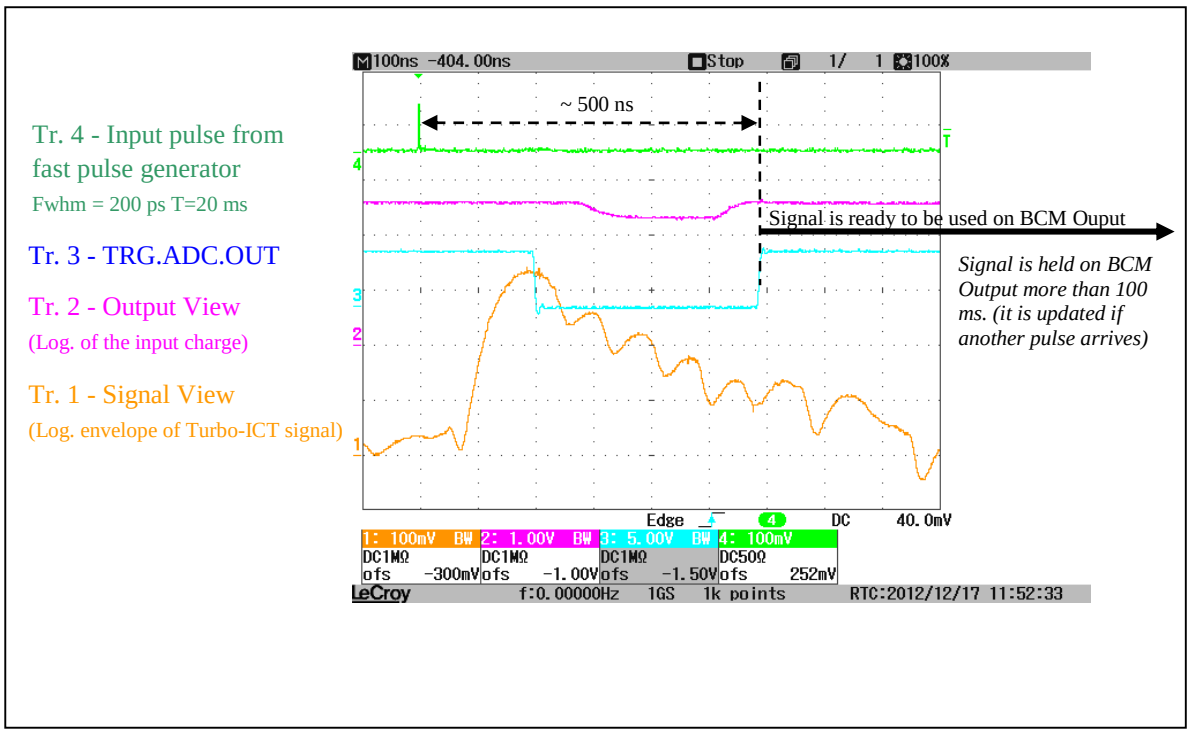
To adjust the hold time:

- Monitor the traces above with an oscilloscope. Check all waveforms.
- Adjust the hold time using the GUI or by adjusting the external trigger delay. Check that the rising edge of "Hold View" is close to the apex of "Signal View".
- Connect a digital voltmeter to "BCM Out".
- Fine adjust hold time to maximize the output voltage. The rising edge of "Hold View" might not coincide with the "Signal View".
- Once installed in the accelerator, hold time has to be set up again to account for changes in the signal delay between Turbo-ICT and BCM-RF.

**Charge measurement, Sample & Hold mode (cont'd)**

**ADC trigger waveforms**

Observe ADC Trigger output "TRG.ADC.OUT" available from the DB9 connector pin 3 on the chassis rear panel.




BCM Output signal is ready to be used on the rising edge of TRG.ADC.OUT which occurs about 500 ns after the input pulse.

Your ADC can be triggered from DB9 pin 3 output signal TRG.ADC.OUT:

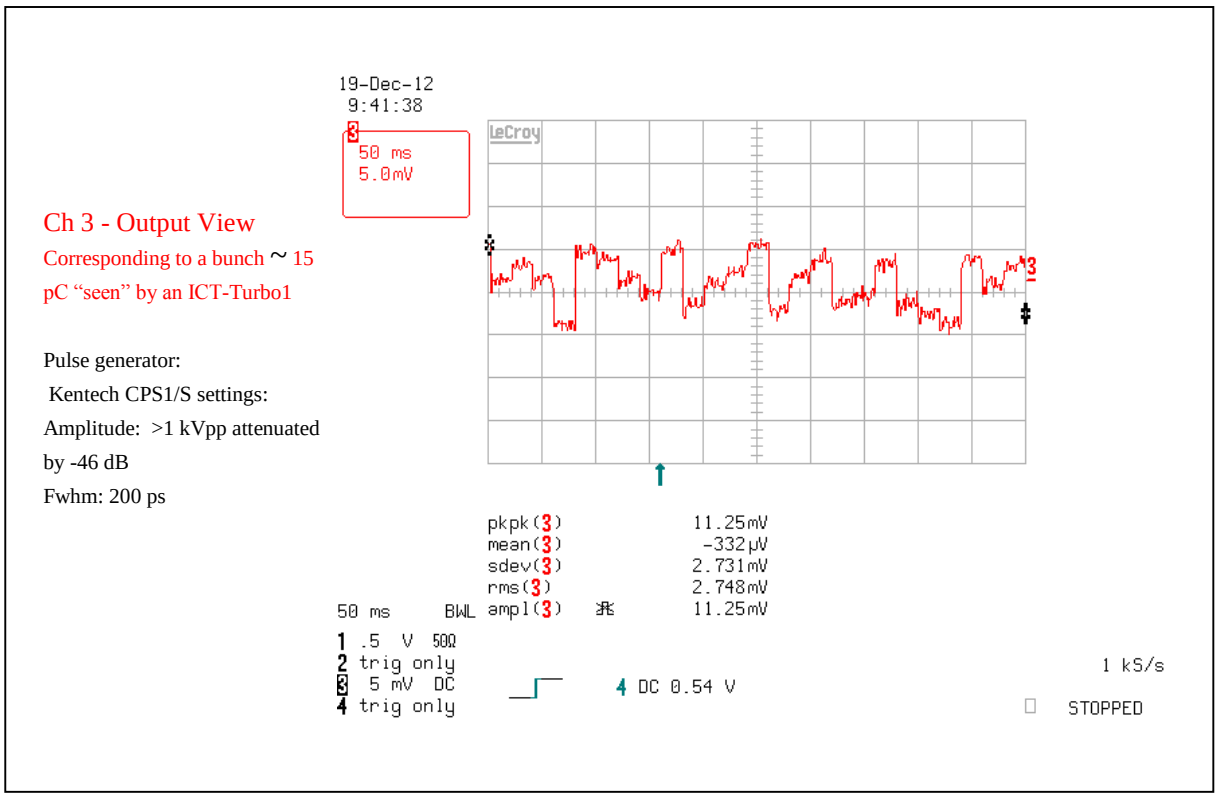
- First edge is 200 ns after the beam bunch.
- Second edge is 500 ns after the beam bunch.
- Polarity of edge is determined by ADC Trigger Edge Polarity switch.

## Charge measurement, Sample & Hold mode (Cont'd)

### Sample-to-sample noise

The BCM Output exhibits noise. The following test gives an idea of the noise, without the need for a sophisticated data acquisition system.

An oscilloscope takes a single sweep of Output View. Its time base is set to display –in a single sweep- the output corresponding to ~ 25 input pulses.



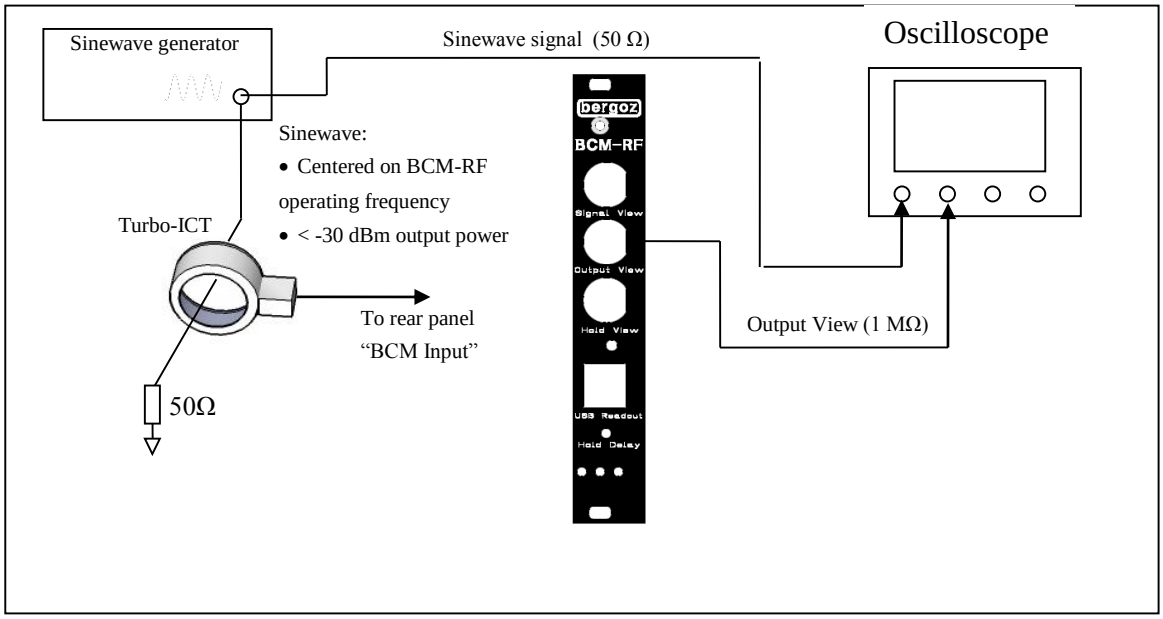

From a succession of 15 pC input pulses, the BCM-RF provides an output noise standard deviation of 2.5 mVrms. Applying the calibrated reverse "log" function from an ICT-Turbo1 to this output noise gives an equivalent input noise of 0.11 pCrms. One can see that the signal over noise ratio is 136, equivalent to 0.7 % resolution.

**QUICK CHECK ....**

**Current measurement, select Track-Continuous mode (T-C), to measure CW beam or long macropulses average current**

See OPERATING MODE SELECTION

SETUP




Connect the Turbo-ICT to "BCM Input" SMA connector on chassis rear panel.

Make sure your AC mains voltage corresponds to BCM-RFC chassis mains voltage.

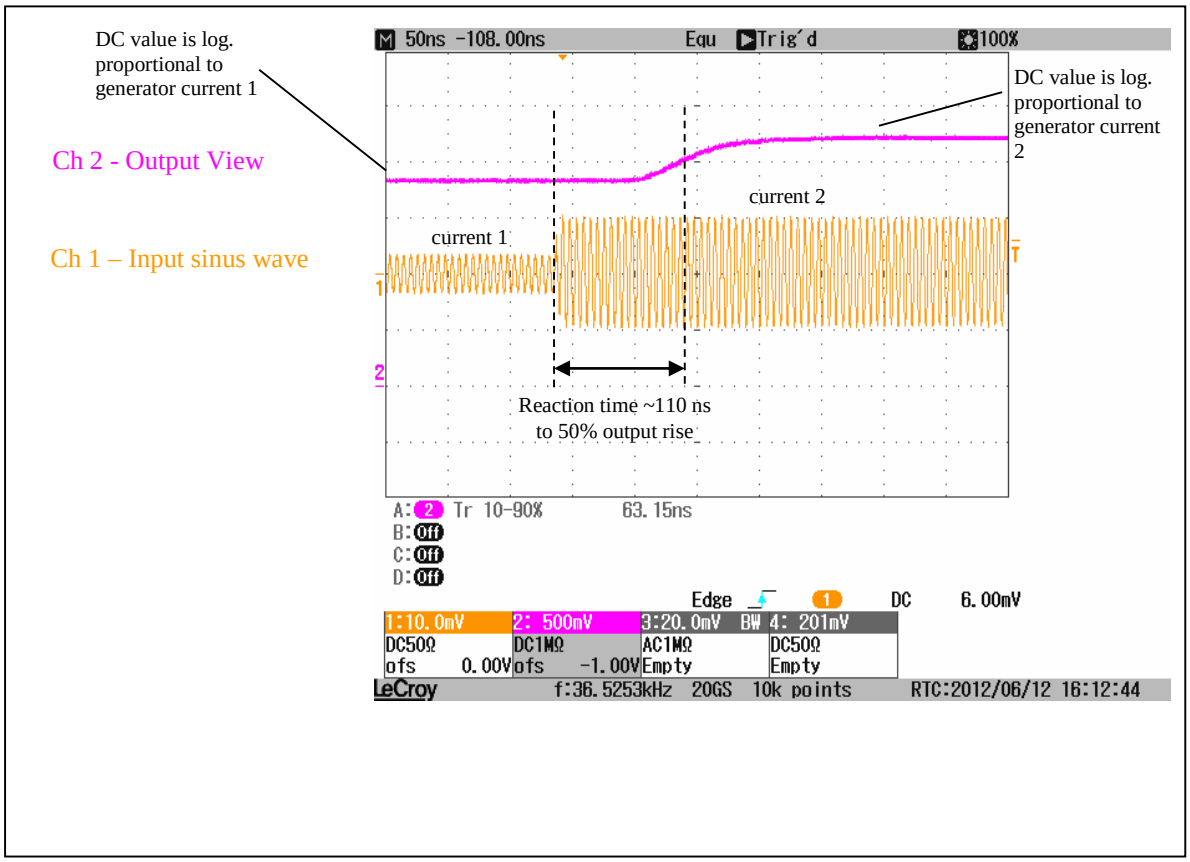
Note: A label with the set AC mains voltage is affixed to the power supply unit front panel.

Connect BCM-RFC chassis AC input to the mains.

- Apply a 50 ohm sinewave signal into Turbo-ICT aperture.
- Sinewave centre frequency: BCM-RF-E operating frequency marked on BCM-RF-E label located on DIN41612M connector, or Certificate of Calibration.
- Output power: <-30 dBm.

## Current measurement, Track-Continuous mode (T-C) (Cont'd)

### Waveforms and reaction time




The signal Output View is proportional to the logarithm of the current from the generator.

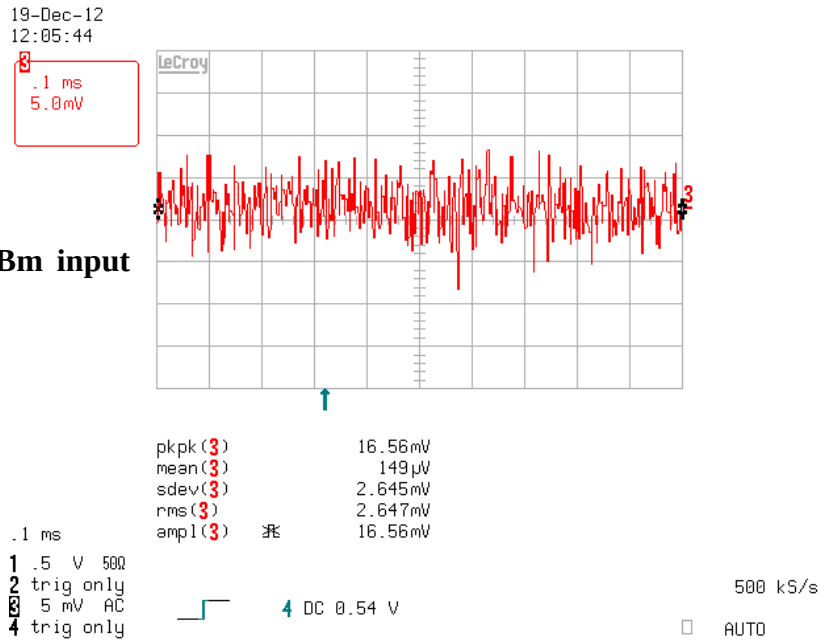
The reaction time, measured from the input current change until the output value rises by 50%, is about 110 ns.

**Current measurement, Track-Continuous mode (T-C) (Cont'd)**

**Noise**

Ch 3 - Output View

**Output noise from - 30 dBm input sinewave (141 uArms)**

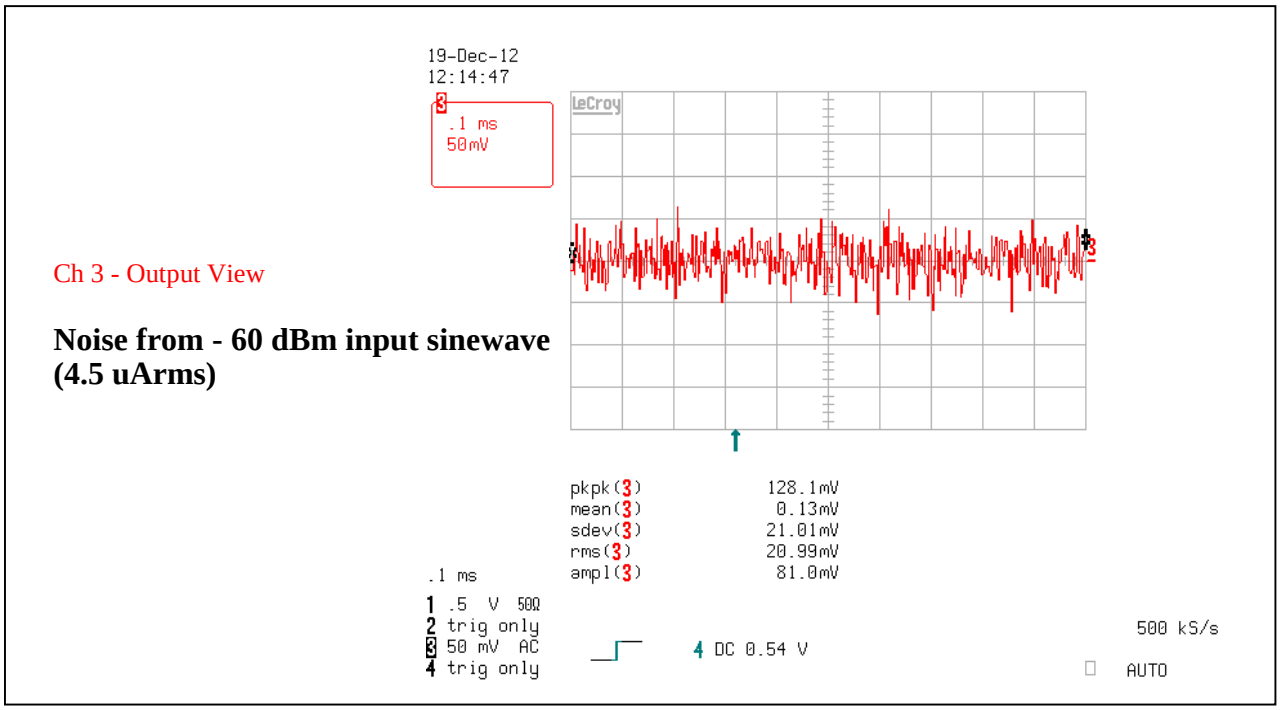



*Note : Above -30 dBm input power, noise remains the same.*

Output View contains ~2.7 mVrms of noise when -30 dBm signal is applied through the ICT-Turbo1 aperture.

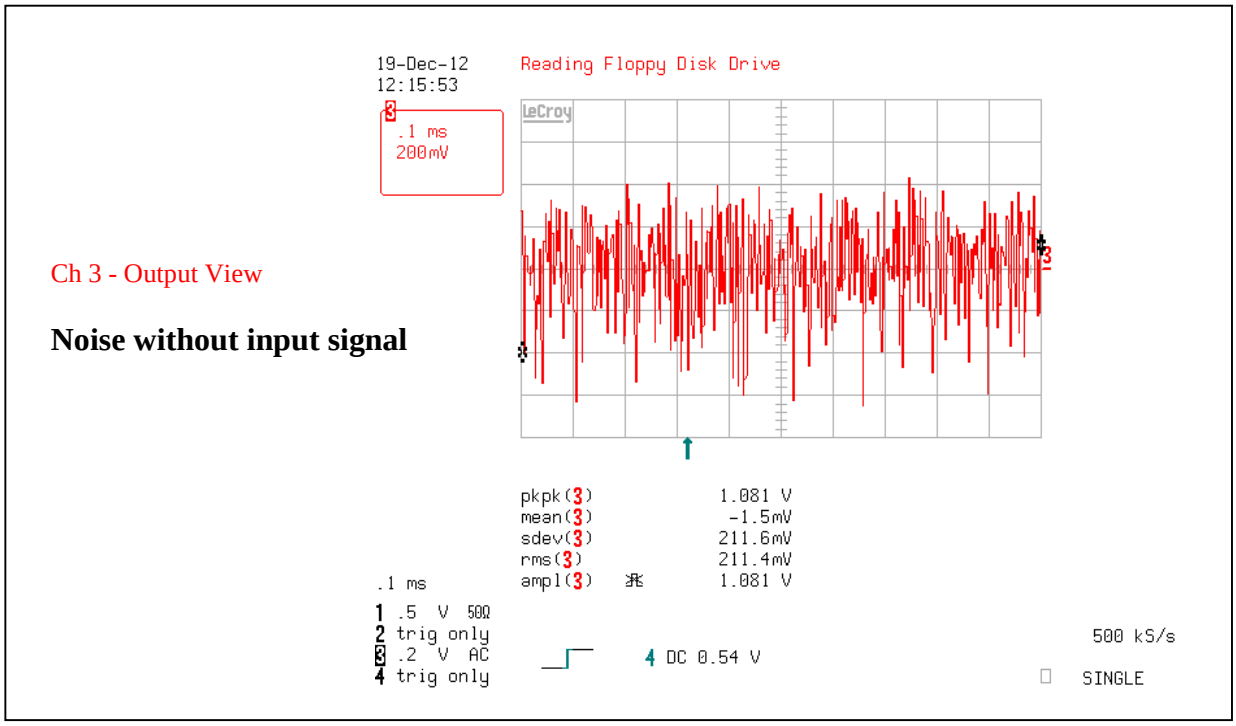
The equivalent input noise taken from the calibrated reverse function is 1 uArms i.e. 0.7% resolution.

**Current measurement, Track-Continuous mode (T-C) (Cont'd)**




The noise (standard deviation) from -60 dBm signal applied through ICT-Turbo1 aperture is about 21 mVrms. The equivalent input noise taken from the calibrated reverse function is 0.14 uArms i.e. 0.7% resolution. Notice that the resolution remains the same although the signal decreases.

## Current measurement, Track-Continuous mode (T-C) (Cont'd)




Without input signal, Output View is noisy because in the absence of an input signal the logarithmic amplifier gain increases.

When no signal is applied through the Turbo-ICT aperture, the noise on Output View is typically some 10 millivolts.

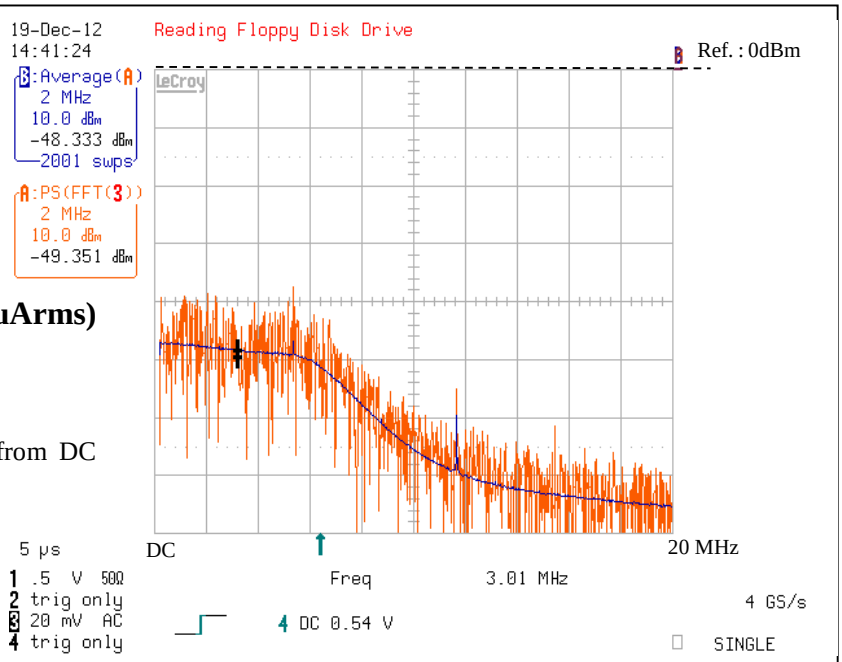
## Current measurement , Track-Continuous mode (T-C) (Cont'd)

### Wide-band output power spectrum

Ch A – DC to 20 MHz Output View
Spectrum power

**- 60 dBm input sinewave (4.5 uArms)**

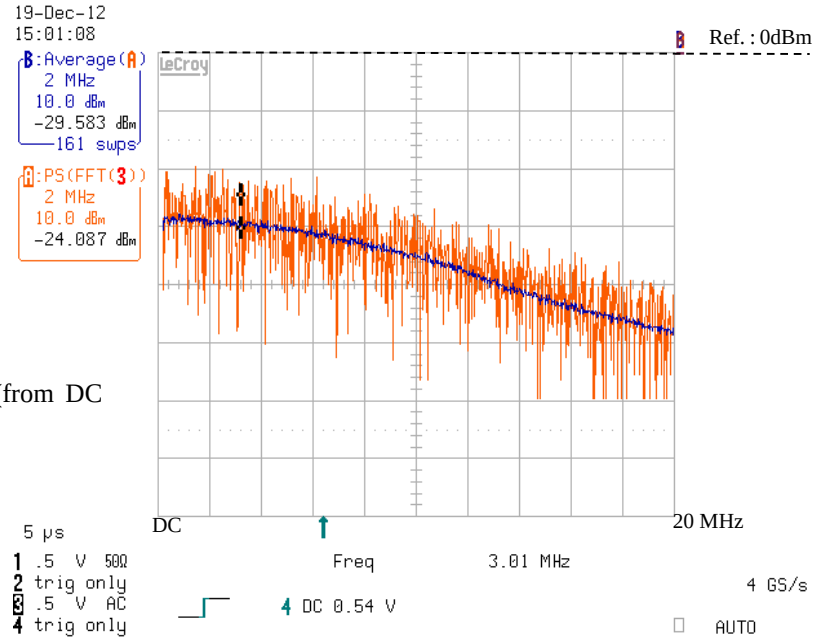
Vertical scale: 10 dB/
Horizontal scale: 2 MHz/ (from DC to 20 MHz)



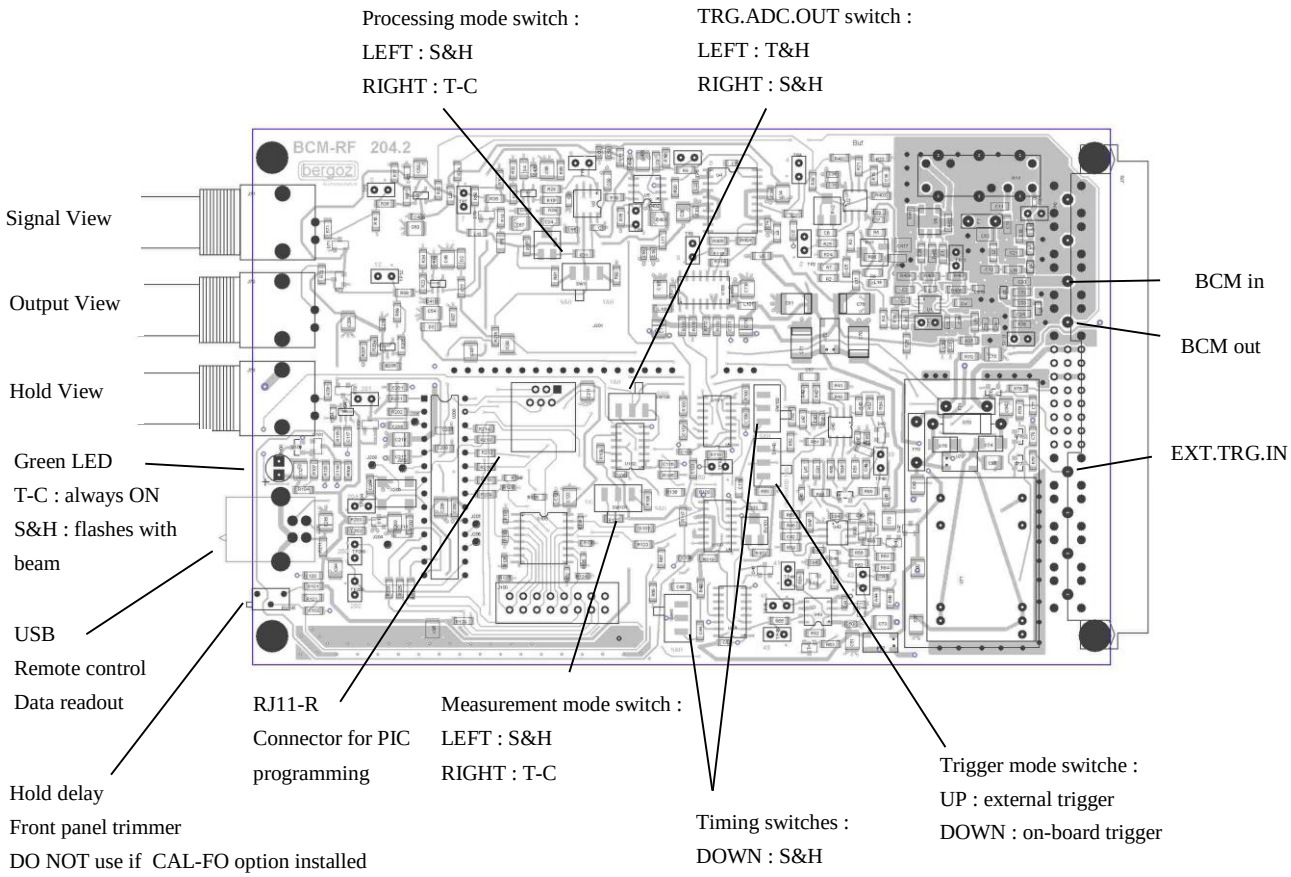

Tr. A – DC to 20 MHz Output View
Spectrum power

**Without input signal**

Vertical scale: 10 dB/
Horizontal scale: 2 MHz/ (from DC to 20 MHz)



## I/O AND SWITCHES



## GENERAL DESCRIPTION

BCM-RF electronic modules (-E) embeds two modes of operation:

T-C mode: BCM-RF output provides the log envelope of the Turbo-ICT modulation in 10 MHz bandwidth. Suitable for CW or macropulse beam current measurements.

S&H mode: BCM-RF output holds the log envelope voltage apex of the Turbo-ICT modulation. The output is a DC level held up to 100ms or until the next bunch arrives. This mode allows repetition rates up to 2 MHz. Suitable for single bunch charge measurements.

This manual describes both modes.

### System components

In a beam line or particle accelerator application, the BCM detects the beam signal with a non-destructive sensor:

• Turbo Integrating Current Transformer (Turbo-ICT).

Electronics are housed in a 3U-high, 19"-wide RF-shielded chassis, which can hold:

• BCM-RF-E.

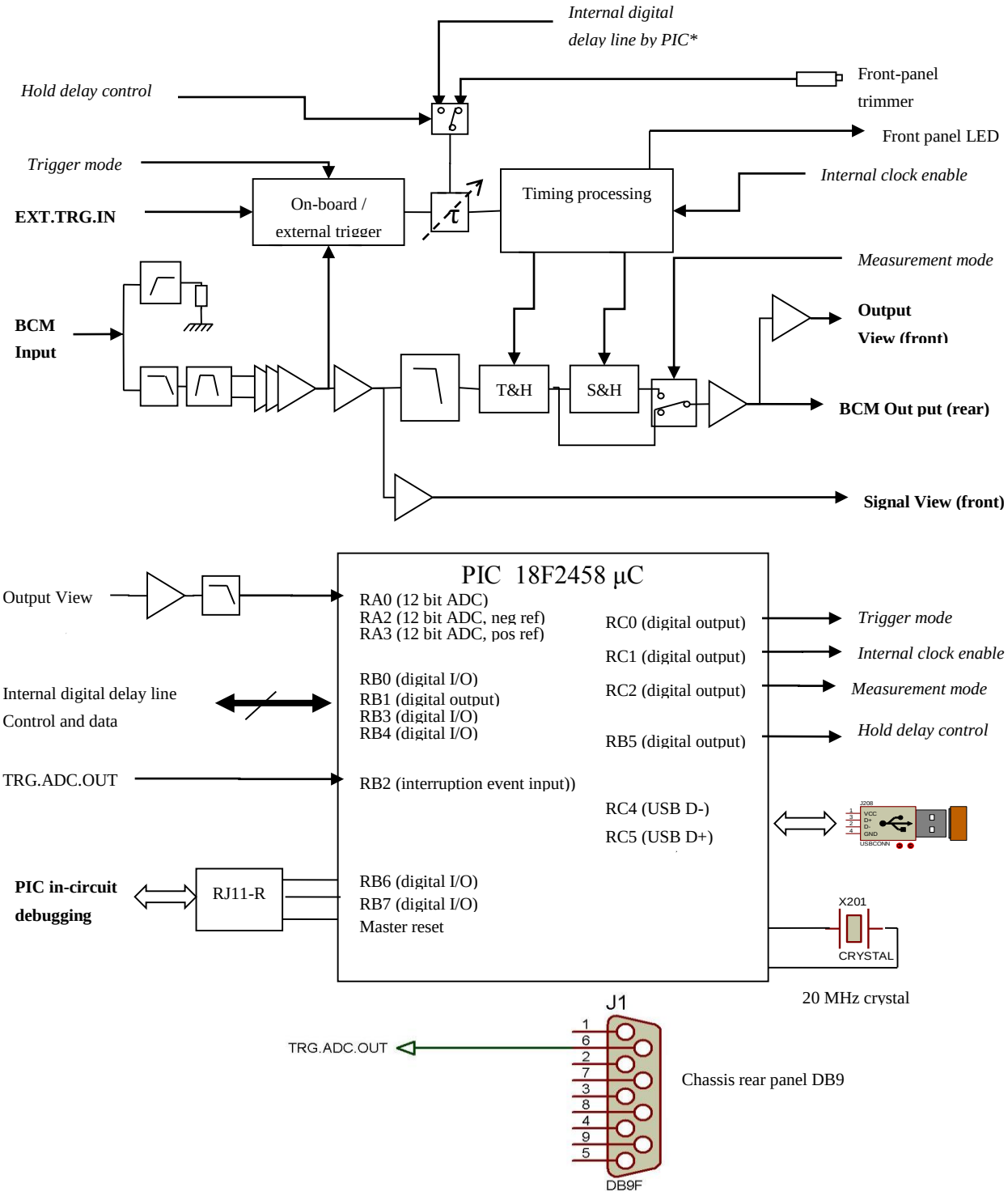
• Power Supply.

The BCM output is a voltage up to +5V, proportional to the log of the beam charge.

In "S&H" mode, the output voltage level is held up to 100ms or until a next bunch arrives.

In "T-C" mode, the output voltage waveform is the log envelope of the Turbo-ICT modulation signal in 20 MHz bandwidth.

## ARCHITECTURE



## SPECIFICATIONS

Typical performance measured with Turbo2 option:

### Charge measurement:

| | |
|---|---|
| BCM-RF mode | S&H |
| Input charge | 300 pC max (more without front-end amplifier) |
| Measurement single range | 500 fC – 300 pC |
| Bunch repetition rate | Single bunch – 2 MHz |
| Output voltage | 0 / 5V, log of the beam charge |
| Reaction time | 500 ns to > 99% final value |
| Noise | 50 fC or 1 % of charge (whichever is higher) |
| Non-linearity | 3% |
| Time response | Hold till next bunch |
| Trigger | on-board or external |
| | (pos. edge, > 2.4V in 50 ohm, > 30 ns width) |

### Current measurement:

| | |
|---|---|
| BCM-RF mode | T-C |
| Measurement single range | 5 uA – 20 mA (more without front-end amplifier) |
| Beam RF | 1 MHz – 350 MHz |
| Output voltage | 0 / +5V, log of beam current |
| Risetime | < 70 ns |
| Reaction time | 100 ns |
| Noise | 0.1 uA or 0.2% of current (whichever is higher) |
| Non-linearity | 3% |
| Time response | reports current variation to 10 MHz bandwidth |

**Input / output interfaces and others …**

| | |
|---|---|
| Front-panel connectors (BNC) : | Signal View (for oscilloscope, 50 ohm or 1 Mohm)<br>Output View (for oscilloscope, 1 Mohm)<br>Hold View (for oscilloscope, 50 ohm) |
| Rear module connector : | DIN 41612-M / 24+8 male, with 1.0/2.4 coaxial inserts |
| Back-panel connectors (SMA) : | BCM Input, 50-ohm coaxial cable from Turbo-ICT<br>BCM Output, for high-impedance readout |
| Trigger Input : | 50 ohm, pos. edge, > 2.4V, > 30 ns width |
| Front-panel potentiometers : | Hold time delay adjustment |
| Power consumption : | +15V, 170 mA / -15V, 110 mA (Turbo-ICT connected) |
| Card size : | 3U x 4F, i.e. Eurosize 100 x 160 mm, 20mm wide |
| Chassis size : | 3U x 19" |

**Power supply and fuses**

See Annex III: Delta Elektronika U-Series linear power supply data sheet

The mains voltage is factory set according to the label stuck to the front panel.

Please remove this label when you change the mains voltage selection.

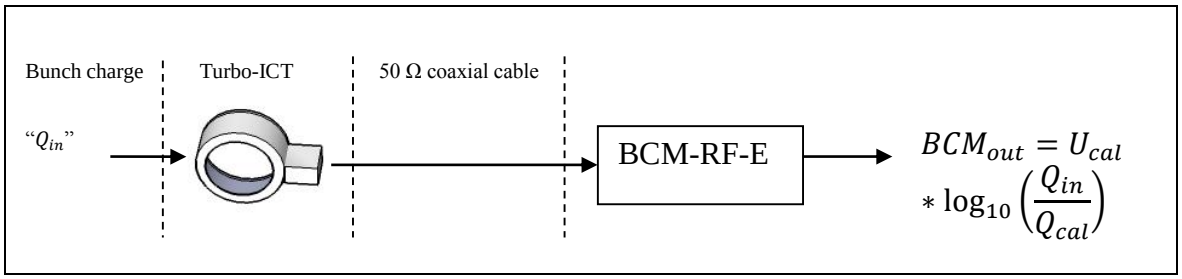
| | |
|---|---|
| Type : | 5U 15-15 modular plug-in ±15V linear power supply |
| Manufacturer : | Delta Elektronika, 4300A Zierikzee, The Netherlands |
| Output voltage : | ±15V, 200 mA |
| Mains voltage : | jumper selectable, 110, 220 Vac,50-60 Hz<br>tested at 90 Vac-50/60 Hz for 100 Vac Japanese mains voltage. |
| Mains voltage selector : | located under the power supply block |
| Card size : | 3U x 10F, i.e. Eurosize 100 x 160 mm, 50mm wide |
| Back-panel connector : | The Power supply mains are wired to a IEC connector via EMI/RFI filter and fuse. |

**SENSITIVITY of the TURBO-ICT and BCM-RF**

BCM Output gives a voltage proportional to the loarithmg of the input bunch charge. The sensitivity is defined by the reverse transfer function of the complete signal chain from Turbo-ICT to BCM-RF-E.

The sensitivity of a given combination of Turbo-ICT, BCM-RF-E and connecting cable is provided in the Calibration Report. Each combination has its own transfer function.

This section describes the sensitivity calculation from the beam to the BCM-RF-E output:




Reverse transfer function (sensitivity):

$$Q_{in} = Q_{cal} * 10^{\left(\frac{BCM_{out}}{U_{cal}}\right)} \ (\mathrm{S-H\ mode})$$

$$I_{in} = I_{cal} * 10^{\left(\frac{BCM_{out}}{U_{cal}}\right)} \ (\mathrm{T-C\ mode})$$

$U_{cal}$ and $I_{cal}$ are measured in Volts and $Q_{cal}$ is measured in pC. These calibration constants are factory measured and written on the Calibration Report.

Notice that losses in the cable connecting Turbo-ICT and BCM-RF were taken into account during calibration. Only in case the expected cable losses (see Calibration Report) differ from real cable losses, additional corrections have to be applied by the user. Real cable losses can be obtained, for example, by network analyser measurements. All losses from the Turbo-ICT output connector to the BCM-RF input connector must be taken into account.

Cable losses only affect $Q_{cal}$ and $I_{cal}$. Hence, any correction is just an additional factor applied to the reverse transfer function:

$$Q_{in} = Q_{cal} * \frac{Real\ Cable\ Losses}{Expected\ Cable\ Losses} * 10^{\left(\frac{BCM_{out}}{U_{cal}}\right)} \ (\mathrm{S-H\ mode})$$

$$I_{in} = I_{cal} * \frac{Real\ Cable\ Losses}{Expected\ Cable\ Losses} * 10^{\left(\frac{BCM_{out}}{U_{cal}}\right)} \ (\mathrm{T-C\ mode})$$

As long as the applied correction remains small, overall performance is not affected. But in case larger corrections must be applied lower and upper limits could shift. Non-linearities will change, too. In such a case, Bergoz Instrumentation can provide further advice.

## GRAPHICAL USER INTERFACE

Bergoz Instrumentation provides a demo GUI to control and read the BCM-RF via USB.

This software is an executable file developed on Labview 7.1 (will be updated to newer version).

It uses Windows generic USB to serial port driver. No external driver is required.

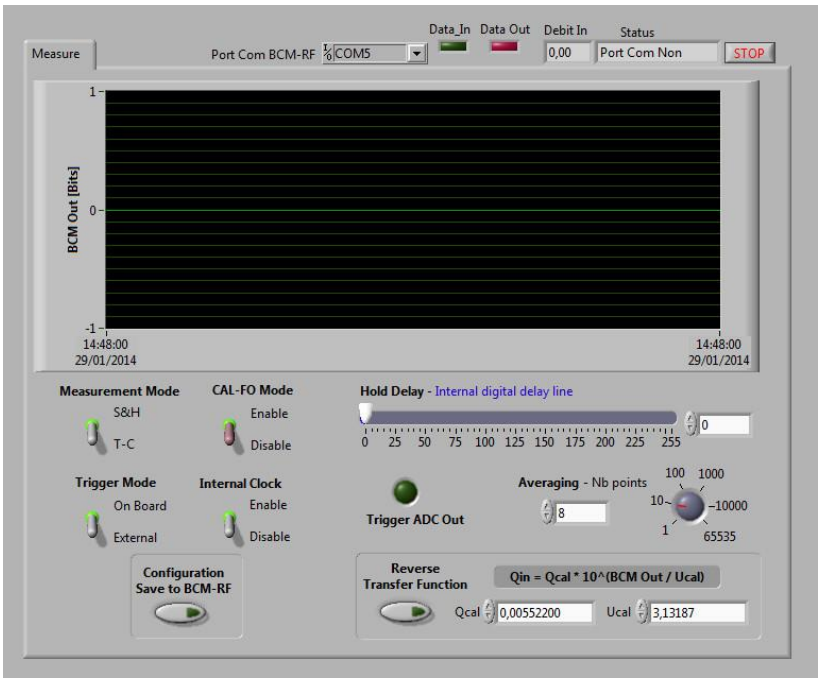
Operating systems supported:

In principle, any operating system that can run LABVIEW 7.1
or the corresponding run time environment, e.g. Win 2000, XP, Vista, 7

LABVIEW run time environments can be obtained from the National Instruments web site.

To control the BCM-RF from USB cable :

- Connect the USB cable from the BCM-RF to the PC.
- Windows recognizes the device and installs the generic serial to USB driver.
- In the devices manager, find the associated serial COM port number.
- On the GUI select the COM port number connected to the BCM-RF.
- Run the GUI.
- Data_In LED starts to blink which means that data comes from BCM-RF.
- Configure the BCM-RF to match your application.
- Store the customized configuration to the BCM-RF's microcontroller by clicking on : "Configuration save to BCM-RF".



## GRAPHICAL USER INTERFACE (Cont'd)

Table shows switches position for different measurement mode. User must set GUI switches to perform the measurement.

**Switches position according to Measurement Mode**

| Measurement Mode | CAL-FO | Trigger Mode | Internal Clock | Hold Delay Control | Trigger ADC Out |
|---|---|---|---|---|---|
| S&H | Disable | On Board or External | Enable | Digital | Blinks on new trigger |
| T-C | Disable | Not Used | Not Used | Not Used | Not Used |
| CAL-FO | Enable | X | X | X | X |

Measurement Mode :

- S&H – Sample and Hold mode measures the bunch charge. It works with single pass up to 2 MHz repetition rate. This mode uses a trigger and internal clock (must be activated).
- T-C – Track Continuous mode measures the average beam current in 10 MHz bandwidth. This mode is a free running process, it does not use any clock or trigger.

Trigger Mode :

- On-board – BCM-RF embeds an on-board trigger synchronized on the incoming signal from Turbo-ICT.
- External – BCM-RF can be triggered from an external TTL rising edge. "Trigger in" SMA connector is located on the rear chassis.

Internal clock :

- BCM-RF internal clock. Must be enabled for S&H mode.

Hold Delay :

- BCM-RF has an internal digital delay line USB controlled by the GUI. The user can adjust the hold delay from 0 ns to 255 ns.

CAL-FO (optional) :

- Online calibration check activation. Only available as option. This is a calibration generator installed on Turbo-ICT and controlled by fiber optics.

Trigger ADC Out :

- Indicator blinks when a new signal arrives. Only available in S&H mode

Averaging :

- User can change the sampling average number of points from 1 to 65535.

Reverse transfer function:

- Reverse function calculates the real bunch charge from the BCM-RF output voltage by using thegiven calibration constants. Per default the reverse function is not activated and the output voltage is plotted. When the reverse function is activated the calculated charge is plotted (pC). Currently the reverse function applies only to S-H mode.

Configuration saved to BCM-RF :

- BCM-RF configuration can be stored into microntroller's EEPROM.

## BCM-RF FIRMWARE

BCM-RF embeds a PIC 18F2458 from Microchip Technology Inc. This microcontroller has a 12 bits ADC and USB registers.

The firmware is written in C with MPLAB 8.9 and MPLAB C18 (C compiler) available from the Microchip website.

The code can be downloaded from www.bergoz.com on the Turbo-ICT / BCM-RF web page. Users can modify the code to match the BCM-RF to their own application.

File name : "BCM-RF-Firmware-x.x".

To program and debug the microcontroller, remove the cover shield and connect an ICD3 Microchip In-circuit debugger to the RJ11-R connector (see I/O AND SWITCHES section).

BCM-RF uses Communication Devices Class USB protocole in POLLING mode.

All characters are transmitted in hexadecimal.

A general frame used to write or read the microcontroller looks like this:

| 1 byte : Command | 1 byte : Frame number of byte | 1 byte : Read / write | 2 bytes : Frame counter | 1 byte : Separation character | 2 bytes : Value | 2 bytes : End characters |
|---|---|---|---|---|---|---|
| 'A' .. 'Z' In Ascii | 0 to 9 | ':' write frame '?' read frame In Ascii | 0 to 65535 | '=' In Ascii | 0 to 65535 | /n/0 In Ascii |

The analog BCM-RF output signal is periodically sampled by the microcontroller's 12 bits ADC. The sampled value is then automatically sent to the host via USB.

In S&H mode, when the microntroller receives a new trigger from ADC_TRG_OUT signal, it sends automatically a "new trigger" frame to host.

Frames automatically sent by BCM-RF to host :

| Command (ascii character) | Description | Example |
|---|---|---|
| A | BCM-RF's ADC sampled value | A0 : xxxx = 0xxx (1.5 byte) |
| ! | New trigger frame (only available in S&H mode) | !0 : 0000 = 0001 |

## MICROCONTROLLER FIRMWARE (Cont'd)

Write commands send by the host to BCM-RF :

| Command Ascii character | Description | Example |
|---|---|---|
| D | Write on-board's digital delay line value. | D0 : 0000 = 00xx (1 byte) |
| E | Write configuration to microcontroller's EEPROM | M0 : 0000 = 0001 |
| I | Set on-board's switches position | I0 : 0000 = 00xx (1 byte) |
| K | Activate on-board CAL-FO mode (optional) | K0 : 0000 = 0001 |
| M | Activate microcontroller's reverse function algorithm. | M0 : 0000 = 0001 |
| T | Send average number of points for ADC | T0 : 0000 = xxxx (2 bytes) |
| V | Write calibration constant Qcal (32 bits value) into microcontroller's EEPROM. | V1 : 0000 = xxxx (2 bytes high )<br>V0 : 0000 = xxxx (2 bytes low) |
| W | Calibration constant Ucal (32 bits value) into microcontroller's EEPROM. | W1 : 0000 = xxxx (2 bytes high)<br>W0 : 0000 = xxxx (2 bytes low) |

Read commands send by the host to BCM-RF.

When the BCM-RF's microcontroller receives a read frame, it answers by a response frame which is similar to the write frame.

| Command Ascii character | Description | Example |
|---|---|---|
| D | Read on-board's digital delay line value. | D0 ? |
| E | Read microcontroller's configuration stored in EEPROM. | E0 ? |
| I | Read on-board's switches position | I0 ? |
| K | Read if on-board's CAL-FO is activated (optional) | K0 ? |
| M | Read if microcontroller's reverse function algorithm is activated. | M0 ? |
| T | Read average number of points for ADC | T0 ? |
| V | Read calibration constant Qcal (32 bits value) into microcontroller's EEPROM. | V1 ?<br>V0 ? |
| W | Read calibration constant Ucal (32 bits value) into microcontroller's EEPROM. | W1 ?<br>W0 ? |

## CONNECTORS PINS ALLOCATION

| BCM-RF Front panel BNC connectors | | | | | |
|---|---|---|---|---|---|
| RF-Chassis Rear SMA connectors | | | | | |
| DB9 female connector on BCM-RFC rear panel | | | | | |
| DIN41612M BCM-RF module rear connector | | | | | |
| **INPUT SIGNALS** | | | | | |
| BCM-RF Input | BCM Input | B8 * | | SMA1 | |
| * coaxial insert 1.0/2.3 type | | | | | |
| **OUTPUT SIGNALS** | | | | | |
| BCM –RF output | BCM Output | B11* | | SMA2 | |
| ADC Trigger TTL output pos/neg edge | TRG.ADC.OUT | C19 | DB9,6 | | |
| **BNC front-panel MONITORING** | | | | | |
| Input signal after log. demodulation | Signal View | | | | BNC 1 |
| BCM-RF Output | Output View | | | | BNC 2 |
| Hold clock (on rising edge) | Hold View | | | | BNC 3 |
| **EXTERNAL TRIGGER INPUT** | | | | | |
| External trigger input 50 Ω, pos. edge > 2V | EXT.TRG.IN | B22* | | SMA3 | |
| **POWER SUPPLY** | | | | | |
| + (8...15) V | +15V | C13 | | | |
| - (8...15) V | -15V | C15 | | | |
| Common | COM | C14 | | | |

## BCM CABLE LAYOUT INSTALLATION

Unnecessary intermediate connectors should be avoided. When for practical reasons patch-panels must be used, the cables on either side of the patch-panel should be passed through tubular ferrite and nanocrystalline cores.

BCM chassis and modules should be kept away as much as possible from RF equipment, klystrons, cavities.

Connectors must be chosen carefully to match the cable used. Connectors manufacturers instructions must be followed meticuously. If cable layout is subcontracted, subcontractors must be informed of the extreme reliability expected from these cables. All cables with connectors must be checked before installation with a network analyzer, up to twice the operating frequency at least.

BCM modules must be installed in an RF-shielded chassis, BCM-RFC/XX or equivalent.

## ACCESSORIES

### BCM Chassis BCM-RFC/XX

The BCM-RFC/XX chassis is built around a 19" Schroff rackable RF chassis.

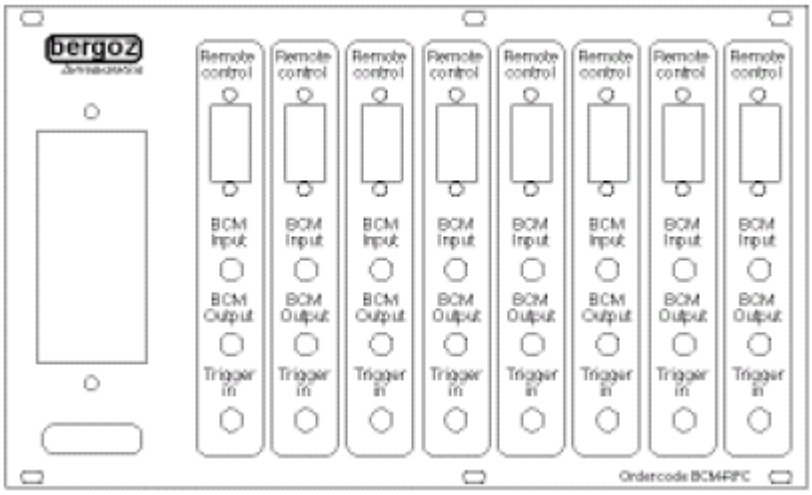
Dimensions of the bin: 3U x 84F

Schroff reference: Europac Lab HF/RF #20845-283

The BCM-RFC/XX is available equipped for 1 up to 16 BCM stations. XX being the number of stations.

BCM-RFC/XX with less than 16 stations are partially equipped BCM-RFC/16. As a result, all BCM chassis are field-upgradable to the full 16-station chassis.

Chassis rear view




### Chassis front

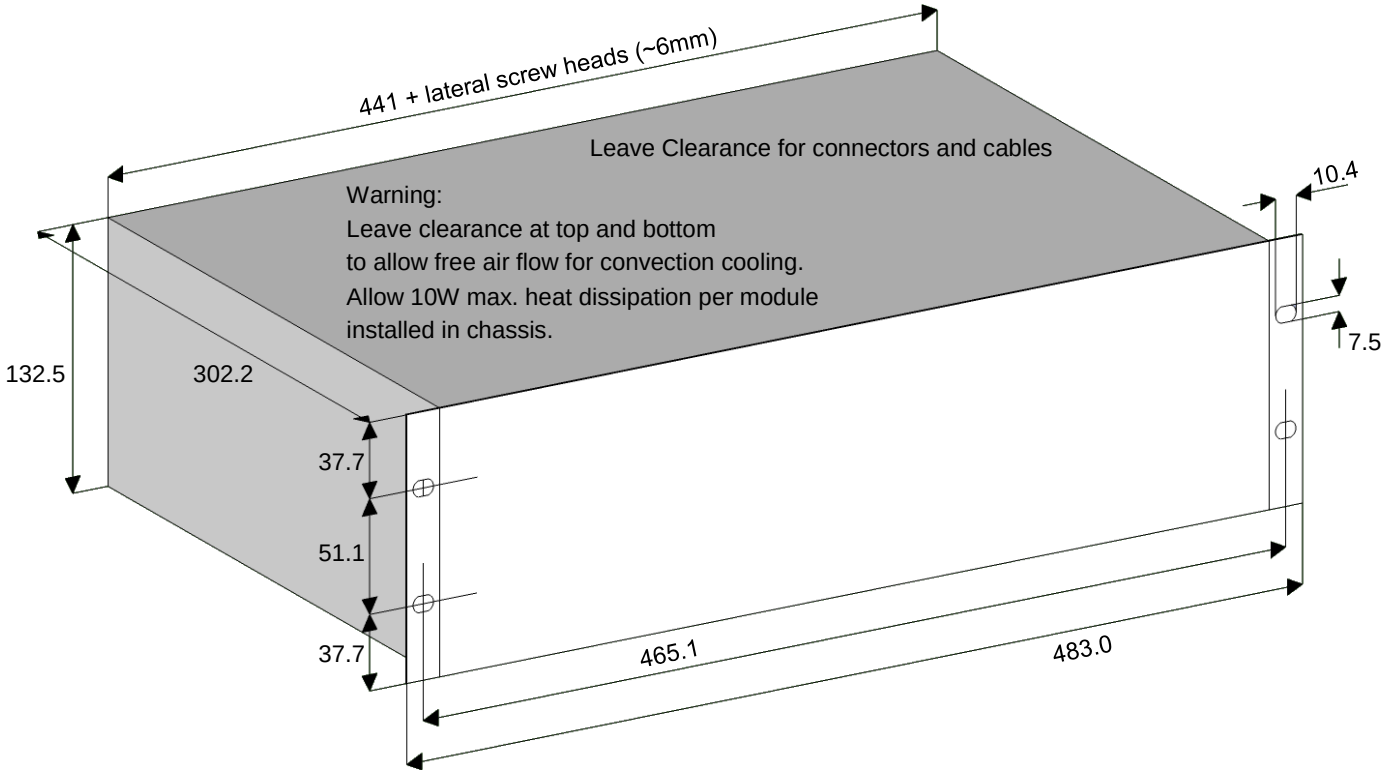
Unequipped stations are masked with RF-shielded blank panels.

### Card Extender BCM-XTD

The card extender allows access to the BCM-RF-E on-board switches while it is connected to the chassis, thus to the readout and control system.

## ACCESSORIES (Cont'd)

BCM Chassis BCM-RFC/XX Outer dimensions



## SCHEMATICS & BOARD LAYOUT

Schematics and board layouts of our instruments remain the exclusive property of Bergoz Instrumentation at all times. They are protected by the copyright laws.

Schematics and board layouts are not delivered with our instruments. They can be obtained at the specific request of the instrument's user.

A request should be sent by fax, worded in the following way:

To: Bergoz Instrumentation

From: User's name

Date:.....

I am a user of instrument type xxx-xxx serial nr. xxx,xxx,xxx,xxx, etc.

Please send me one copy of the corresponding schematics and board layout.

I will use it for the instrument's maintenance only.

I will make copies only for my own use.

I will inform others who need these schematics that they should request them from Bergoz Instrumentation.

Signed: .....

## ACKNOWLEDGEMENTS

The fundamental principles of our BCM-RF-E module and Turbo-ICT were developed internally at Bergoz Instrumentation.

Our BCM-RF-E module was designed by Sebastien Artinian,. Some functions are borrowed from the earlier LR-BPM design by Alexander Kalinin.

Saint Genis Pouilly, December 2012