NEW AUTOMATIC BUNCH CURRENT SENSITIVE FAST ATTENUATOR FOR RF FRONT-END OF BUNCH-BY-BUNCH FEEDBACK SYSTEM AT SPRING-8

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(JASRI/SPring-8)

Contents

- SPring-8 Bunch-by-Bunch Feedback System
- Filling modes
- Bunch current sensitive automatic attenuator
  Present & New(under development)
- Test result
- Summary

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- ***SPring-8 Bunch-by-Bunch Feedback System***
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SPring-8 Bunch-by-Bunch Feedback System

Storage Ring
light source

RF Frequency : 508.58MHz
Harmonics : 2436
Revolution Period : 4.8μs

BPM

180°hybrid
Δ

$x(n-1)$ $x(n)$

$x(n) \propto$
position × current

Attenuator

g

4ADCs
127M
SPS

FPGA based
Feedback Signal
Processor

$$y(n) = \sum_{i=0}^{m} a_i \, x(n-i)$$

FPGA :
FIR filter
1-turn delay
Gain Control

DAC
508M
SPS

G

Kicker
Against unwanted beam
motion

$$V_k(n) = Gg \sum_{i=0}^{m} a_i x(n-i)$$

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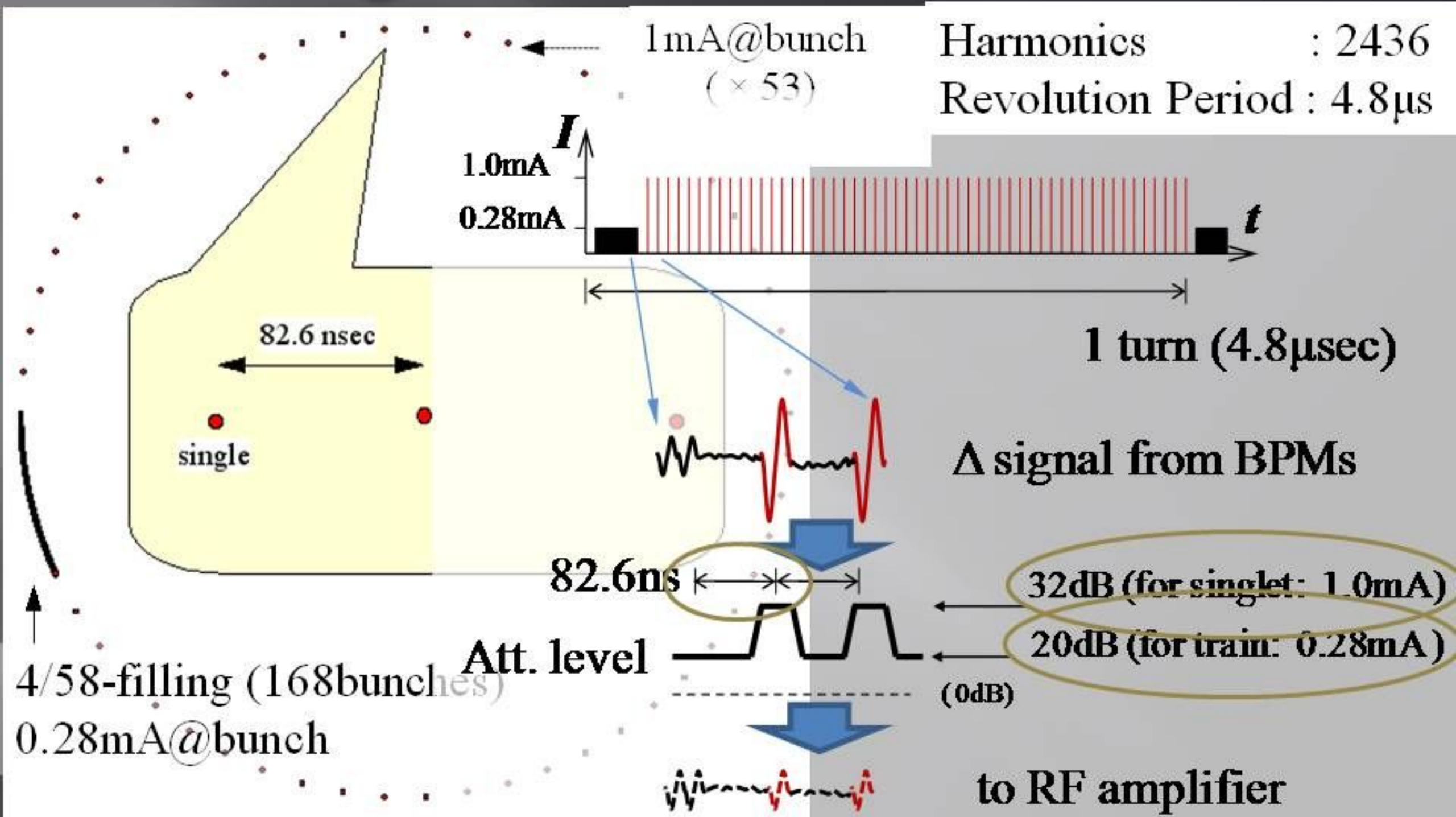
Filling mode : 4/58-filling + 53 bunches



The feedback system is adjusted to
the bunch current of 0.05mA/bunch

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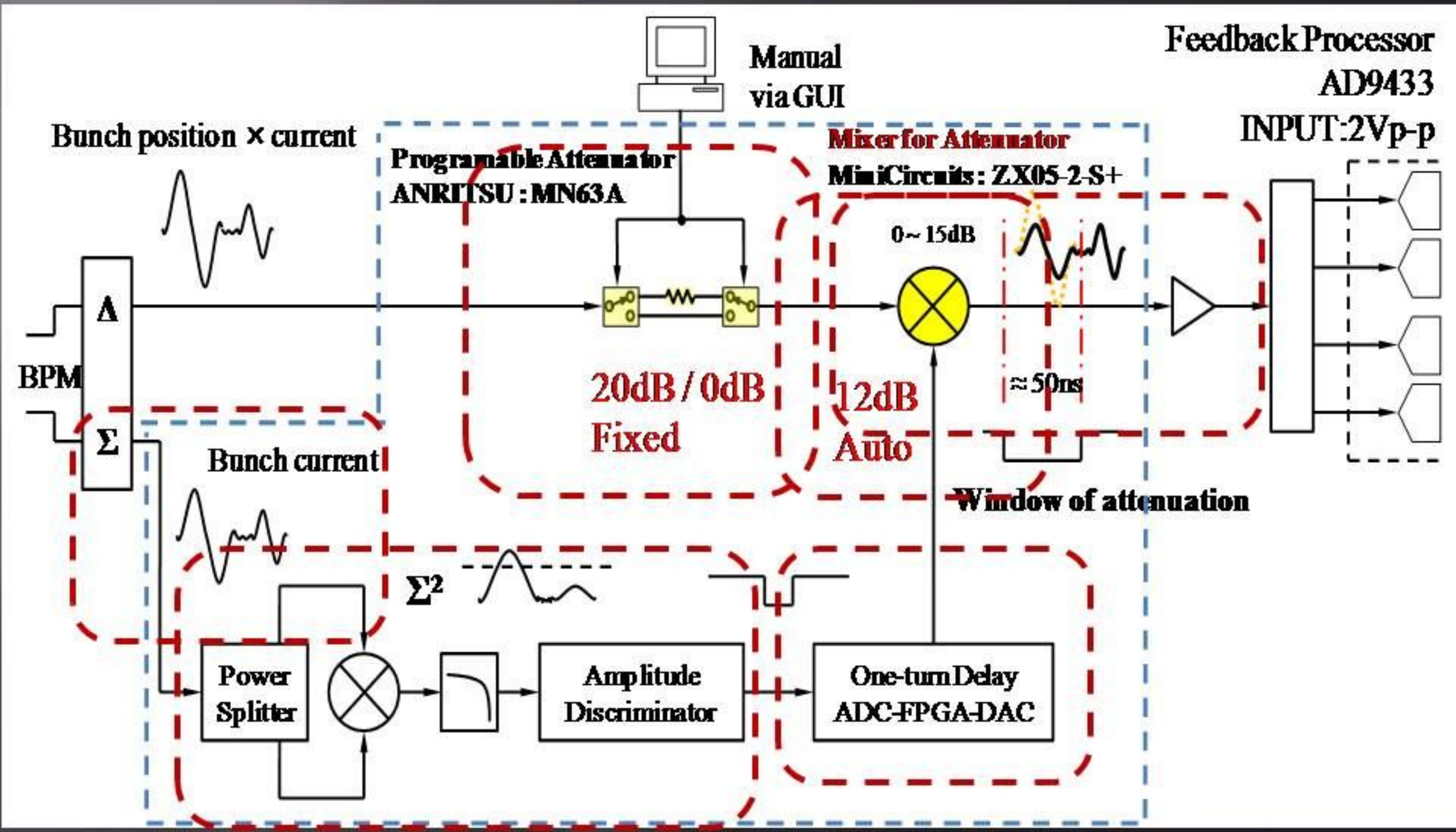
Bunch current sensitive automatic attenuator (present) 0 / 12 dB

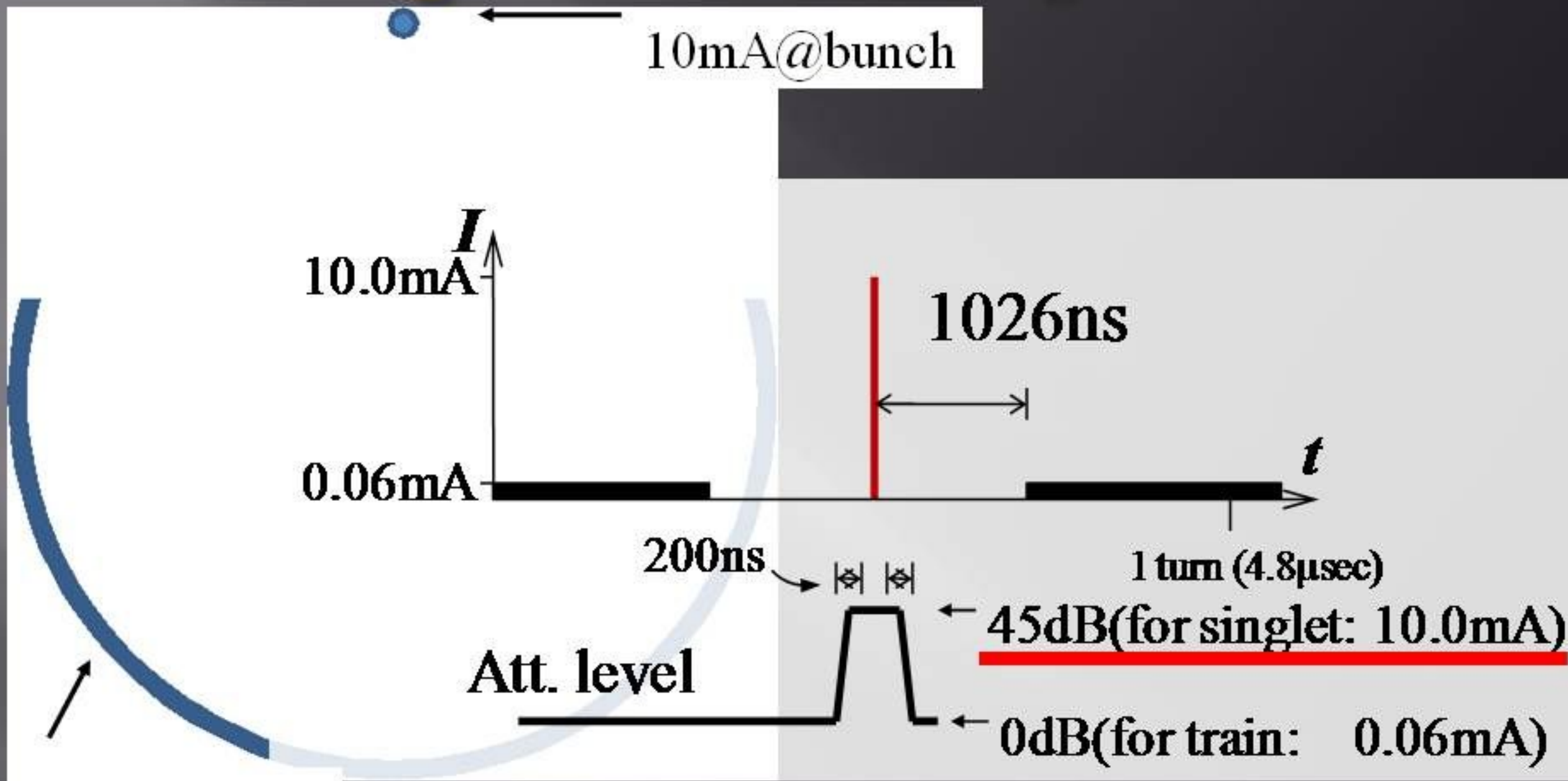


Filling modes

Total 2436 bucket, Storage current = 100mA

mode		# of bunches		Bunch Current (mA)		Current ratio: singlet /train	Att. (dB)	
		train	singlet	train	singlet		train	singlet
multi				0.05			0	
hybrid	I	348	5	0.24	3.00	12.5	20	32
	II	168	26	0.38	1.40	3.0	20	32
	III	174	12	0.46	1.60	3.5	20	32
	IV	168	53	0.28	1.00	3.6	20	32
	V	1392	1	*0.06*	*10.0*	166.7	0	45

Filling mode : 4/7-filling + 1 bunch



Present automatic variable level
is only about 12dB ! << 45dB

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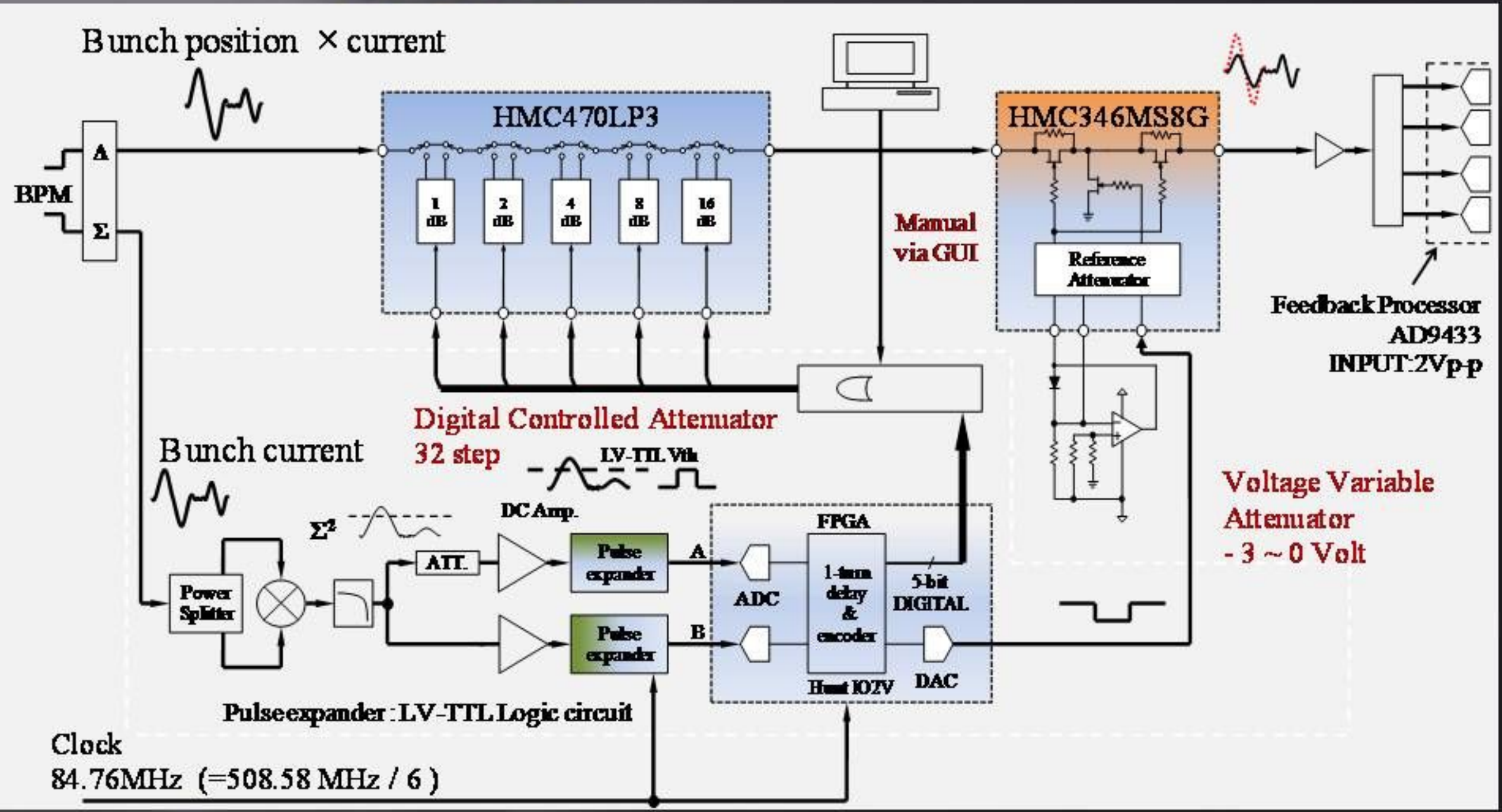
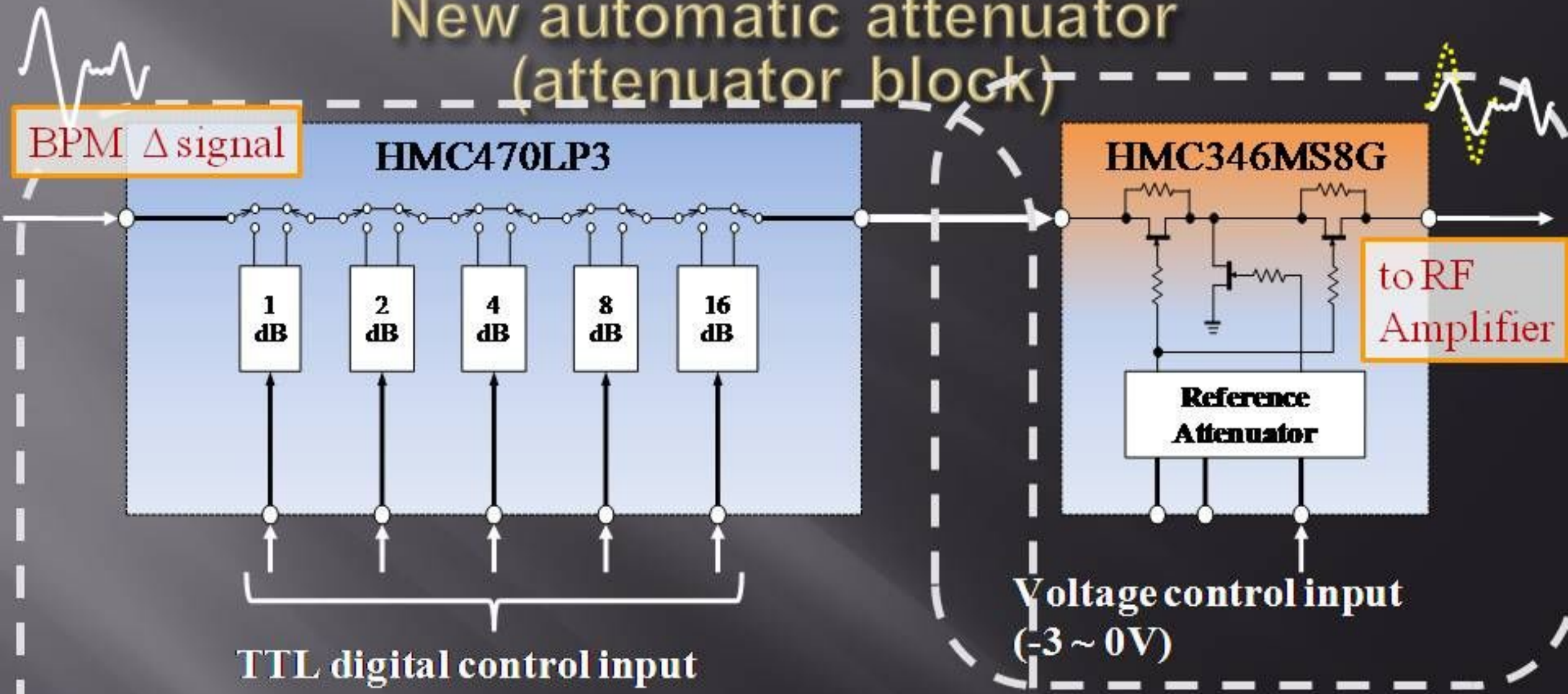
New automatic attenuator(development) 0/45dB



New automatic attenuator (attenuator block)



HMC470LP3E;

1dB LSB GaAs 5-Bit DIGITAL Control Attenuator

Switching time: < 180ns

RF Input Power : ***Max +27dBm***

HMC346MS8GE;

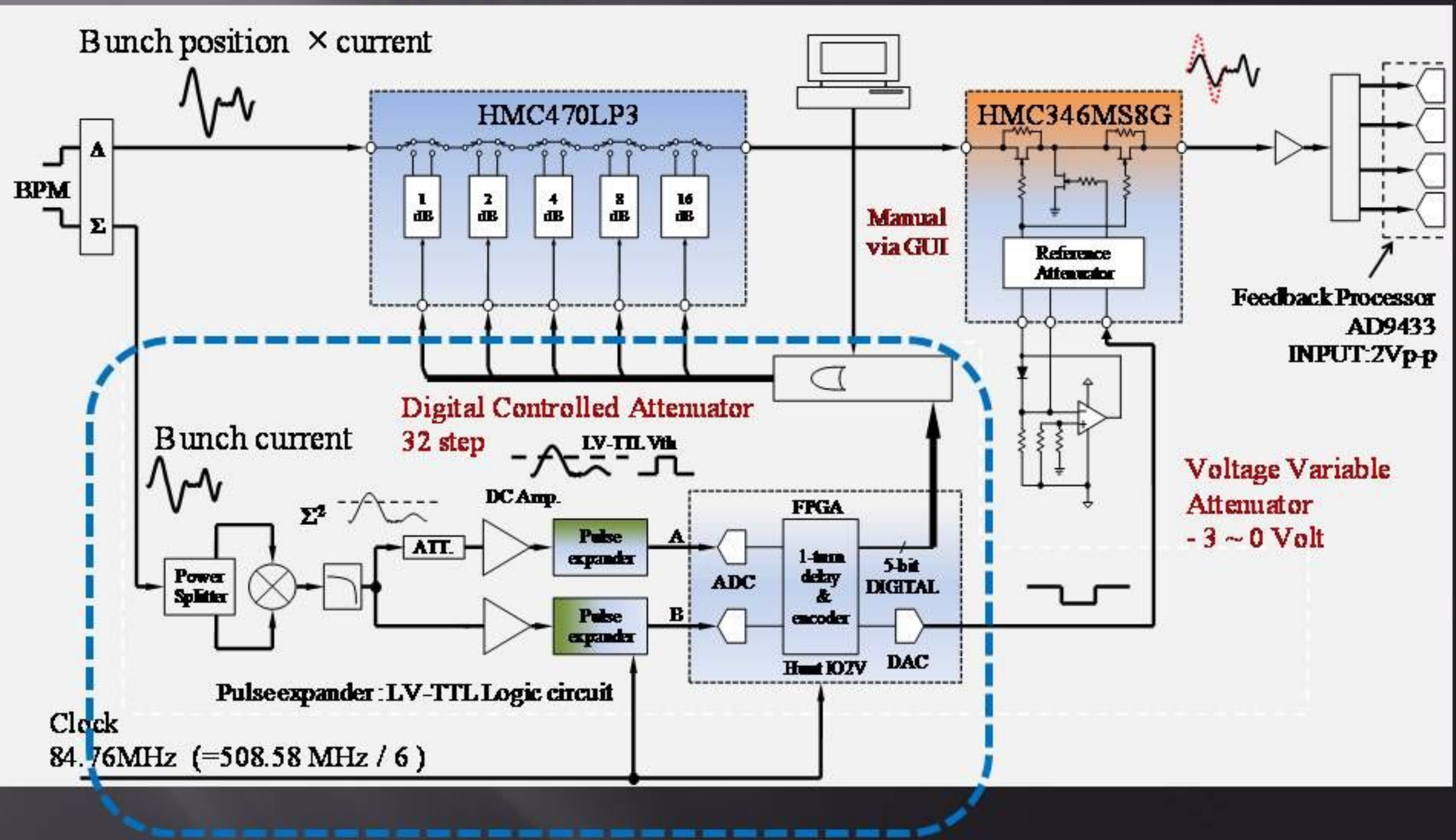
GaAs Voltage-Variable Attenuator

Switching time: < 8ns

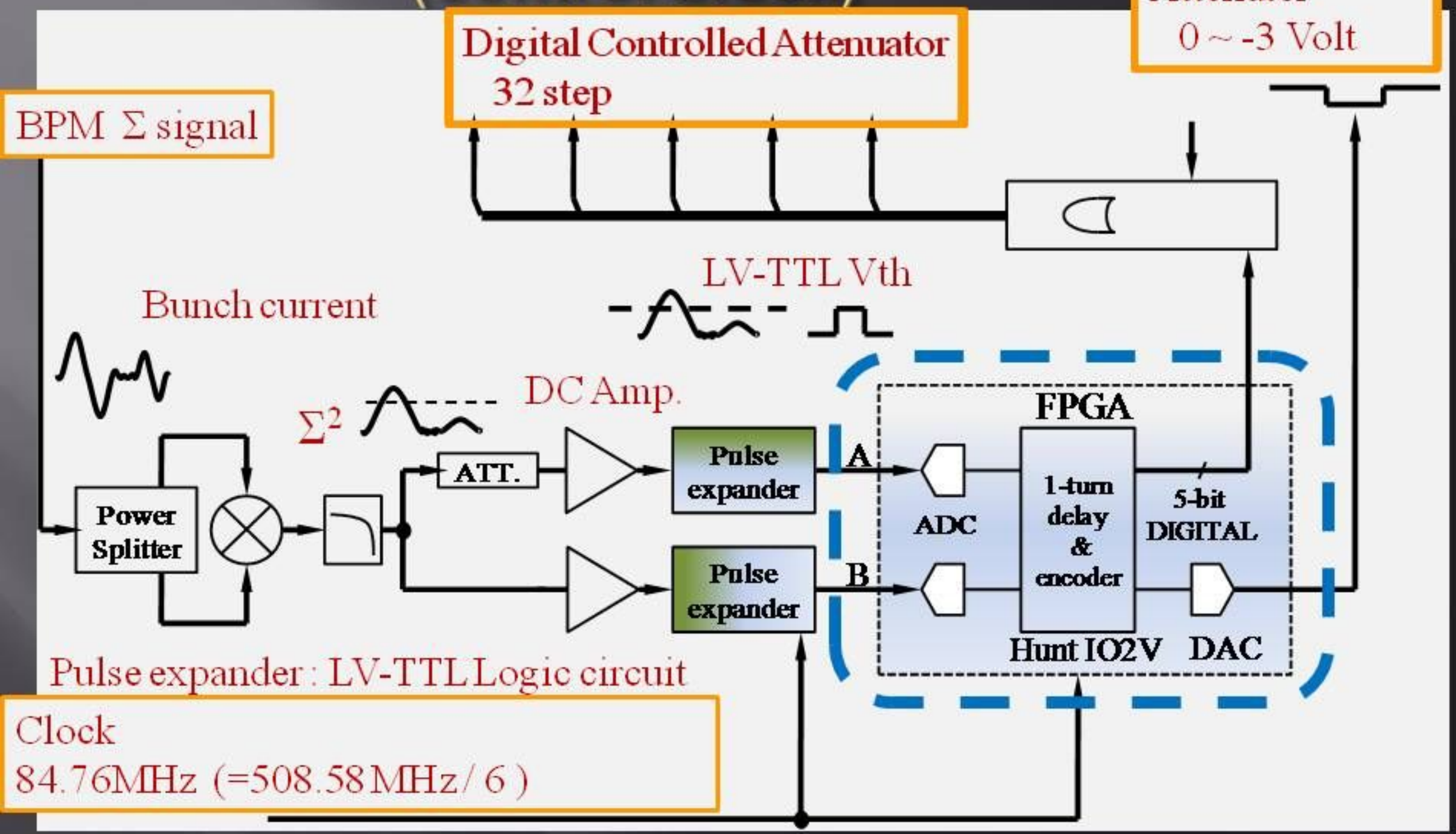
RF Input Power : Max +18dBm

by
Hittite Microwave Corporation

New automatic attenuator(development) 0/45dB



New automatic attenuator (control block)



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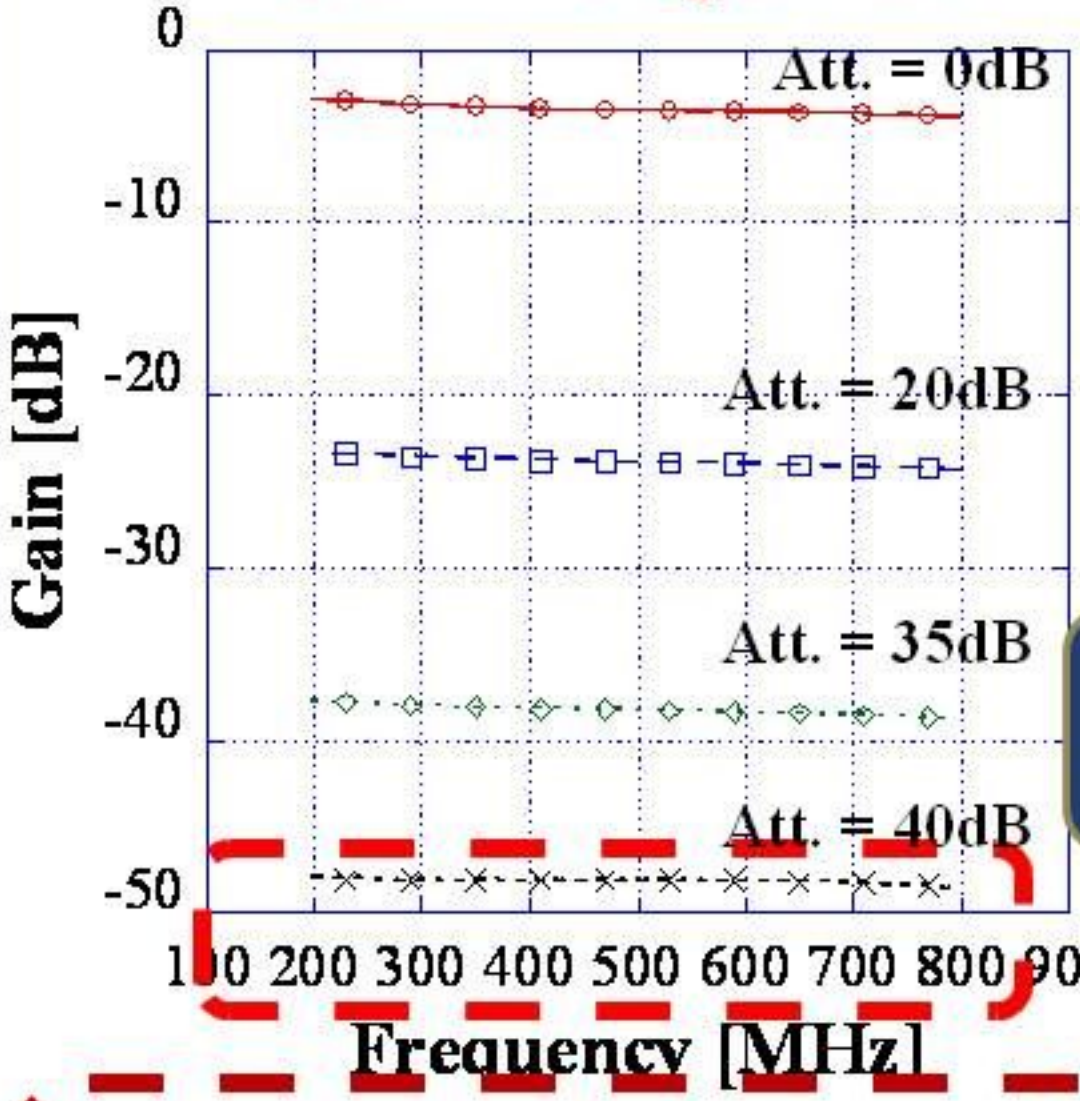
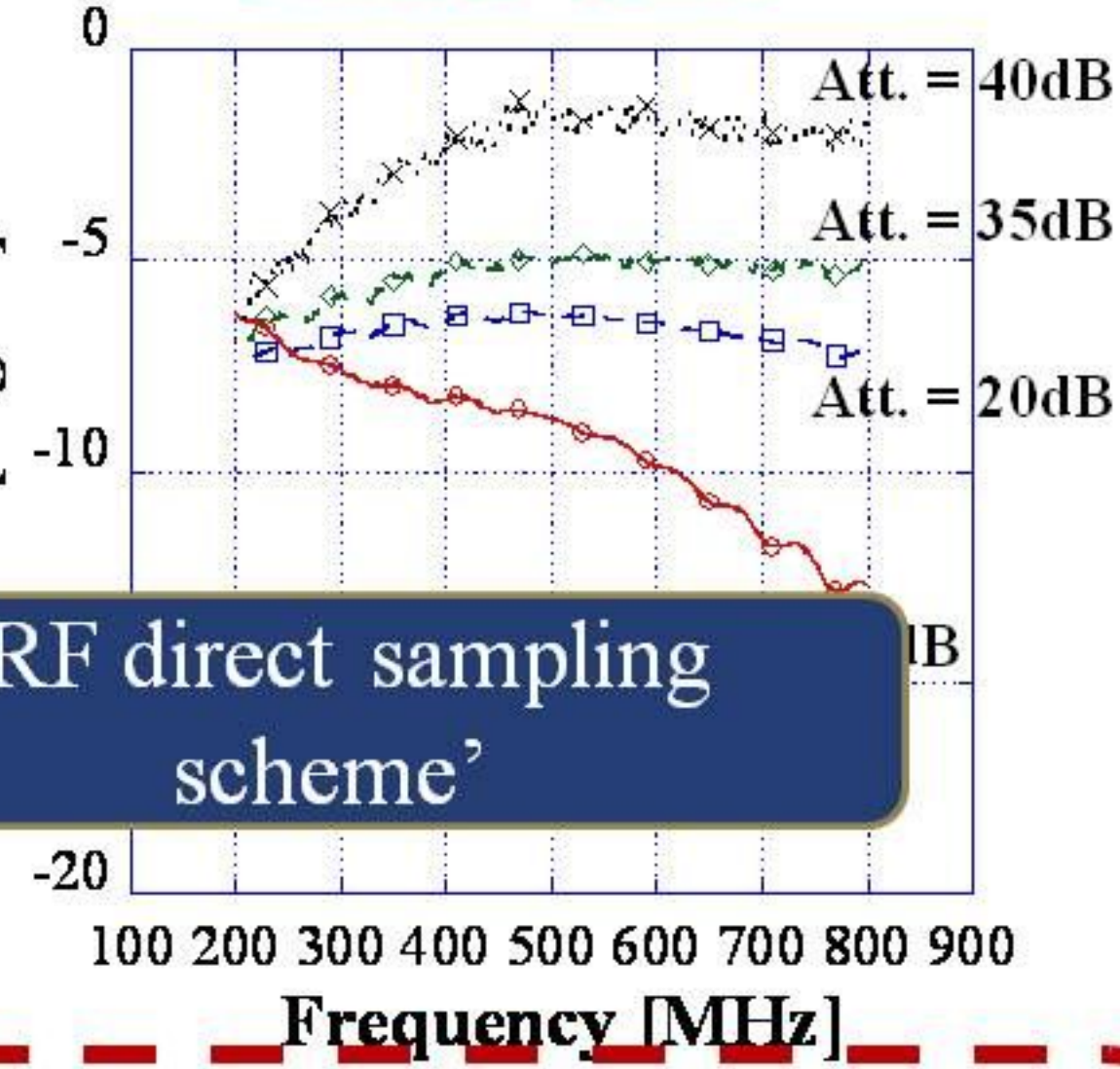
Test Result (static)

Gain response



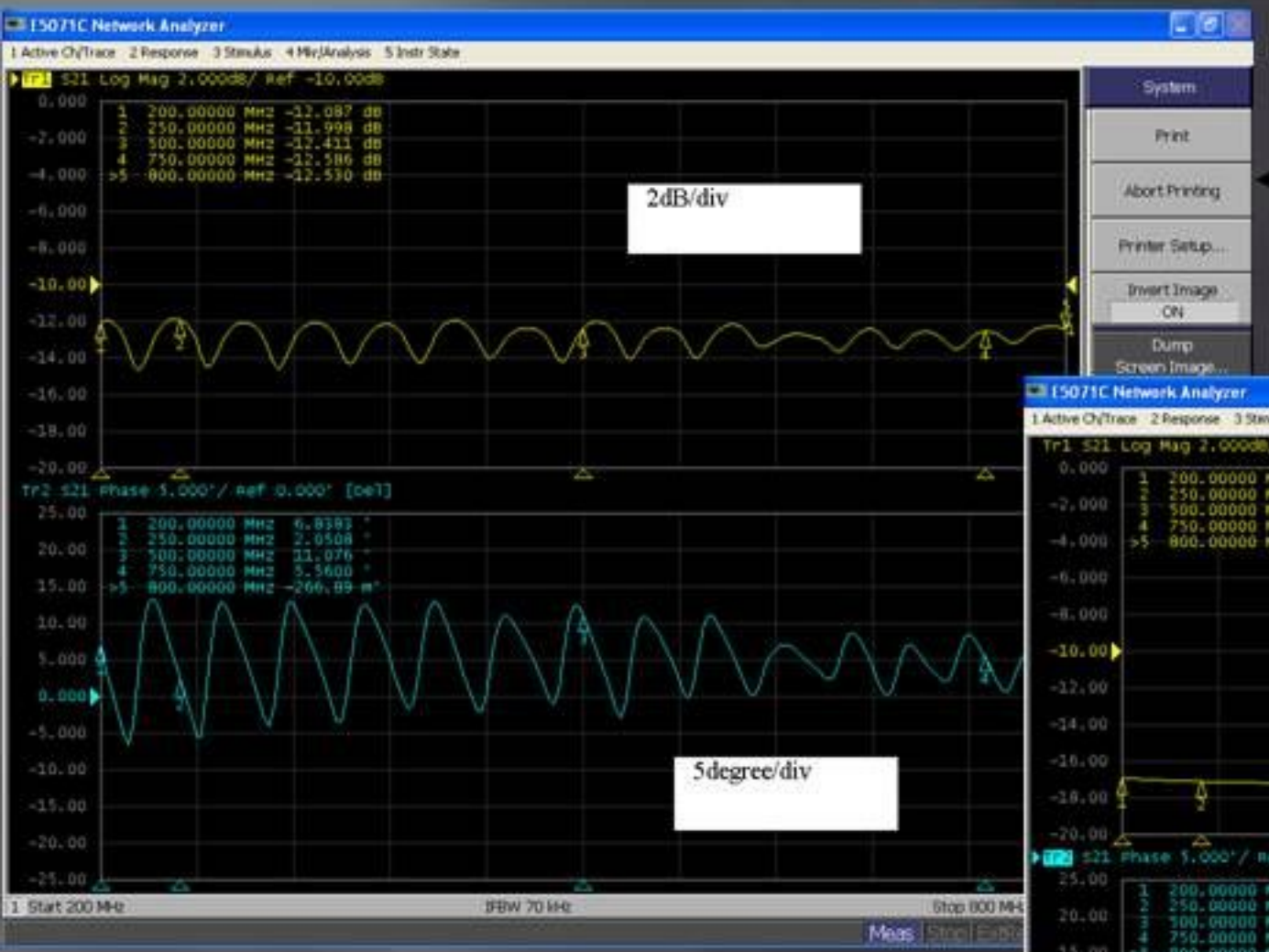
Phase shift



'RF direct sampling scheme'

Attenuation [dB]	0 (0 + 0)	20 (20 +0)	35 (20 + 15)	45 (30 + 15)
HMC470 (digital, bin.)	0	20 (16 +4)	20 (16+4)	30(16+8+4+2)
HMC346 (voltage, [V])	0 V	0 V	- 2.54 V	- 2.54V

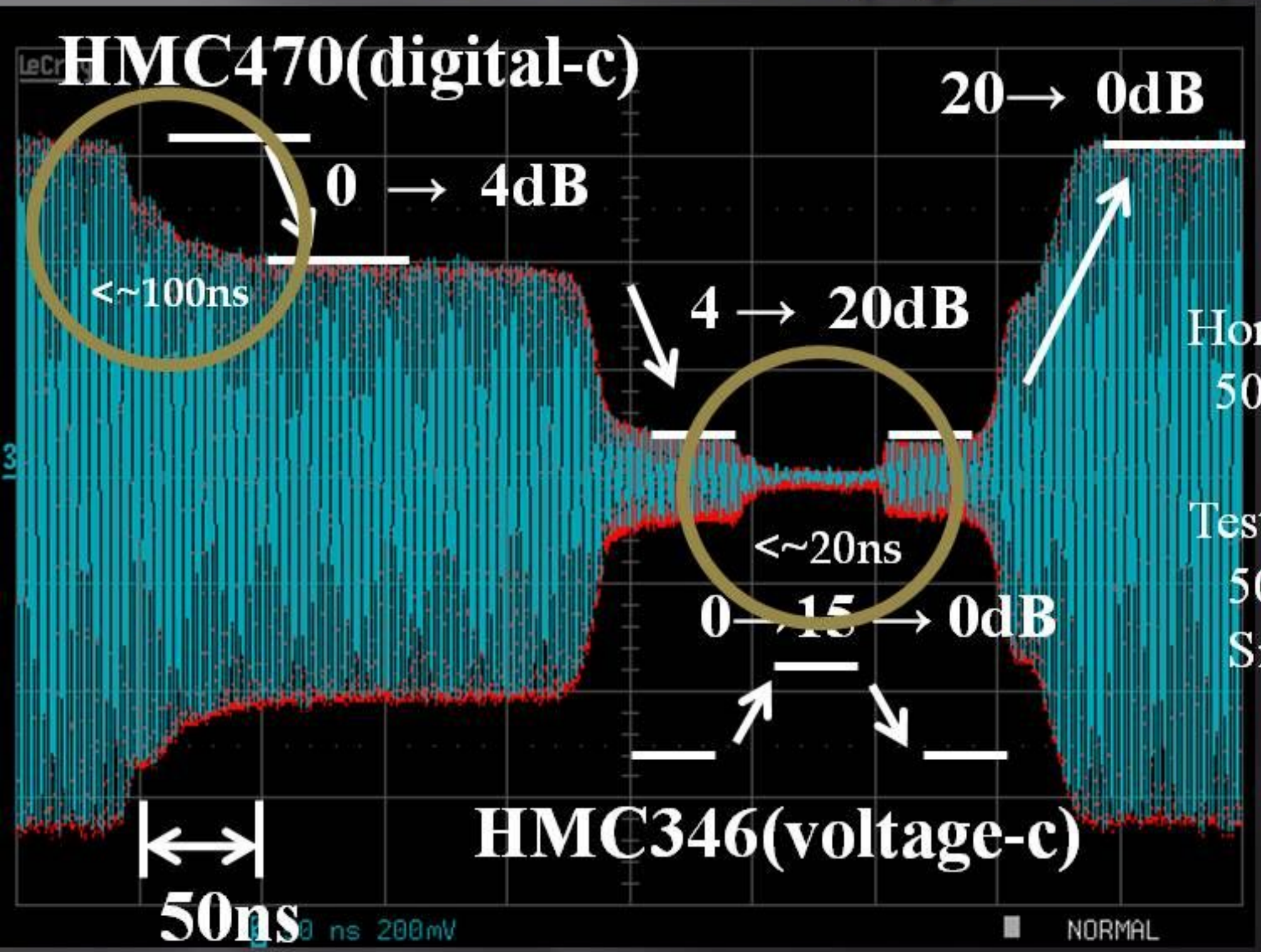
Test Result



← Present System (RF mixer)

New System(test bench) →

Test Result (dynamic)



Horizontal scale:
50ns/div

Test input signal:
508MHz
Sin. Wave

Attenuation : 0 → 4 →20 →35 → 20 → 0 dB

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Summary

- Prototype of new bunch current sensitive automatic attenuation system was developed and its timing response and attenuation level were confirmed to be applicable to the hybrid filling with 10mA/bunch singlets and 0.06mA/bunch train.
- We intend to replace the control block of the new system with a SPring-8 bunch-by-bunch feedback processor by an implementation on FPGA, to simplify the circuit and for flexible operation.
- Presently we will serve more flexible filling modes for users with the new attenuation system.

Thank you for listening!