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Log-ratio
Beam Position Monitor
User's Manual

Rev. 1.0

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SUMMARY

Page

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 local 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 local 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 local 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 fax.

SERVICE PROCEDURE

Products requiring maintenance should be returned to Bergoz Instrumentation or its local 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, name and fax number of the user. Contact Bergoz Instrumentation or your local distributor to determine where to return the product. Returns must be notified by fax 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 POSITION MONITOR ....

This manual applies to the Log-ratio BPM only: LR-BPM
Other models, e.g. "BPM", "MX-BPM", "VF-BPM" are described in other manuals.

The Log-ratio BPM system includes:

Description	*Order code*
• Log-ratio BPM electronics module	LR-BPM-XXXMHz
• Direct A,B,C,D wideband outputs, option	LR-BPM-ABCD
• Sample & Hold on A,B,C,D,X and Y, option	LR-BPM-SH

The options are mounted on the LR-BPM electronics module.

Accessories

• Beam-Based Center determination module	BPM-BBC
• 19" chassis with power supply	BPM-RFC/X, X = BPM stations number
• Table-top test kit with power supply	BPM-KIT
• 3U-Card extender with coaxial contacts	BPM-XTD
• RF service module with four front-panel BNC	BPM-SERV/RF
• TTL commands service module with front-panel DB9 and DB15 connectors	BPM-SERV/CMD

Check that the voltage of the power supply corresponds to your mains voltage.

On the table-top kit BPM-KIT: The AC input voltage range is indicated on the power supply module. If it does not correspond to your AC mains, use a transformer or contact the manufacturer to get another power supply.
In the 19" chassis BPM-RFC: The power supply is autoranging from 98V…264V.

Check the fuse configuration, that it corresponds to your national regulations.

The table-top test kit does not have any fuse.
The 19" BPM-RFC chassis fuse compartment is configured at the time of shipment according to its destination:
- North America: mains ground wire unfused.
- All other destinations: both mains wires are fused.

To verify which fuse configuration is installed on your chassis, pull out the removable fuse block, using a small screwdriver.
- The unfused ground configuration has a shorting bar and a 2A 6x32 fuse.
- The configuration with both AC lines fused is equipped with two 2A 5x20 fuses.

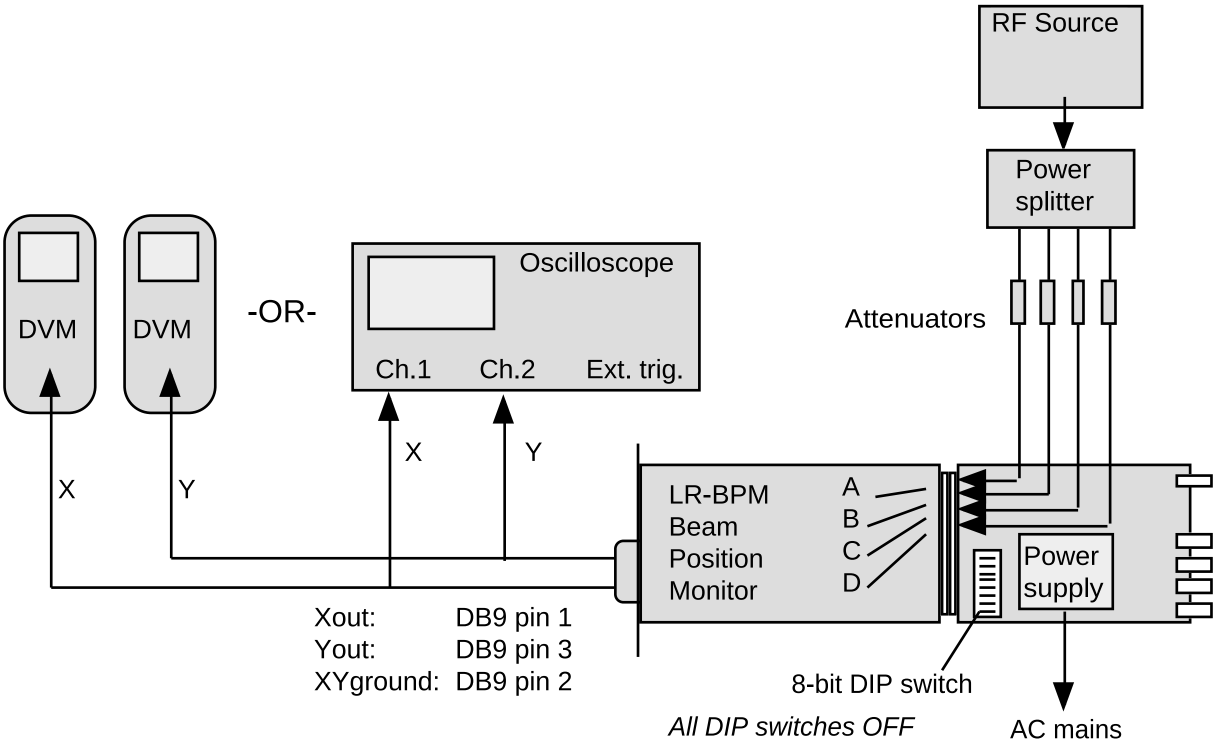
To change this configuration, unscrew the fuse holder off the fuse block, flip the holder over and screw it back onto the fuse block. Insert the following fuses:
- For unfused ground configuration: one 2A 6x32 fast fuse.
- For both AC lines fused configuration: two 2A 5x20 fast fuses.

QUICK CHECK

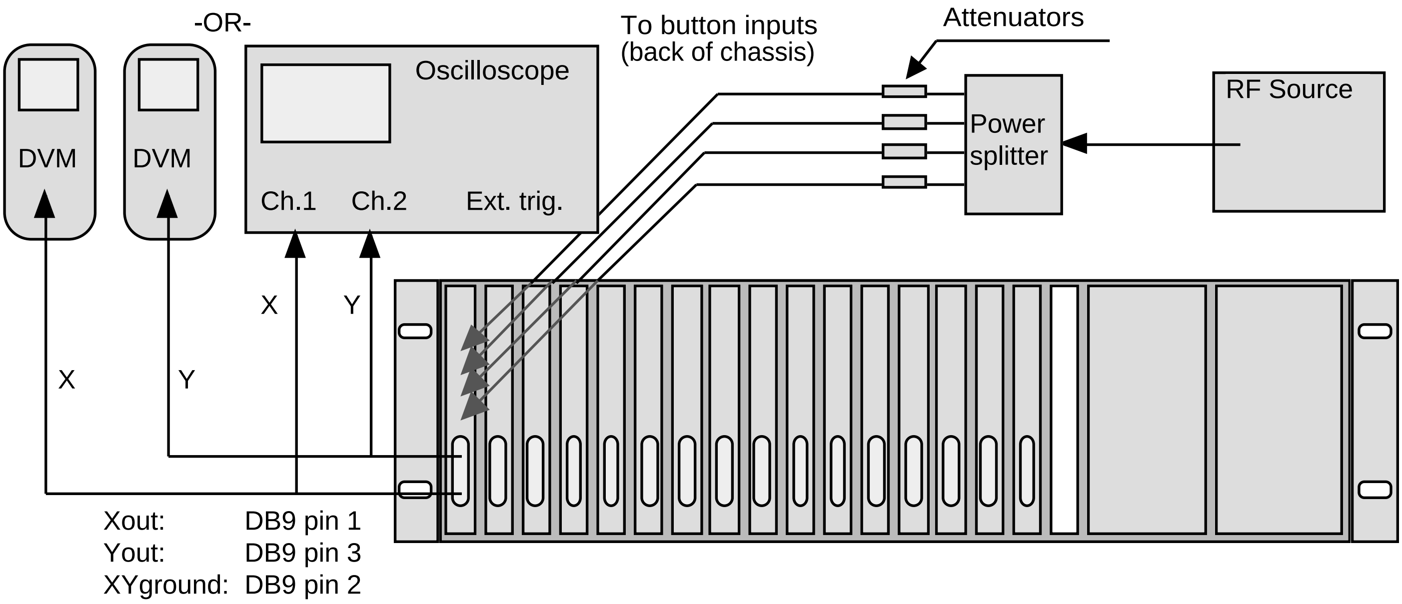
You can check immediately that your BPM system is working.

Setup

If you have the table-top test kit (BPM-KIT), use the following set-up:



If you have a 19" chassis (BPM-RFC/X), use the following set-up:



QUICK CHECK (Cont'd)

To display X and Y signals, you can use either two DVMs, or an oscilloscope.
Attach the equipment together as shown above.

Set the DVMs on Volt-DC, or the oscilloscope on:
Time base on 0.2 ms / div., free running,
Channel 1 to Xout signal, sensitivity 0.2 V / div., 1 MΩ DC coupling
Channel 2 to Yout signal, sensitivity 0.2 V / div., 1 MΩ DC coupling

Set the RF source to the LR-BPM operating frequency.
E.g. set to 500 MHz to test LR-BPM-500MHz.
Amplitude ca. -10 dBm

Use 4 similar attenuators, each 3 dB. The same test can be done with 5 and 10 dB.
Please note that attenuators are seldom more precise than ±0.1 dB. This will be reflected upon the LR-BPM X and Y readings.

Please note that signals applied to LR-BPM inputs will be attenuated by the 4-way splitter:
Transformer-type 4-way splitters typically attenuate by 7dB,
4-way resistive splitters, or cascaded 2-way splitters attenuate by 12dB.

Connect to Test Kit or 19” BPM-RFC chassis to AC mains, the DVM (or oscilloscope) will display X and Y values.
If the RF signals applied to all four LR-BPM inputs were exactly equal, and if the LR-BPM module were perfect, the values of X and Y would be exactly 0 Volt.
This is generally not the case, X and Y will be many 10s or even 100s of millivolts off.

You can determine how much of this offset is caused by attenuator inequality:
Swap the attenuators A and C, then B and D and observe the offset change.

You can determine how much of this offset is caused by power splitter imbalance:
Instead of connecting attenuator A to power splitter output 1, connect it to output 3 and connect attenuator C to output 1.
Do the same for attenuators B and D with power splitter outputs 2 and 4.

The next tests will consist of:

- Simulating beam displacements of 6 dB, 10 dB and 14 dB
- Exploring the LR-BPM dynamic range by varying the RF source output power.

Beam displacement

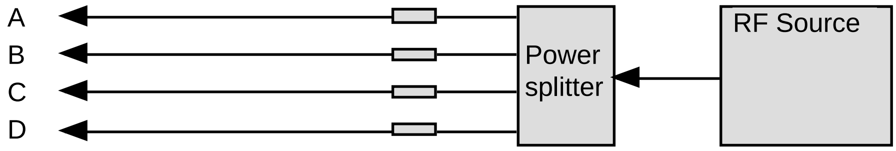
The RF source output power should be in the range -10dBm ... -35 dBm

The LR-BPM on-center sensitivity is factory-set to 55.5 mV per dB of signal difference between opposite pickups. For pickups with small angle (e.g. buttons), 6 dB corresponds to beam displacement equal to 1/6 of vacuum chamber radius. As the beam goes off center, this sensitivity becomes lower due to the algorithm X = Log (A/C). Please consider that the pickup sensitivity becomes *higher* as the beam goes off center, and one non-linearity tends to compensate the other.

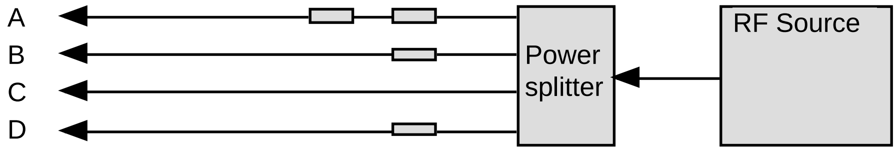
Modules LR-BPM are manufactured in two versions:
- For orthogonally placed pickups: up, down, left and right
- For rotated pickups: upper-right, upper-left, lower-left and lower-right

QUICK CHECK Beam displacement (Cont'd)

Before simulating a beam displacement, start by noting the X and Y zero offsets, using four equal attenuators:



Then simulate the displacement by removing an attenuator from one input and inserting it in the opposite input: A <=> C, and B <=> D. Example:



Attenuator C is removed from input C, and added to input A, thus simulating a displacement of the beam towards C (stronger signal on C pickup).

The following combinations can be tried, yielding the X and Y values listed here.
Please note these are *displacements*. Take the zero offsets due to power splitter imbalance and attenuators inequality into consideration.

Input	Attenuators	Equivalent displacement	Rotated pickups	Orthogonal pickups
A	3 + 3	1/6 of radius towards C		
B	3		X = -0.245 V	X = -0.347 V
C	0		Y = -0.245 V	Y = 0 V
D	3	*(button pickups << chamber diameter)*		
A	3 + 3	1/6 of radius towards C		
B	3 + 3	1/6 of radius towards D	X = 0 V	X = -0.347 V
C	0		Y = -0.490 V	Y = -0.347 V
D	0	*(button pickups << chamber diameter)*		
A	5 + 5	1/4 of radius towards C		
B	5		X = -0.407 V	X = -0.576 V
C	0		Y = -0.407 V	Y = 0 V
D	5	*(button pickups << chamber diameter)*		
A	5 + 5			
B	5 + 5		X = 0 V	X = -0.576 V
C	0		Y = -0.814 V	Y = -0.576 V
D	0	*(button pickups << chamber diameter)*		
A	10 + 7	1/3 of radius towards C		
B	10		X = -0.570 V	X = -0.806 V
C	3		Y = -0.570 V	Y = 0 V
D	10	*(button pickups << chamber diameter)*		

QUICK CHECK Beam displacement (Cont'd)

Note. The above voltages are representations of the algorithms:
$X = K_X \, Log(A/C)$ and $Y = K_Y \, log(B/D)$ for orthogonal pickups, and
$X = K_X \, (Log(A/C) + Log(B/D)) \cos \alpha$, and $Y = K_Y \, (-Log(A/C) + Log(B/D)) \sin \alpha$ for rotated pickups.

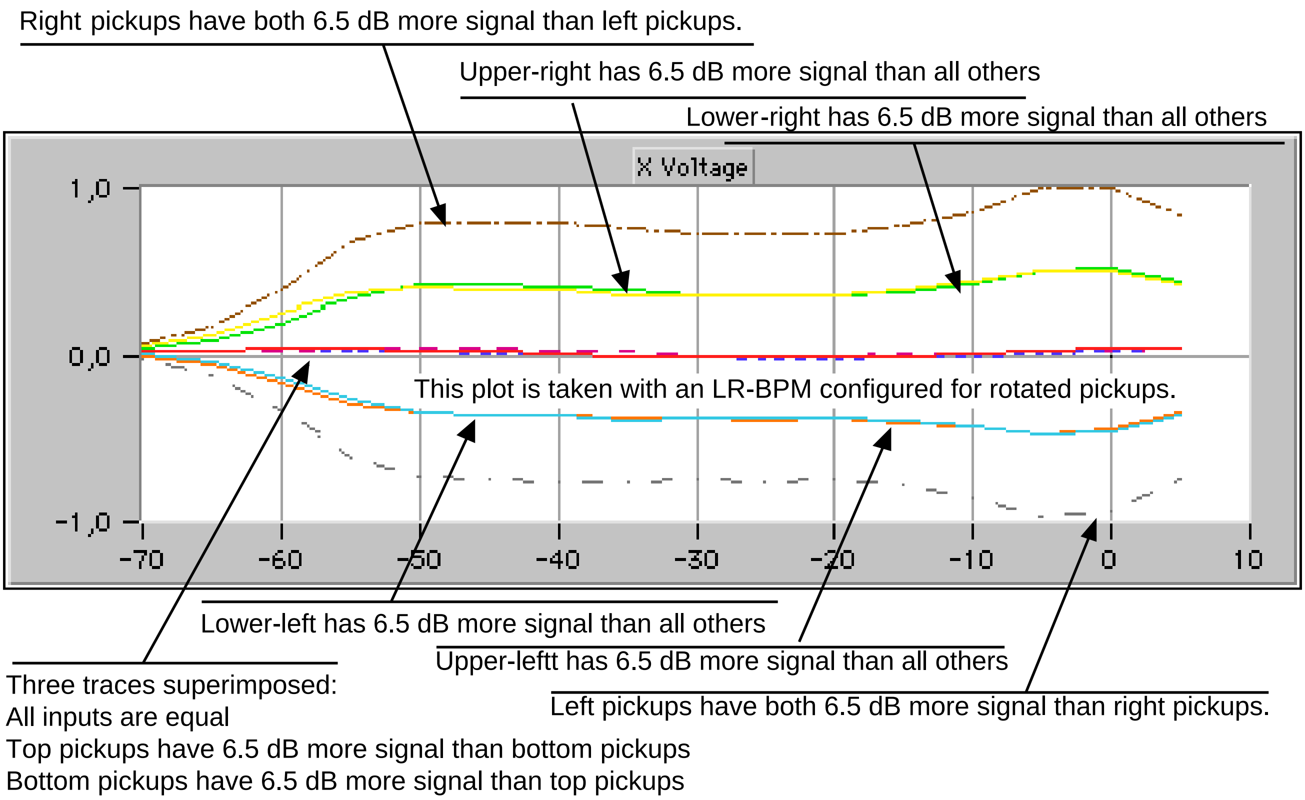
Where: α is the tilt angle of the pickups,
K_X and K_Y are set to 1.1513 Volts
Note: This value was chosen because it corresponds to a difference-over-sum ratio equal to 1 V, for small amplitude displacements off-center. E.g. 0.001 V for 0.005 x R.

To maintain the condition A+C = B+D when two attenuators are cascaded in one input, their attenuation should be increased. E.g. 3+3 dB should really be ~6.5 dB with ~0.5 dB in opposite input. 5+5 dB should really be ~11.4 dB and 1.4 dB in opposite input, 10+10 dB should really be ~25d dB and ~5 dB in opposite input.

Explore the dynamic range

Set the input attenuators is such way that X and Y are off center.
Vary the power from the RF source to simulate beam intensity variations.
Explore the range from +7 dBm down to -70 dBm.
Remember that 4-way transformer-type splitters absorb typically 7 dB and resistive splitters absorb 12 dB.

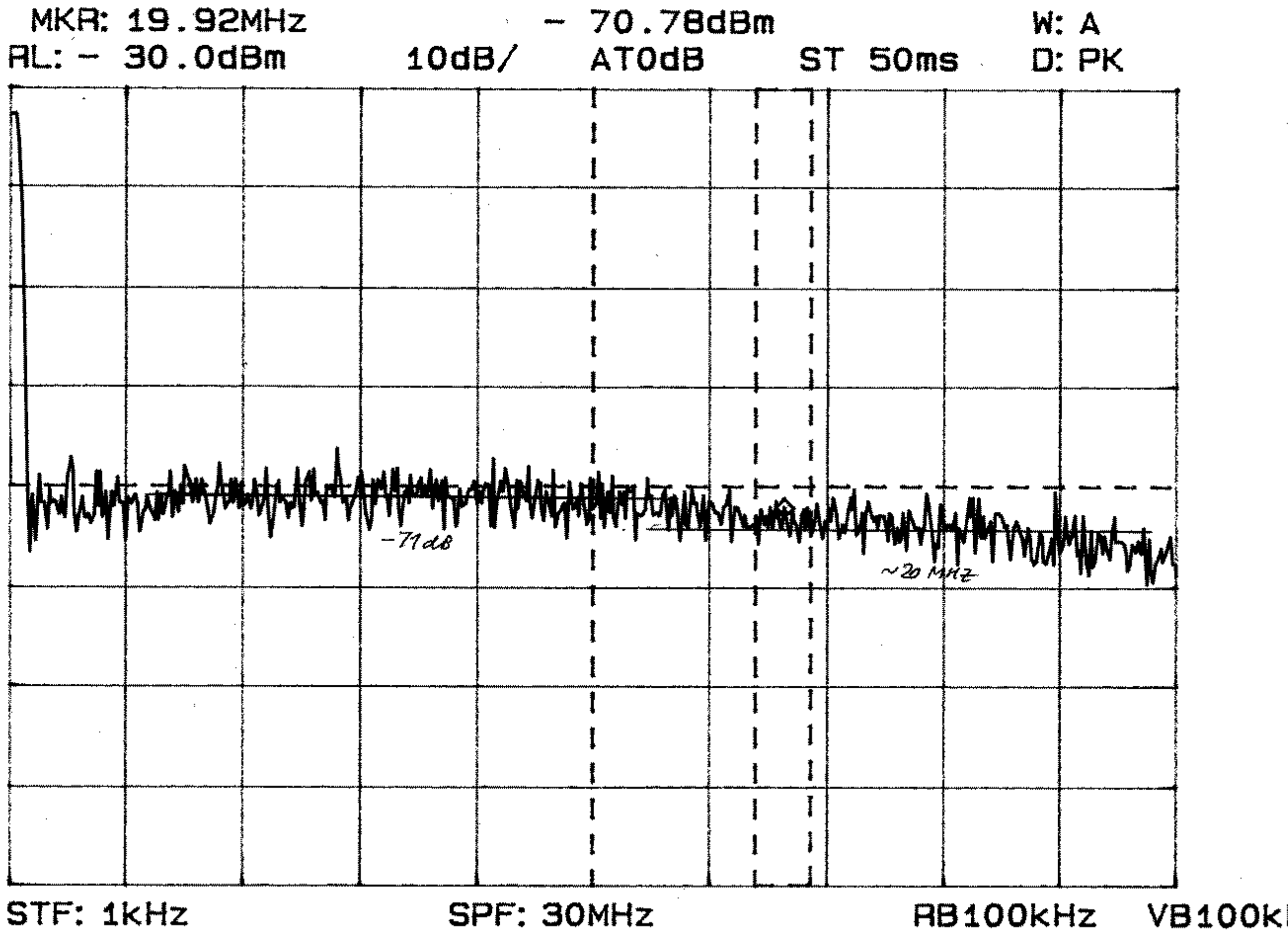
While the RF source output power is changed, observe the intensity dependence of X and Y outputs on the voltmeters. The X and Y output voltages vary with input power applied to the LR-BPM inputs:



QUICK CHECK (Cont'd)

Noise spectrum

Observe the noise spectrum with an FFT or baseband spectrum analyser, at various signal levels. The output noise spectrum looks like:



Noise over 1 kHz to 30 MHz bandwidth, with 100 kHz resolution bandwidth
Plot taken with Anritsu 2601B Spectrum analyser.
Probe -20 dB.

Comments on measurement:

Noise = -71 dBm + 20 dB (probe) = -51 dBm = 0.63 mVrms in 100 kHz
Noise density = 0.63 mV / √100 kHz = 2 µV/√Hz
Noise rms over 20 MHz = 2 µV/√Hz x √20MHz = ~10 mVrms

Putting the noise spectrum in perspective:

On-center sensitivity is 39.2 mV/dB for rotated pickups.
With XOUT and YOUT = 392 mV, the displacement is ≈0.03 of radius.

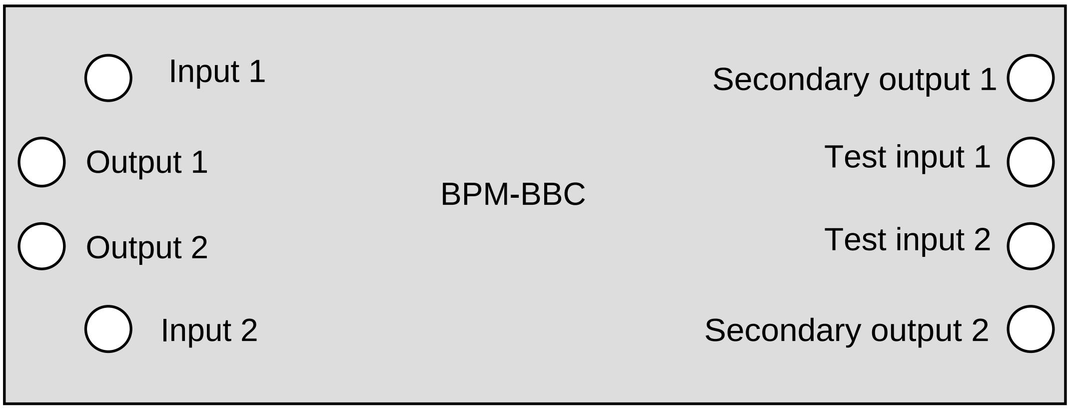
Thus 10 mV rms noise over 20 MHz is 1/140 of vacuum chamber radius. Say, 150 µm rms in a 20-mm radius vacuum chamber.

QUICK CHECK (Cont'd)

Beam-Based Center determination

Your shipment may include the product BPM-BBC, BPM Beam-Based Center determination device.

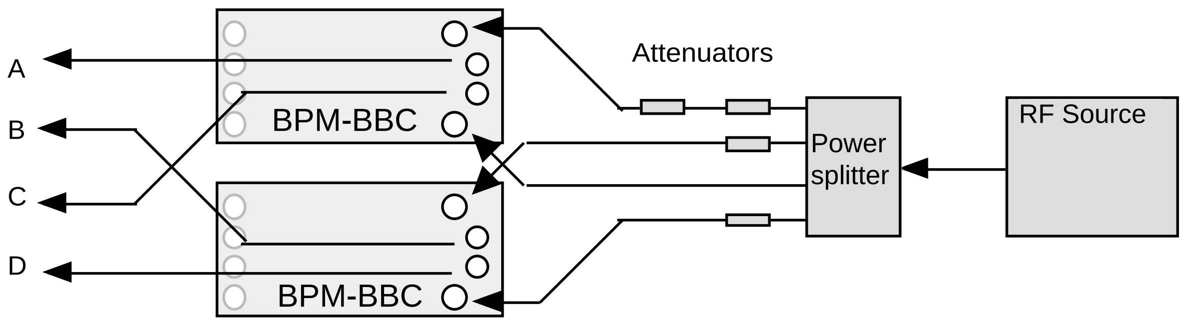
Each BPM-BBC consists of TWO boards. Each one looks like this:



Each board handles the signals from two OPPOSITE pickups.
E.g. Pickups A & C, or pickups B & D, Up and Down, Left and Right.

Note: BPM-BBC has an insertion loss of 10 dB in each channel.
BPM-BBC will not fulfill its purpose of equalizing signals if connected to adjacent pickups. It must be connected to opposite pickups.

Connect the BPM-BBC:



All four unused SMA connectors (Secondary Outputs & Test Inputs) should be terminated by 50Ω.

Connect the A, B, C and D signals to the BPM test kit or 19" BPM-RFC chassis, whichever you use.

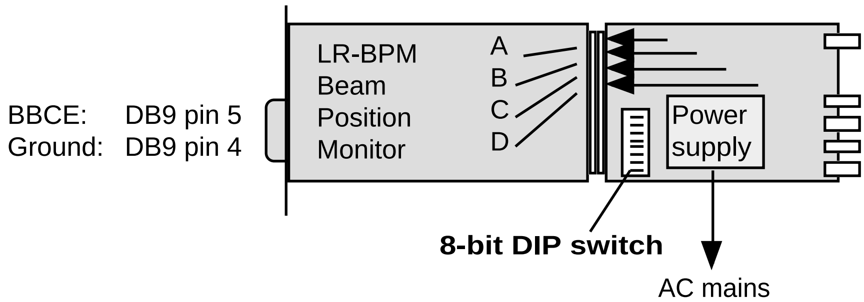
Observe the effect of BPM-BBC on X and Y output signals. The pickup inputs must be unequal, so X and Y have non-zero values. Use asymetrical configuration of attenuators to simulate off-center beam.

QUICK CHECK Beam-Based Center determination (Cont'd)

BPM-BBC can be enabled by the LR-BPM module, via the pickup coaxial cables.
To enable BPM-BBC, the signal BBCE must be pulled down.

Enabling BPM-BBC will equalize the signals sent to LR-BPM, simulating beam-on-center.

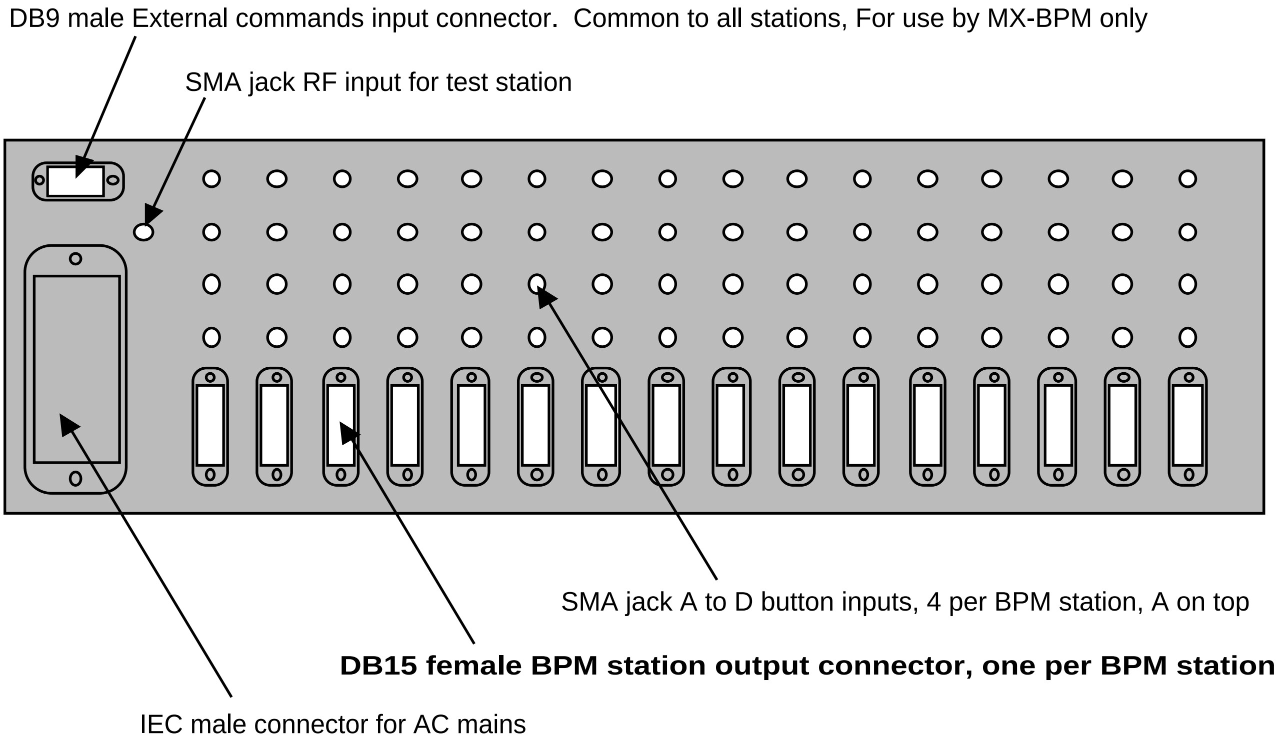
If you use BPM-KIT, pull down BBCEnable by switching ON the DIP switch marked AGCD/BBCE.
Note: On BPM-KITs originally made for multiplexed BPMs, this switch is only marked AGCD



If you use a 19" BPM-RFC chassis, to enable BPM-BBC you have the alternative:

a) Pull down to ground BBCE on pin 5 of DB9 front panel connector of LR-BPM module
   Note: Same DB9 has ground on pin 4.

b) Pull down BBCE on pin 1 of the DB15 chassis rear panel connector which corresponds to the station you are using (refer to picture hereafter).
   Note: Same DB15 has ground on pin 10.



ADVANCED CHECK

Before performing the advanced check, it is recommended to get familiar with the Log-Ratio BPM in CW (Continuous Wave) mode as described in earlier chapter "Quick Check".
After the initial setup, the checking procedure is the same.

Advanced check will make you familiar with the LR-BPM behavior in single pass mode:

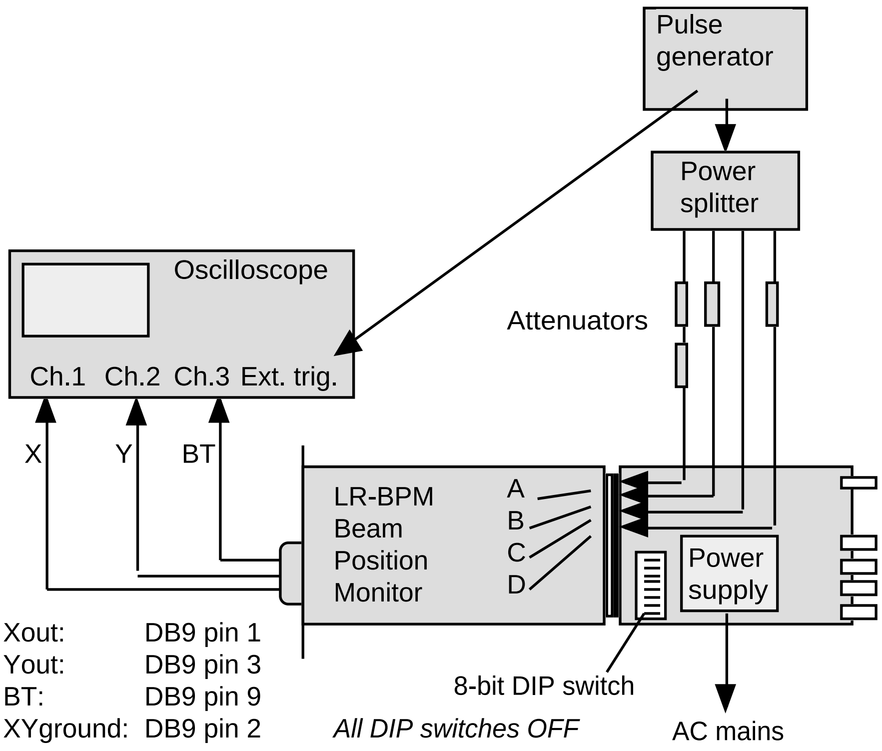
- Select a pulse generator capable of making short pulses with ~3.5 Vpeak in 50 ohms.

The generator output pulse length should not exceed T/2, where T is the period of the the LR-BPM operating frequency.
Example: LR-BPM-500MHz. T = 2 ns, the pulse length should not exceed 1 ns.

Suitable pulse generators could be found from Avtech in Canada, Berkeley Nucleonics Corp. in Richmond, CA, Barth Electronics Inc. in Boulder City, NV, or Picosecond Pulse Labs from Boulder, CO.
Old-fashioned mercury-switch pulsers like TEK-109 are very suitable.

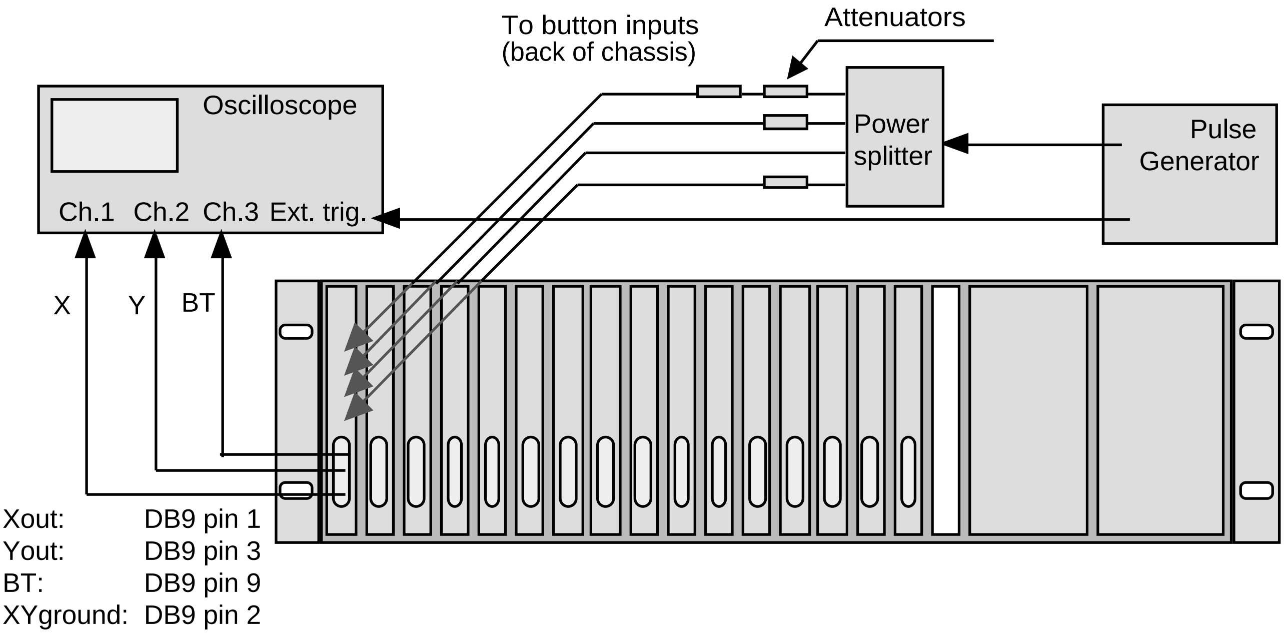
Setup

Using the BPM-KIT Table-top test kit:
Remove the LR-BPM cover shield as described in the On-board adjustments chapter.



ADVANCED CHECK Setup (Cont'd)

Using a 19" BPM-RFC chassis:



Remove the LR-BPM cover shield as described in the Quick Check.
Place the LR-BPM module on a card extender type BPM-XTD.

Set the oscilloscope on:
Time base on 100 ns / div., external trigger from the Pulse Generator trigger output
Channel 1 to Xout signal, sensitivity 0.2 V / div., 1 MΩ DC coupling
Channel 2 to Yout signal, sensitivity 0.2 V / div., 1 MΩ DC coupling
Channel 3 to Beam Trigger signal, sensitivity 0.2 V / div., 1 MΩ DC coupling

Set the Pulse generator to any repetition rate, pulse length shorter than T/2, where T is the period of the LR-BPM operating frequency.
Set pulse peak voltage to ~3.5 V.

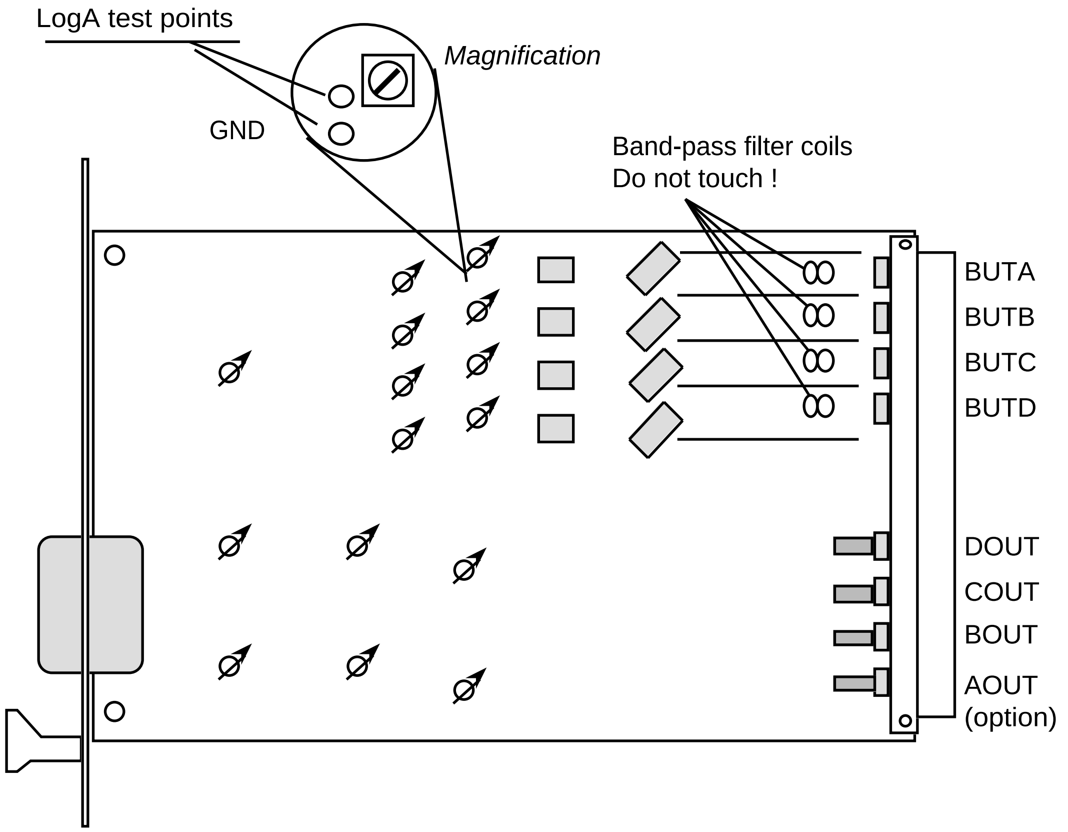
Use an asymmetrical combination of attenuators to simulate beam off center.

Start the pulse generator and look for the Beam Trigger signal on the oscilloscope. When the trigger delay is adjusted, set the timebase to 20 ns/div.

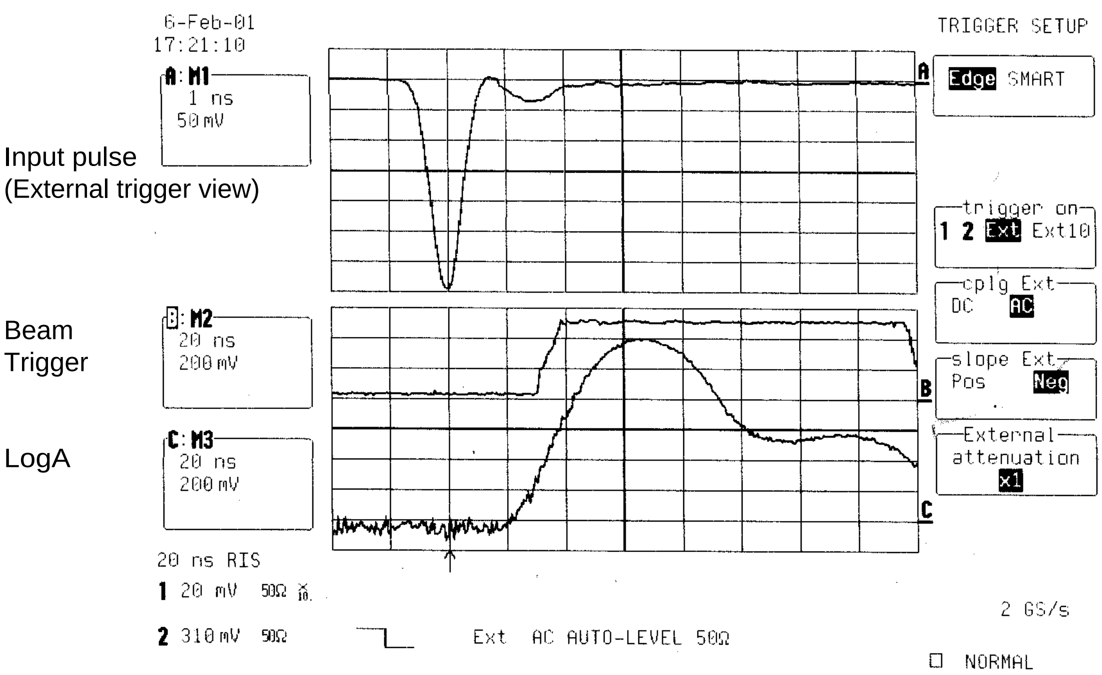
Attach a probe to channel 4. It can be 500-ohm, or -20dB high-Z.

ADVANCED CHECK Setup (Cont'd)

With the probe, take the signal "LogA" off the LR-BPM board:



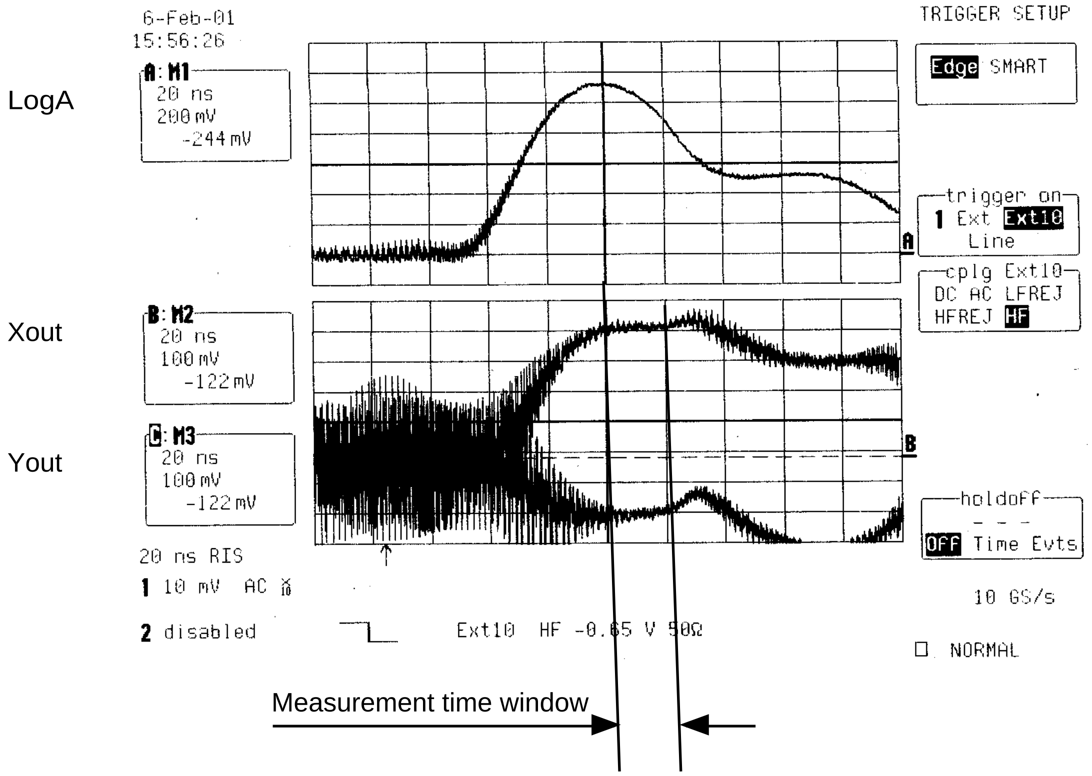
The signals on the oscilloscope will look like:



Observe the Beam Trigger BT rising ~20 ns before the apex of LogA.

ADVANCED CHECK (Cont'd)

X and Y output signals for single pass



Observe the Xout and Yout signals represent X/Y positions for ~20 ns after LogA pulse apex. LogA apex is itself ~20 ns after Beam Trigger rising edge.

Observe the signals Xout and Yout are very noisy before the pulse is applied. It is a characteristics of the logarithmic representation of large variations.

Further tests

More tests can be conducted with other input attenuators configurations.
The pulse amplitude from the Pulse Generator can be reduced to explore the dynamic range.

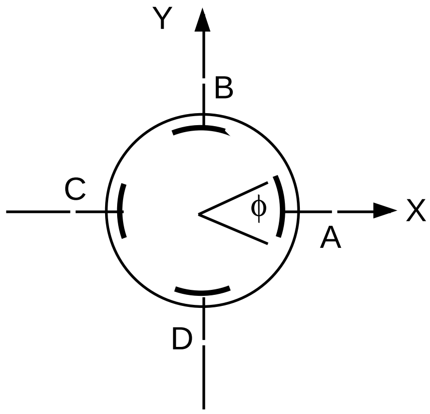
ALGORITHM, SENSITIVITY & POLARITY

Orthogonal pickups version

$X = K_X$ Log A/C

$Y = K_y$ Log B/D

Where K_y and K_y are factory-set
for on-center sensitivity 55.5 mV/dB
For pickup electrodes with small ϕ,
55.5 mV corresponds to 1/36 of radius
beam displacement.

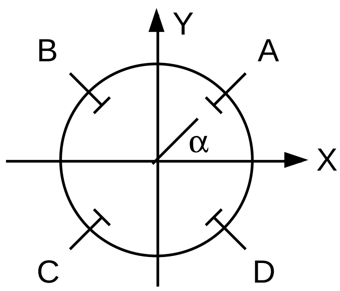


Rotated pickups version

$X = K_X$ [Log (A/C) – Log (B/D)] cos α

$Y = K_y$ [Log (A/C) + Log (B/D)] sin α

Where K_X and K_y are factory-set
for on-center sensitivity 55.5 mV per
dB of difference between opposite pickups.
When $\cos\alpha = \sin\alpha = 1/\sqrt{2}$, the sensitivity in X and Y
equals $55.5\text{mV}/\sqrt{2} = 39.2$ mV.
For pickup electrodes with small ϕ,
39.2 mV in X or Y corresponds to 1/36 of radius
beam displacement along the X, resp. Y axis.



Note:

Pickups with larger ϕ, such as striplines, have higher sensitivity to beam displacement.
Pickup sensitivity increases with ϕ as $\sin(\phi/2) / \phi$. [1]

[1] Log-ratio Signal-Processing Technique for Beam Position Monitors, Robert E. Shafer, Proceedings of the Fourth Accelerator Instrumentation Workshop, Berkeley 1992.
AIP Conf. proceedings No. 281, pages 120-128.

ON-BOARD ADJUSTMENTS

The LR-BPM module is equipped with many on-board potentiometers.
Some can be readjusted easily by the users, while others require precise tools and procedures for their adjustment. The function of each adjustment is described hereafter.

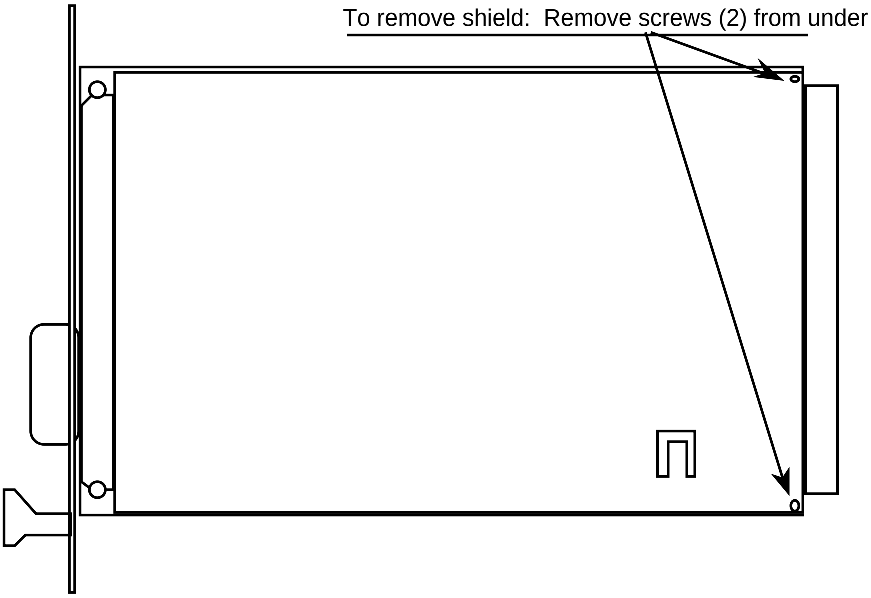
Procedure

Proceed as described in "Quick Check".
The table-top test kit (BPM-KIT) is the easiest setup to readjust potentiometers.
An alternative is to extended the LR-BPM module out of its chassis, using the card extender (BPM-XTD).

Note: No damage will occur to LR-BPM modules if they are inserted or removed while the power is on.

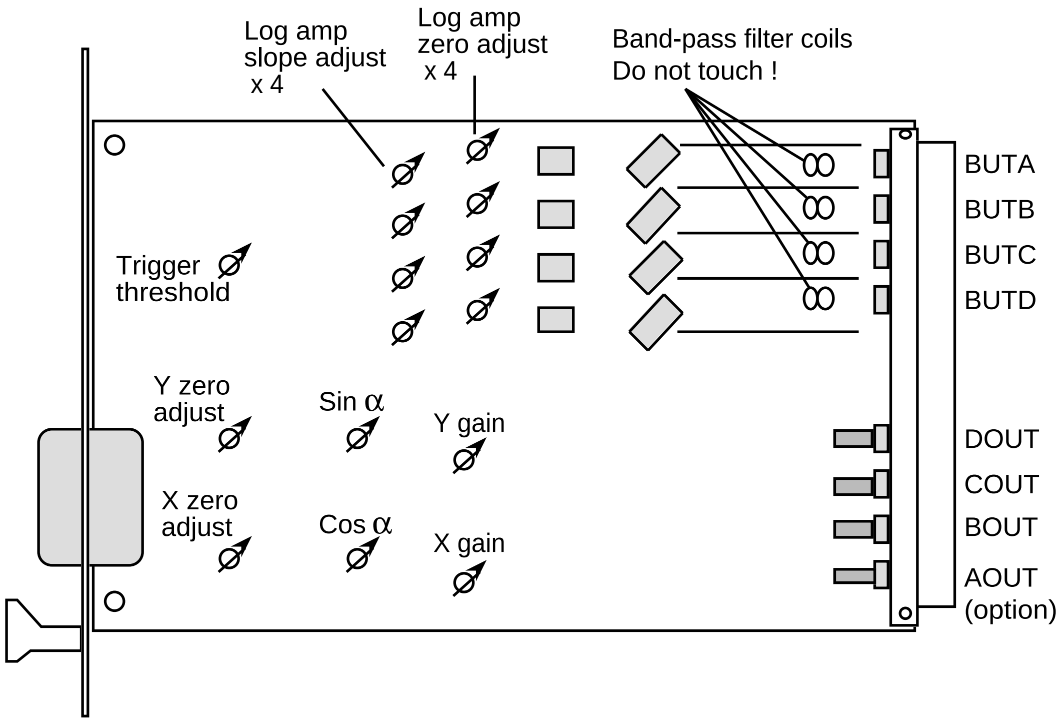
Note: The card extender has unequal button-to-button attenuations. It introduces an offset in X and Y. The card extender offset was measured at the time of shipment. To recheck it, measure the X and Y offsets with and without extender.

To adjust the on-board potentiometers, remove the shield:



ON-BOARD ADJUSTMENT (Cont'd)

Log-ratio Beam Position Monitor board



It is not recommended to change the following adjustments:

Band-pass filter coils	Adjusted to the operating frequency, e.g. 500 MHz
Log amplifier zero adjust	To match the origin of two opposite log amplifiers
Log amplifier slope adjust	To match the slope of all four log amplifiers

Users' adjustments

To adjust these potentiometers, use a screwdriver with a ceramic tip. A metal tip changes the signal !

Trigger threshold	Sets the trigger level sensitivity (200mV factory-set) Adjustable up to 500 mV of Sum-of-logs
Cos α and Sin α	Sets the pickups tilt angle (both are 1/√2 factory-set)
X gain & Y gain	Sets the X and Y gains X and Y gains factory settings: 347mV for 6 dB between opposite orthogonal pickups (1 on 1), 490mV for 6 dB between opposite rotated pickups (2 on 2).
X zero adjust	Matches the log(A/C) input levels
Y zero adjust	Matches the log(B/D) input levels

LR-BPM PRINCIPLE OF OPERATION

The signals from the pickup electrodes are processed simultaneously thru four independent channels. Each channel consists of an input band-pass filter, followed by an amplification chain with logarithmic response.
When a single short pulse is applied to the band-pass filter, it will oscillate at its own resonant frequency for about 250 ns, allowing enough time for the logarithmic amplifier to detect the log of its envelope.

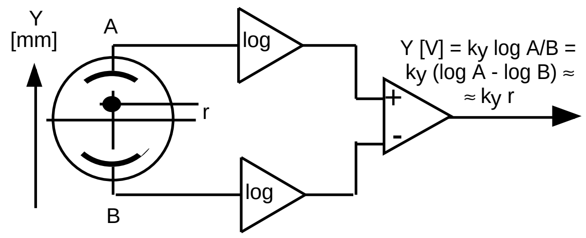
Each amplifying chain produces a signal which peak amplitude is proportional to the log of the input signal, be it a single pulse, a pulse train, or a continuous wave.

Log signals from opposite pickup electrodes are deducted from one another to obtain Log(A) - Log(C) = Log(A/C) which is said to be a very faithful representation of beam displacement between two pickup electrodes.

If the pickup electrodes are placed along the axes in which the beam displacement is to be measured, the displacement X = Kx Log(A/C), directly. The Kx gain is obtained by an amplifier with adjustable gain. The same goes for the Y axis.

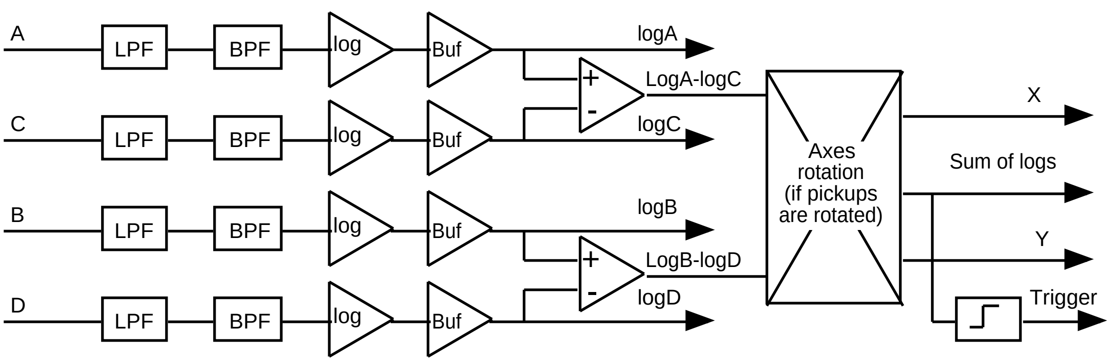
If the pickup electrodes are placed along axes rotated as compared to the beam position measurement axes, the A-C and B-D axes must be rotated to obtain the beam displacement values along X and Y. This is achieved by applying the cosine of the tilt angle to one axis and the sine of the tilt angle to the other axis, before summing them. This is done wideband with >10 MHz response.

Schematic representation of the log-ratio BPM, an original concept of Robert E. Shafer:



Position measured by this method is more linear, over a wider range, than difference-over-sum.

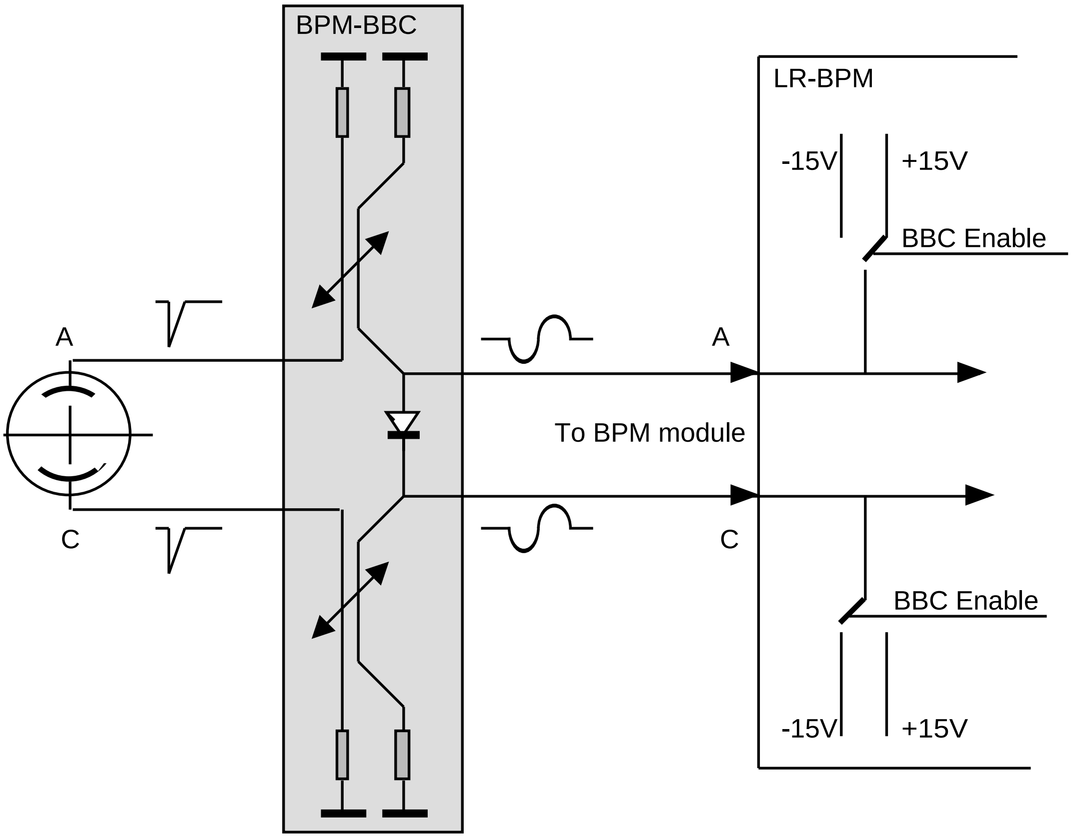
BLOCK DIAGRAM



BPM-BBC PRINCIPLE OF OPERATION

The BPM-BBC circuit has two functions:
a) When short bunch pulses are applied to its inputs, each BPM-BBC stripline coupler produces a single sine wave with period independant of bunch length.
b) It allows the user to measure X and Y position offsets due to pickups, cables and electronics.

When enabled, the BPM-BBC circuit simulates a beam on center; it sends signals of equal amplitude to the LR-BPM. This allows the user to measure the X and Y offsets for an on-center beam. To equalize the signals, a bias is applied to the PIN-diode making it conductive. The bias current is controlled by the TTL signal BBCE, applied to the LR-BPM module.



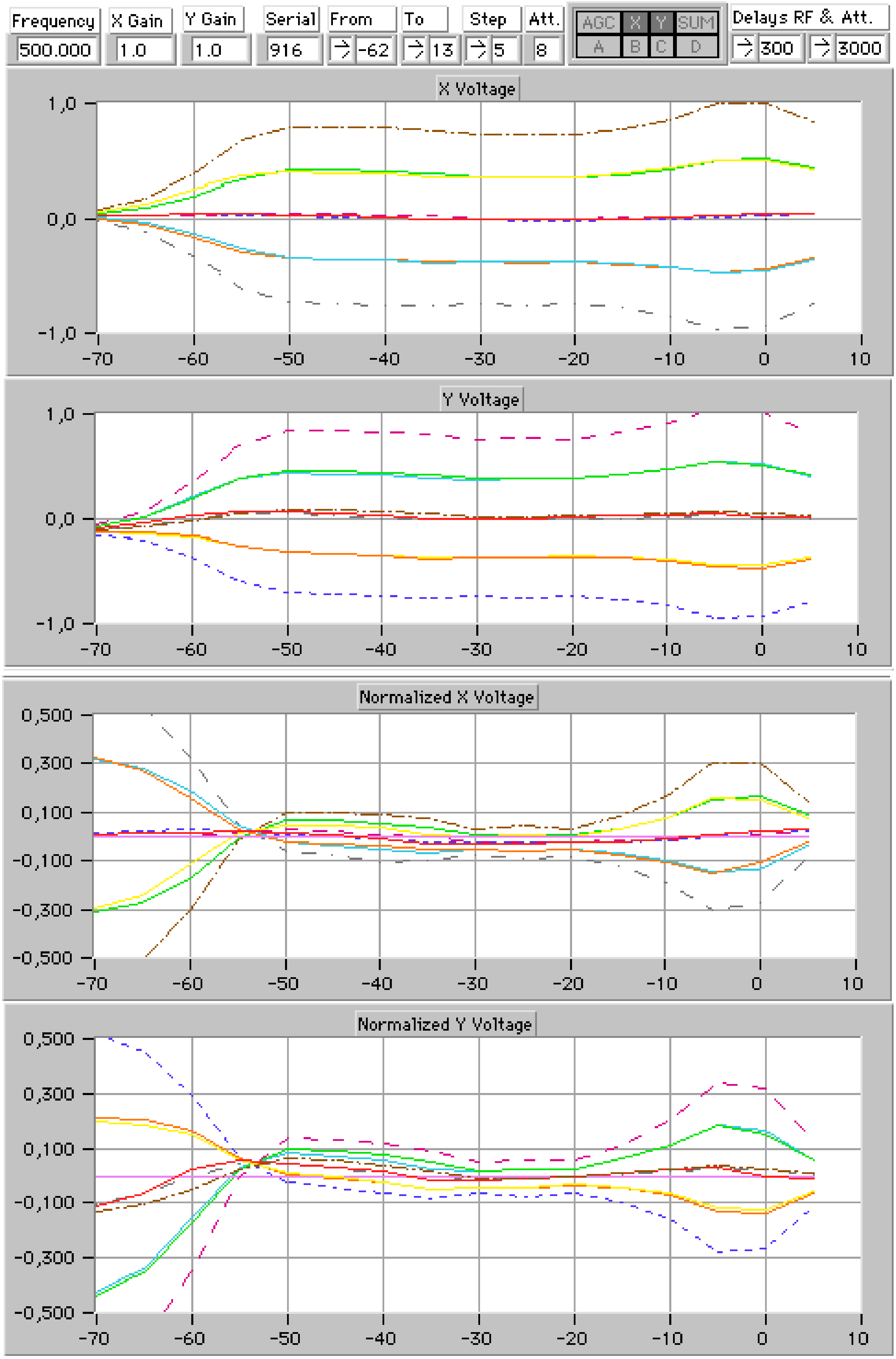
Insertion loss: 10 dB per channel

The signals applied to BPM-BBC should be synchronous, otherwise the level of equalized signals diminishes.. Thus, it is recommended to connect the BPM-BBCs to the pickups with short cables of equal length.

PERFORMANCE

Performance with CW input signals is reported for each module. Plots are attached to the Certificate of Calibration. Example on next page.

Note: While the X and Y signals have >10 MHz bandwidth, the virtual instrument LabVIEW making the plots limits the bandwidth observed to 0...~2 kHz.


Frequency
500.000
X Gain
1.0
Y Gain
1.0
Serial
916
From
-62
To
13
Step
5
Att.
8
AGC X Y SUM
A B C D
Delays RF & Att.
300
3000
X Voltage
1,0
0,0
-1,0
-70 -60 -50 -40 -30 -20 -10 0 10
Y Voltage
1,0
0,0
-1,0
-70 -60 -50 -40 -30 -20 -10 0 10
Normalized X Voltage
0,500
0,300
0,100
-0,100
-0,300
-0,500
-70 -60 -50 -40 -30 -20 -10 0 10
Normalized Y Voltage
0,500
0,300
0,100
-0,100
-0,300
-0,500
-70 -60 -50 -40 -30 -20 -10 0 10

SIGNALS

Pickup Inputs

BUTA **BUTB** **BUTC** **BUTD**	Pickup inputs A, B, C, and D. Impedance 50Ω. See Algorithms, Sensitivity & Polarity, this manual, for pickups assignment.

Output wideband signals

XOUT	X displacement. Bipolar signal up to ±2V. 0 Volt represents pickup center.
YOUT	Y displacement. Bipolar signal up to ±2V. 0 Volt represents pickup center.
XYGND	Analog ground for the above signals.

Optional Output wideband signals

Note: These optional signals are made available to compute beam position when the algorithm implemented in the circuit Log(A/C) is unsuitable. This can be the case of 6-button BPM pickups or asymmetric geometry of pickup electrodes.

LOGA	Logarithmic representation of BUTA input.
LOGB	Logarithmic representation of BUTB input.
LOGC	Logarithmic representation of BUTC input.
LOGD	Logarithmic representation of BUTD input.

Input and output signals

Input and output signals hereafter are specific to each BPM module

BT	Beam Trigger. 500-mV positive going pulse with rising edge ~20 ns before log signals reach their apex.
BT*	Beam Trigger. 500-mV negative going pulse with falling edge ~20 ns before log signals reach their apex.
BTGND	Ground for BT and BT* signals
BBCE	BPM-BBC Beam-Based Center determination Enable signal TTL signal. Pull down to equalize BBC output signals. Pullup resistor 4K7.
GND	Ground for above signal(s).

Common external commands

Common external commands are commands which are common to all BPM modules in a BPM chassis.

None are handled by LR-BPM

BPM CABLES LAYOUT INSTALLATION

Cable layout

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 cores. Ferrite material must have high permeability at the BPM operating frequency.

The four cables pertaining to the same BPM stations must be laid side by side. Cables, BPM 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 meticulously. 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; i.e. up to 1 GHz for 500 MHz operating frequency.

BPM modules must be installed in an RF-shielded chassis.

Note: Unlike most BPM electronics, the LR-BPM module does not require the button signals to be in phase. Cables do <u>*not*</u> *need to be phase-adjusted. The LR-BPM module tolerates any phase change, even 180°.*

CONNECTORS PINS ALLOCATION Rev. 1.0

LR-BPM Connectors Pins Allocation				
DB15 female connector on BPM-RFC rear panel (one connector per BPM sation)				
DIN41612M LR-BPM module rear connector				
DB9 female connector on LR-BPM front panel				
RF Input signals				
Input A	BUTA		b2 *	
Input B	BUTB		b5 *	
Input C	BUTC		b8 *	
Input D	BUTD		b11 *	
* Coaxial insert 1.0/2.3 type				
Wideband output signals				
X output	XOUT	1	a15	8
Y output	YOUT	3	a18	7
Analog ground for X and Y outputs	XYGND	2	a20. a17, a14	15, 6, 13, 14
Optional output signals				
Log of A	LOGA		b31 *	
Log of B	LOGB		b28 *	
Log of C	LOGC		b25 *	
Log of D	LOGD		b22 *	
* Coaxial insert 1.0/2.3 type				
Single bunch trigger outputs				
Beam Trigger, positive-going	BT		c19	
Trigger ground	BTGND		c20	
Beam Trigger, negative going	BT*	9		
Trigger ground	BTGND	8		
External command				
Beam-based Center Enable	BBCE	5	a13	1
Ground	GND	4	b14	10
Power supply & Grounds				
+ (8...15) V	+15V		c13	
- (8...15) V	-15V		c15	
Common	COM		c14	
Ground	GND	6, 7	a19, b18, c18	9, 12

ACCESSORIES

Table-top test kit (BPM-KIT)

Three versions are available. Only difference is the power supply voltage:
- BPM-KIT-100V
- BPM-KIT-115V
- BPM-KIT-220V

The BPM-KIT includes:

- A power supply. *Check AC mains voltage on power supply module before using*
- A DIN41612M 24+8 mating connector
- Four coaxial cables connected to the button inputs, terminated by SMA plugs
- A DB9 male connector for External Commands input.
  Similar connector and pin-out as used on the BPM chassis BPM-RFC/X
- A DB15 female connector for Output signals
  Similar connector and pin-out as used on the BPM chassis BPM-RFC/X
- Five BNC jacks for:
  X output XOUT
  Y output YOUT
  Sum output SOUT
  AGC voltage output VAGC
  External clock input CLK
- 8-bit DIP switch, to control (pull down):
  PLL time constant. Reserved for future use
  Single Button Sampling SBS*
  Button address BADD1 and BADD0
  Peak and Hold Reset PHRESET*
  Peak Demodulator PDM. Reserved for future use
  Fast Gate Enable ENGAT*
  Clock CLK. For production tests.

The BPM-KIT is very convenient. It allows the BPM module to be placed flat on the table.
In this position, the shield can be removed, and the user can:

a) Re-adjust the zero of the BPM. This is useful when the "normal" beam position is not at the geometric center of the button pick-ups.

b) Re-adjust the X and Y gains, to change the sensitivity of the BPM. This is useful in two situations:
- when the beam is very stable, the gain can be increased
- when the beam has very large displacement from the center, the gain can be decreased.

c) Re-adjust the local oscillator frequency. This is necessary when changes are made to the accelerator lattice. It could be useful also to change the working sideband, when one sideband is disturbed by a local television transmitter.

d) Change the bandwidth of the intermediate frequency filters. It may be needed to have a narrower IF bandwidth to reject the revolution frequency on very large rings.

The adjustments above cannot be made when the BPM processing unit is in the chassis. They require a BPM-KIT or a card extender BPM-XTD.

ACCESSORIES (Cont'd)

Card Extender BPM-XTD

The card extender allows access to the BPM module adjustments while it is connected to the chassis, thus to the readout and control system.

The BPM-XTD is not as convenient as the BPM-KIT for adjustments.

The coaxial connections extensions of the button signals cause an offset of the X and Y outputs when the extender is used. This is due to the difference in signal attenuation between the 4 extension cables. These differences are recorded on a label affixed to the extender.

TTL Commands Service module BPM-SERV/CMD

Not available at the time this manual is written.

The TTL Commands Service module can be inserted in a BPM station of a chassis, in place of the BPM module.

It brings to the front panel:

- On a DB9 female connector, the External Commands applied by the control system to this station
  Similar connector pin-out as used on BPM-RFC/X and BPM-KIT, but reversed gender.

- On a DB15 male connector, the Output lines to which the BPM module would apply its Outputs.
  Similar connector pin-out as used on BPM-RFC/X and BPM-KIT, but reversed gender.

This module is useful because access to the cables at the rear of the chassis will be very difficult.
With this module, one can:

(a) Observe and debug the signals sent by the control system to a BPM station
(b) Feed known signals into the BPM readout system, to test it.

RF Service module BPM-SERV/RF

Not available at the time this manual is written.

The RF Service module can be inserted in a BPM station of a chassis, in place of the BPM module.

It brings to the front panel –on SMA jacks– the four signals applied to this BPM station by the BPM buttons.

For oscilloscope and spectrum analyser viewing of the BPM button signals.

Very useful, because the RF cables at the rear of the chassis are too crowded to be disconnected.

ACCESSORIES (Cont'd)

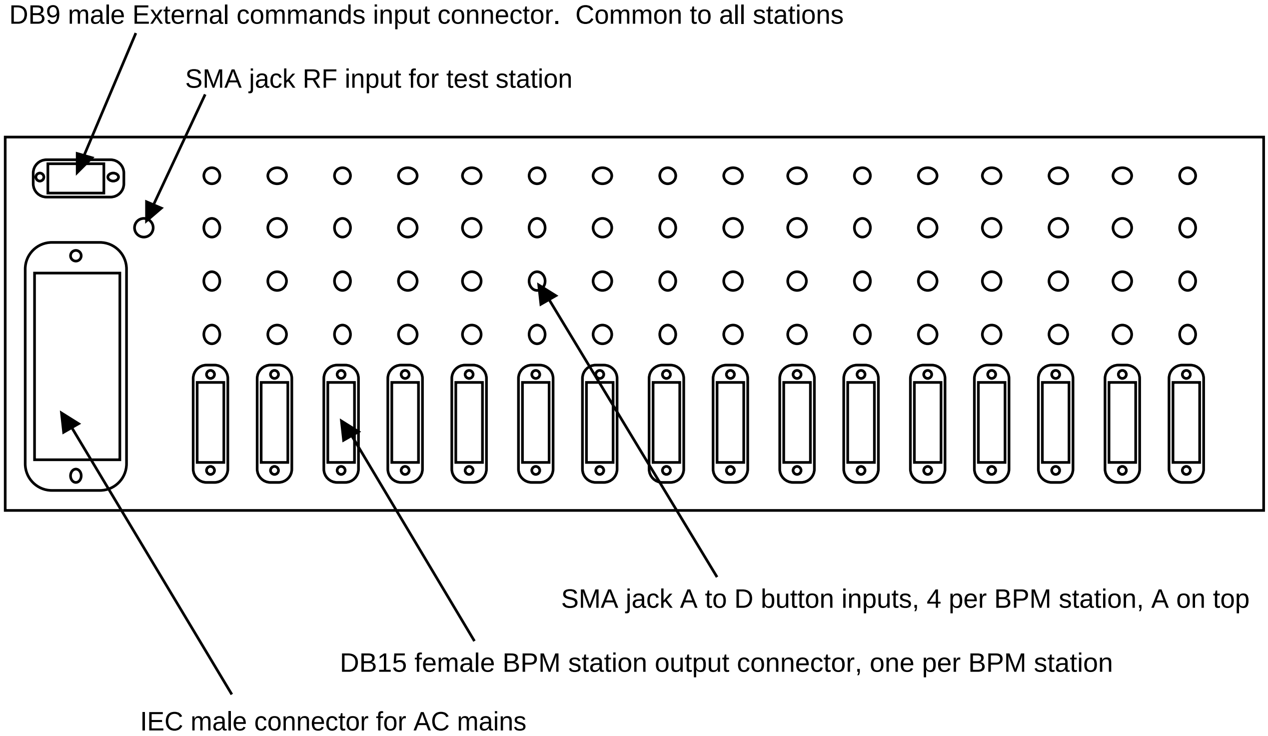
BPM Chassis BPM-RFC/X

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

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

Chassis rear view



SPECIFICATIONS

Power Supply module

AC mains voltage	Autoranging 98…132Vac and 185…265Vac with automatic range changeover
Power derating	No derating down to 85 Vac (at full chassis load)
Output	± 15 V, unequal loading tolerant
Power	75 W
Efficiency	84% at 220Vac 81% at 110 Vac
Inrush current	limited to 10A max.
Dimensions	per DIN41494: 3U high, 8F wide, 160mm deep
Manufacturer	Delta Elektronika BV, the Netherlands
Model	75 SX 15-15

BPM MODULE REAR CONNECTOR DIN41612M 24+8

Note: For connections, See Connector Pins Allocation, this manual.

BPM chassis for 1 up to 16 BPM modules are part of Bergoz Instrumentation sales program (BPM-RFC/X) and include the necessary mating connectors (See BPM chassis, this manual). The following is of interest to those who wish to design their own chassis.

The BPM module rear connector commonly designated DIN41612M 24+8 is a male connector with 24 pin contacts and 8 holes for coaxial connectors. V42254-B1200-M240 from Siemens is the reference used.

The coaxial connectors inserted in the rear connector are of the "jack"-type series 1.0/2.3.
Four V23601-A1227-E1 from Siemens are used for button inputs (jack, right angle, soldering type)
One V23601-A602-E71 from Siemens is used for the optional Fast Gate (jack, straight, crimp)

On the chassis side (or "Backplane" side), for each BPM module, the following is needed:

- One DIN41612M female connector with 24 pin contacts and 8 holes for coaxial connectors.

We recommend using Siemens connectors to assure compatibility:
V42254-B2240-M240 from Siemens, for wrapping connection
V42254-B2202-M240 from Siemens, for soldering connection (4.5-mm pins)
Other references available for press-fit connection.

- Four or five coaxial "plug"-type connectors, series 1.0/2.3.

A large number of manufacturers produce these connectors. However, to assure good connector mating, we recommend that you use connectors from Siemens:
V23601-B302-E71 or V23601-A302-E71 for straight cable attachment to RG316 (Øext.≤2.6mm)
V23601-A302-E1 for straight cable attachment to RG178 (Øext.≤1.9mm)
V23601-A502-E71 (18.7mm long) for 90° angle cable attachment.to RG316 (Øext.≤2.6mm)
V23601-A556-E71 (22.3mm long) for 90° angle cable attachment.to RG316 (Øext.≤2.6mm)
V23601-A502-E73 (18.7mm long) for 90° angle cable attachment.to RD316 (Øext.≤3.0mm)
V23601-A556-E73 (22.3mm long) for 90° angle cable attachment.to RD316 (Øext.≤3.0mm)

Cable type correspondence:

US manufacturers' designation	VDE designation	IEC designation
RG316	5YC5Ye 0,5/1,5	50-2-1
RD316	5YCC5Y 0,5/1,5	--
RG178	5YC5Ye 0,3/0,86	50-1-1

Siemens recommends to use connector crimping tool reference M1002-K1.

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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: ....

ACKNOWLEDGEMENT

The fundamental principles of our Log-ratio BPM module were developed by Robert E. Shafer while at Los Alamos National Laboratory. We sincerely thank him for his considerable contribution.

Our LR-BPM module was developed by Alexandre Kalinine. Earlier work was performed by Klaus Unser and Jim Hinkson, which contributed to Kalinine's design.

Saint Genis Pouilly, revised June 2001