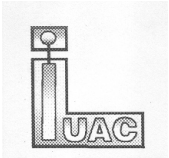

Technical Report on
Dual ultrafast Amplifier & Discriminator circuit

Abstract

Specifications

Descriptions

Logic diagram

Schematic diagrams

Panel Layouts

Test plots

Developed by:

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TECHNICAL REPORT

TITLE	**:Technical Report on Dual Ultrafast Amplifier & Discriminator circuit**
AUTHORS	**:** S.Venkataramanan, Abhishek Rai
CATEGORY	**:** Instrumentation (Nuclear Electronics)
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Abstract: A dual channel ultrafast Amplifier & Discriminator circuit consists of two independent channels of electronics housed in a single width NIM module, has been successfully prototyped and bench tested. This unit will be used to process the signals from Charge pick-off units of superconducting Linac (linear accelerator) of IUAC, for beam energy measurement and other diagnostic purposes.

Specifications	**:**	**Dual ultrafast Amplifier & Discriminator circuit**
Form factor	:	single wdith NIM cabinet
Input DC supply	:	+6V / 0.2A, -6V / 0.8A
Printed circuit board	:	FR-4, 4 layer
Connectors	:	Sub miniature Type A (**SMA-F)**
Wide band Amplifier		
Bandwidth	:	10MHz – 2.2 GHz (-3dB) ¥
Power gain	:	+21dB¥
Supply	:	+5.2V, 50mA each
No. of Amplifiers	:	2 (one independent, one is connected with discriminator)
Attenuation	:	Attenuation possible “Pi” type at input & output
Ultrafast Discriminator		
Input dynamic range	:	-2V to +3V across 50 ohms (clamped to +/-5V)
Bandwidth of comparator	:	8 Ghz
Low Level Threshold (LLTH):		-2V to +0.3V adjustable from front pnel
LLTH monitor	:	1/10th of actual through 2mm jack
Outputs RAW	:	Fast NIM unshaped signal
Output Shaped	:	2 Nos. of Fast NIM width adjustable (10ns to 200ns) on PCB
Edge selection	:	Switch selectable (FP) selection on +/- edge of RAW signal
Visual indication	:	LED Blinker on FP

Note: (¥) Refer to Plot: 1

Descriptions: Dual ultrafast Amplifier & Discriminator module houses two independent channels of electronics housed in a single width NIM module, to process the signals from Charge pick-off units of superconducting Linac (linear accelerator) for beam energy measurement and other diagnostic purposes. The typical signal generated by the charge pick-off units are ultrafast signals and typically havings pulse width around 1ns. Such pulses have signal bandwidth of more than 1GHz. In order to preserve the signal to noise ratio, a low noise, wideband (30dB) preamplifier has been used to amplifiy signal from the charge-picko off unit.

The module houses a spare wideband amplifier (upc1678-CEL) and another identical wideband amplifier is wired at the input of a ultra fast low level discriminator as shown in Fig:1. These wideband amplifiers are cascaded when required and used to boost the input signal before further processed. The provision for attenuator at input and output of amplifiers can be used to adjust the overall amplifier gain.

A ultrafast discriminator is used to generate a logic signal corresponding to the arrival of the pulse at the charge pick-off unit. The discrimination level can be set from front panel trimmer potentiometer and measured with digital multimeter. For this purpose ADCMP581, a ultrafast ECL comparator (8GHz bandwidth) is used. The same signal is further processed by a monostable multivibrator to generate a wide pulse (300ns) and denoted as shaped pulse. This monoshot can be triggered on either edge of the raw signal as per user requirements with a help of front panel switch. In order to preserve the bandwidth of the input and output signals, SMA type connectors are used. The logic outputs are suitably converted to fast NIM level and provided on panel.

Typical response to ultrafast pulser and sinusoidal wave at different frequencies are plotted here. A sample charge pick-off signal due to Linac beam and corresponding logic output is also shown here.

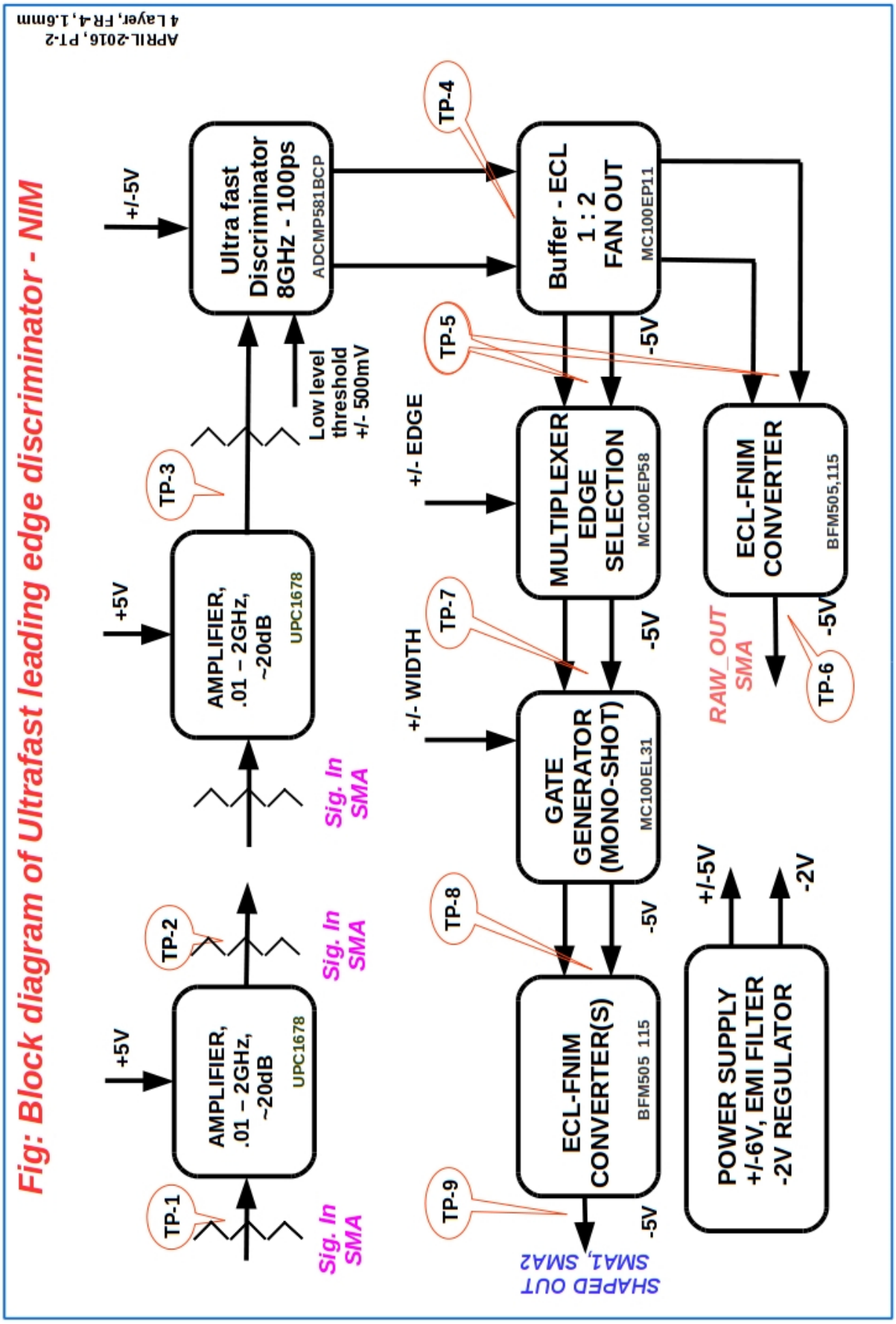


Fig:1 Detailed Block diagram of Dual ultra-fast Amplifier & Discriminator circuit

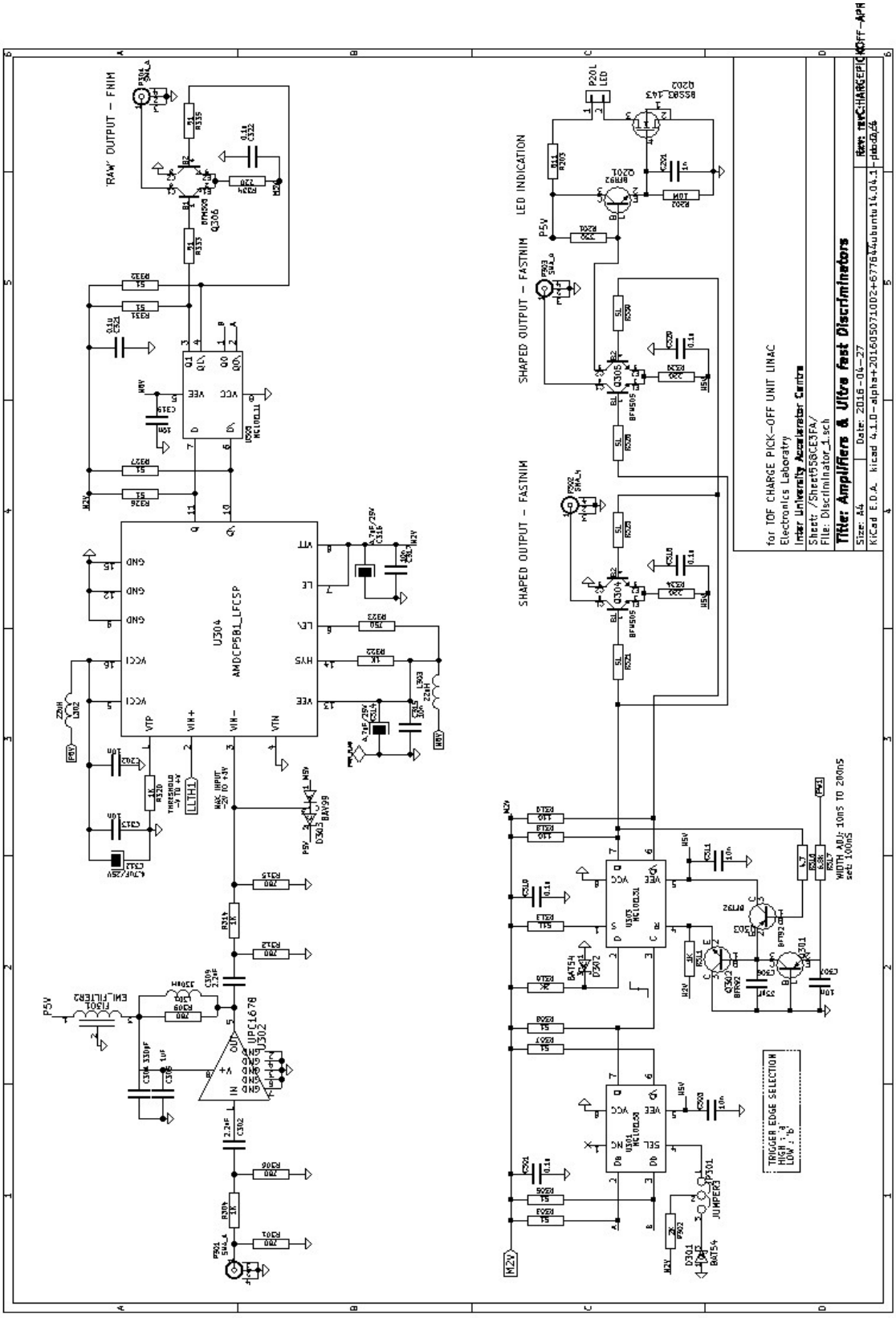


Fig: 2 Amplifier and Discriminator circuits

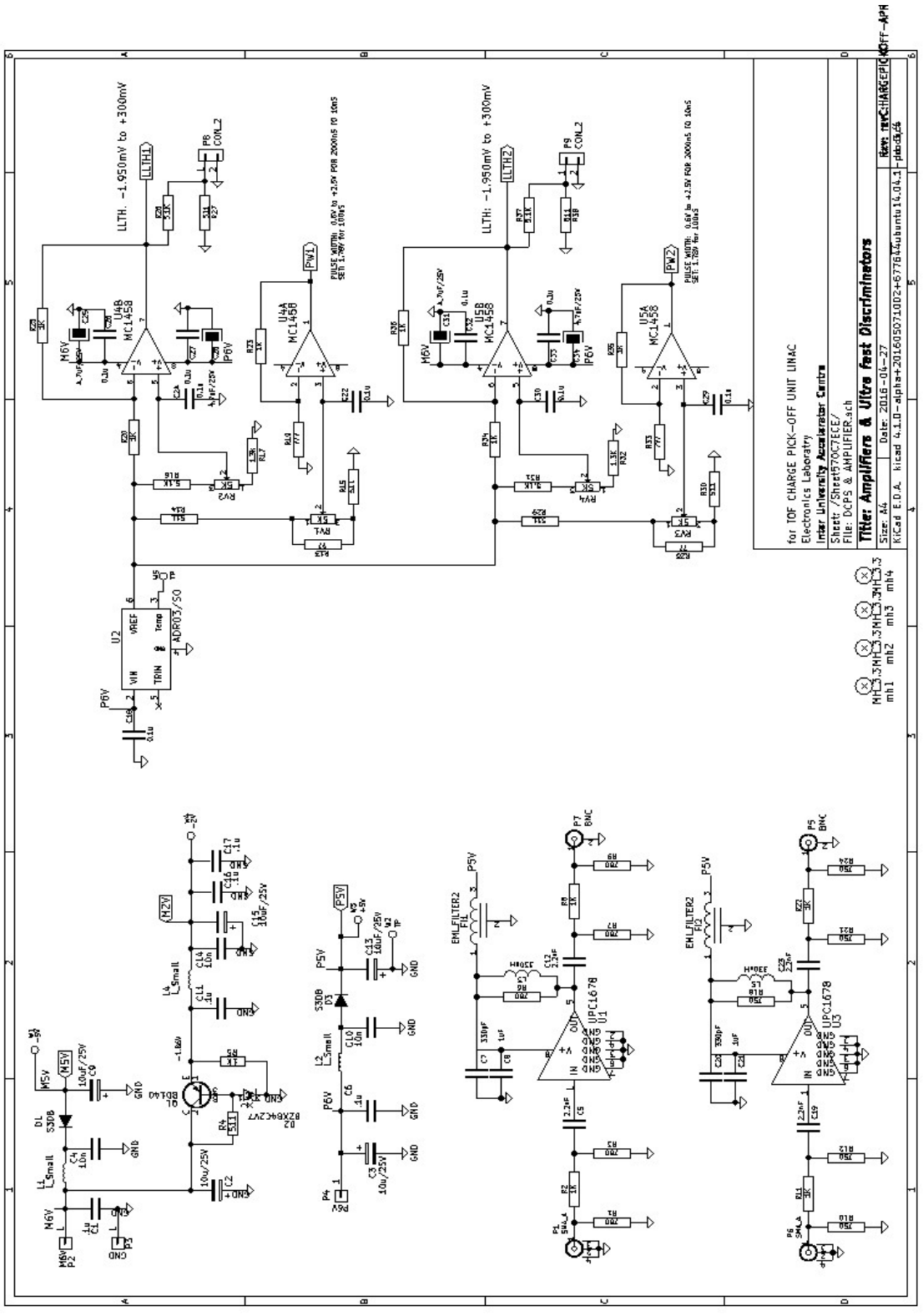
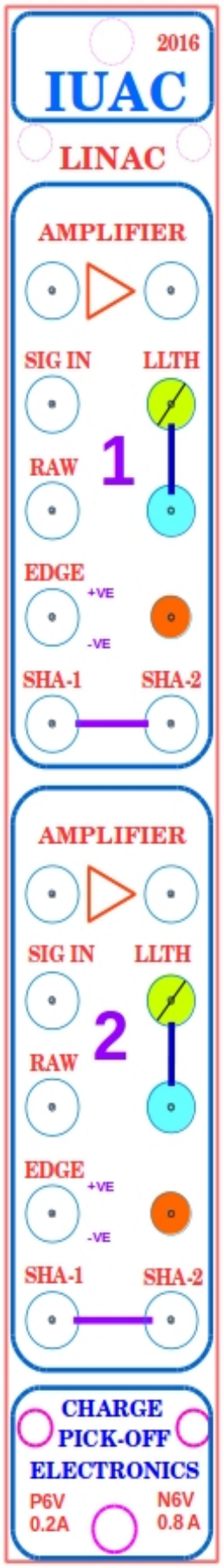


Fig:3 DC power, reference voltages and spare Amplifiers

Bill of materials for Ultra fast discriminator Dual NIM version APRIL 2016

Sl. NO	Designator	Package	Quantity	Designation	Supplier and ref
1	mh4,mh1,mh2,mh3,mh4	mhsq_3.3mm_5.6mm	5	MH_3.3	local
2	FI301,FI101	EMI_NFE31	2	NFE31R	murata
3	Q101,Q103,Q301,Q303	SOT-23	4	BFT92	nxp
4	C106,C306	MYSM_C_0805	2	33pF	multicomp
5	R103,R105,R107,R108,R121,R125,R126,R127,R128,R130,R131,R132,R133,R135,R303,R305,R307,R308,R321,R325,R326,R327,R328,R330,R331,R332,R333,R335	SM_R_0805	28	51	multicomp
6	U105,U305	MSOP-8-NEW	2	EL11	CEL
7	C1,C6,C11,C16,C17	MYSM_C_0805	5	.1u	multicomp
8	C2,C3	MY_TAN_B	2	10u/25V	multicomp
9	C4,C10,C14,C103,C107,C110,C112,C114,C116,C118,C303,C307,C311,C313,C315,C317,C319,C202,C402	MYSM_C_0805	19	10n	multicomp
10	C5,C12,C19,C23,C102,C108,C302,C309	MYSM_C_0805	8	2n2	multicomp
11	C7,C20,C104,C304	MYSM_C_0805	4	330pF	multicomp
12	C8,C21,C105,C305	MYSM_C_0805	4	1uF	multicomp
13	C9,C13,C15	MY_TAN_B	3	10uF/25V	avx
14	C18,C22,C24,C26,C27,C101,C109,C117,C119,C120,C121,C301,C310,C318,C320,C321,C322,C29,C30,C32,C33	MYSM_C_0805	21	0.1u	multicomp
15	C25,C28,C111,C113,C115,C312,C314,C316,C31,C34	MY_TAN_B	10	4.7uF/25V	avx
16	D1,D3	Diode-SMB_Standard	2	S3DB	nxp
17	D2	SOT-23	1	**BZX84C2V7**	nxp
18	D101,D102,D301,D302	SOT-23	4	BAT54	nxp
19	D103,D303	SOT-23	2	BAV99	nxp
20	FI1	EMI_NFE31	1	NFE31	MURATA
21	FI2	EMI_NFE31	1	EMI_FILTER2	MURATA
22	JP101	SIP-3	1	EDGE	local
23	JP301	SIP-3	1	EDGE	local
24	L1,L2,L4	44_woundbead_TH	3	L_Small	multicomp
25	L3,L5,L101,L301	SM_R_0805	4	330nH	multicomp
26	L102,L103,L302,L303	SM1210L	4	22uH	multicomp
27	P1,P101 (142-0701-201)	SMA_3_h	2	SIG_IN1	element14
		for cable			
28	P2 (19-55V-3-TGG)	tp	1	M6V	element14
29	P3,W2	tp	2	GND	precision electroech
30	P4	tp	1	P6V	precision electroech
31	P6	SMA_3_h	1	SIN_IN2	element14
32	P8	SIP-2	1	LTH_MON	local
33	P102,P302	SMA_3_h	2	SHA_1	element14
34	P103,P303	SMA_3_h	2	SHA_2	element14
35	P104,P301	SMA_3_h	2	RAW	element14
36	P304	SMA_3_h	1	SIG_IN	element14
37	Q102,Q302,Q201,Q401	SOT-23	4	BFR92	nxp
38	Q104,Q105,Q106,Q304,Q305,Q306	SOT-363	6	BFM505	nxp
39	R1,R3,R6,R7,R9,R10,R12,R18,R21,R24,R101,R106,R109,R112,R115,R123,R301,R306,R309,R312,R315,R323	SM_R_0805	22	750	multicomp
40	R2,R5,R8,R11,R20,R22,R23,R25,R104,R111,R114,R120,R122,R304,R311,R314,R320,R322,R34,R35,R36	SM_R_0805	21	1K	multicomp
41	R4,R14,R15,R27,R113,R313,R29,R30,R38,R203,R403	SM_R_0805	11	511	multicomp

42	R13,R28	SM_R_0805	2	??	multicomp
43	R16,R26,R31,R37	SM_R_0805	4	5.1K	multicomp
44	R17,R32	SM_R_0805	2	1.3K	multicomp
45	R19,R33	SM_R_0805	2	???	multicomp
46	R102,R110,R302,R310	SM_R_0805	4	2K	multicomp
47	R116,R316	SM_R_0805	2	4.7	multicomp
48	R117,R317	SM_R_0805	2	6.8K	multicomp
49	R118,R119,R318,R319	SM_R_0805	4	110	multicomp
50	R124,R129,R134,R324,R329,R334	SM_R_0805	6	220	multicomp
51	RV1,RV2,RV3,RV4	BOURNS-3386W	4	5K	multicomp
52	U1,U102,U302	MSOP-8-NEW	3	UPC1678	cel
53	U2	SO8E	1	ADR03/SO	adi
54	U3	MSOP-8-NEW	1	UPC1678	cel
55	U4,U5	SO8E	2	MC1458	ti
56	U101	MSOP-8-NEW	1	EL58	onsemi
57	U103	MSOP-8-NEW	1	EL31	onsemi
58	U104,U304	LFCSP-VQ-16	2	AMDCP581	adi
59	U301	MSOP-8-NEW	1	EL58	onsemi
60	U303	MSOP-8-NEW	1	EL31	onsemi
61	W1	tp	1	-5V	precision electroech
62	W3	tp	1	+5V	precision electroech
63	W4	tp	1	M2V	precision electroech
64	W5	tp	1	TP	precision electroech
65	P9	SIP-2	1	LLTH_MON1	precision electroech
66	Q1	TO126-123-TH	1	BD179	nxp
67	C201,C401	MYSM_C_0805	2	1n	multicomp
68	R201,R401	SM_R_0805	2	330	multicomp
69	R202,R402	SM_R_0805	2	10M	multicomp
70	P201,P401	SIP-2	2	LED	precision electroech
71	Q202,Q402	SOT-143	2	BSS83	nxp
72	P5 (142-0701-201)	BNC_COAX	1	OUT_2	element14
73	P7 (142-0701-201)	BNC_COAX	1	OUT_1	element14



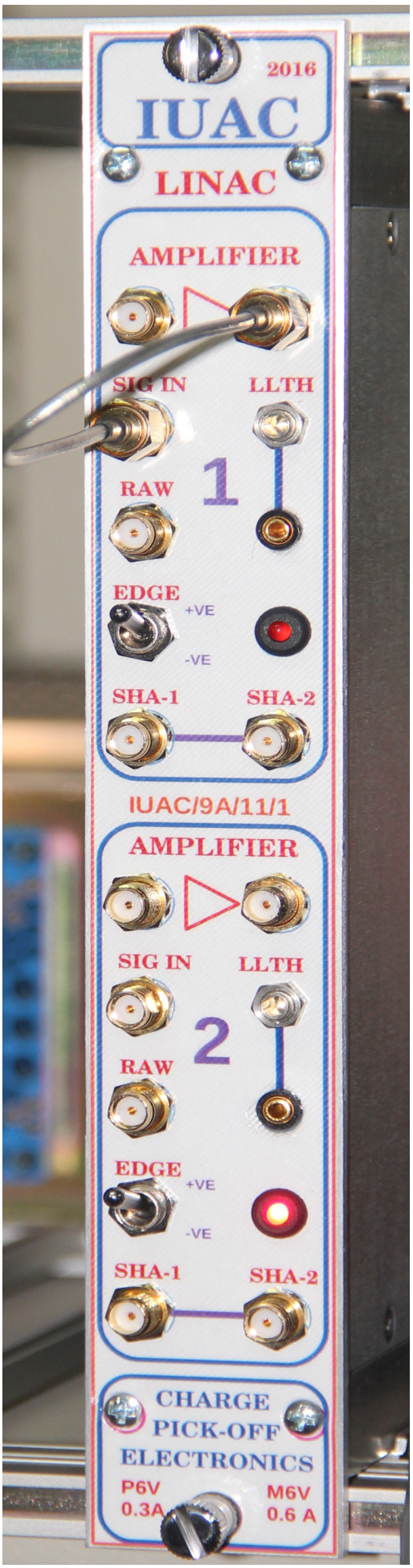
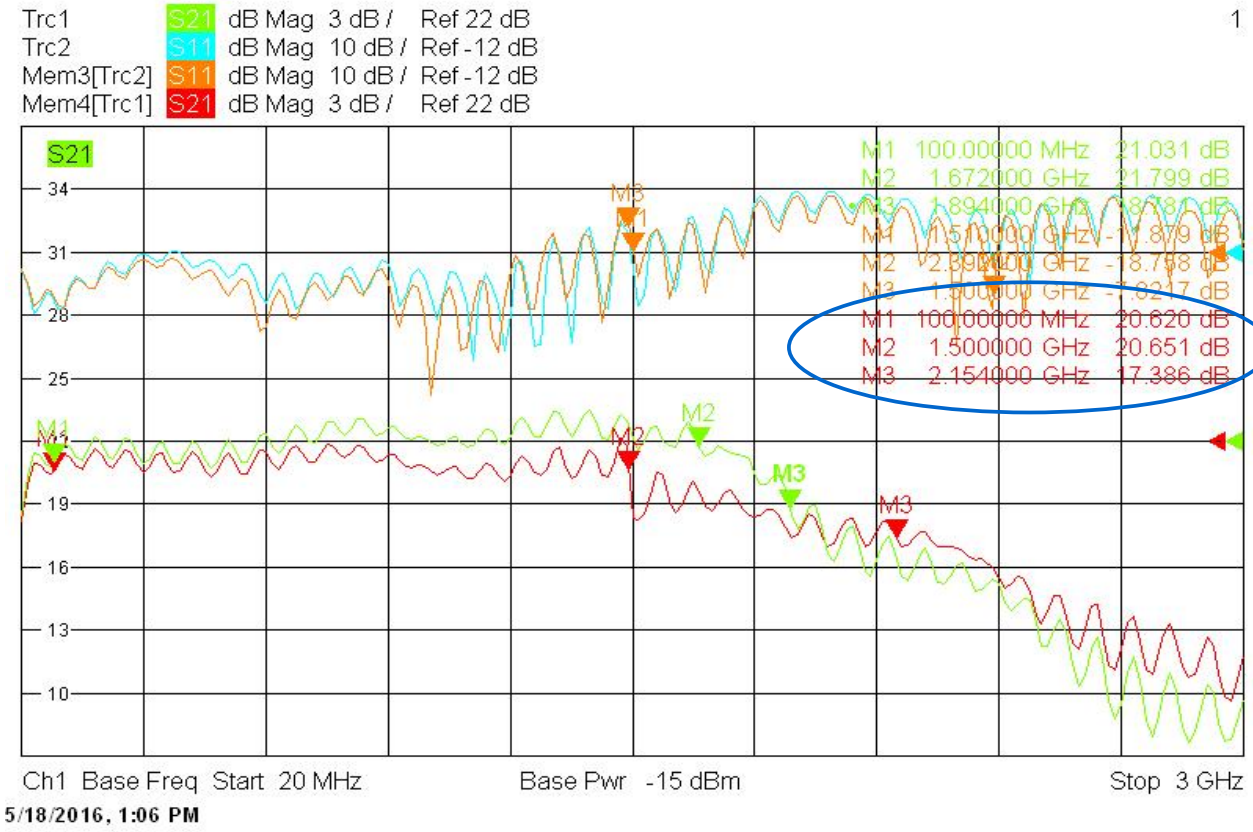
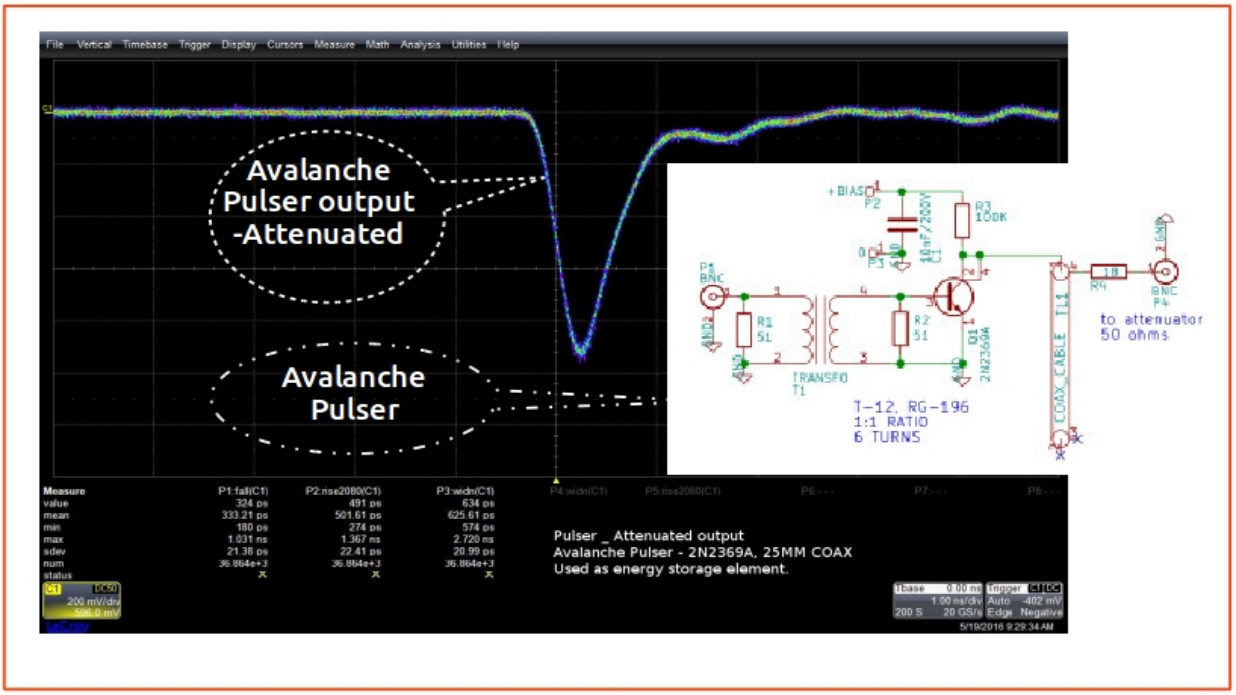


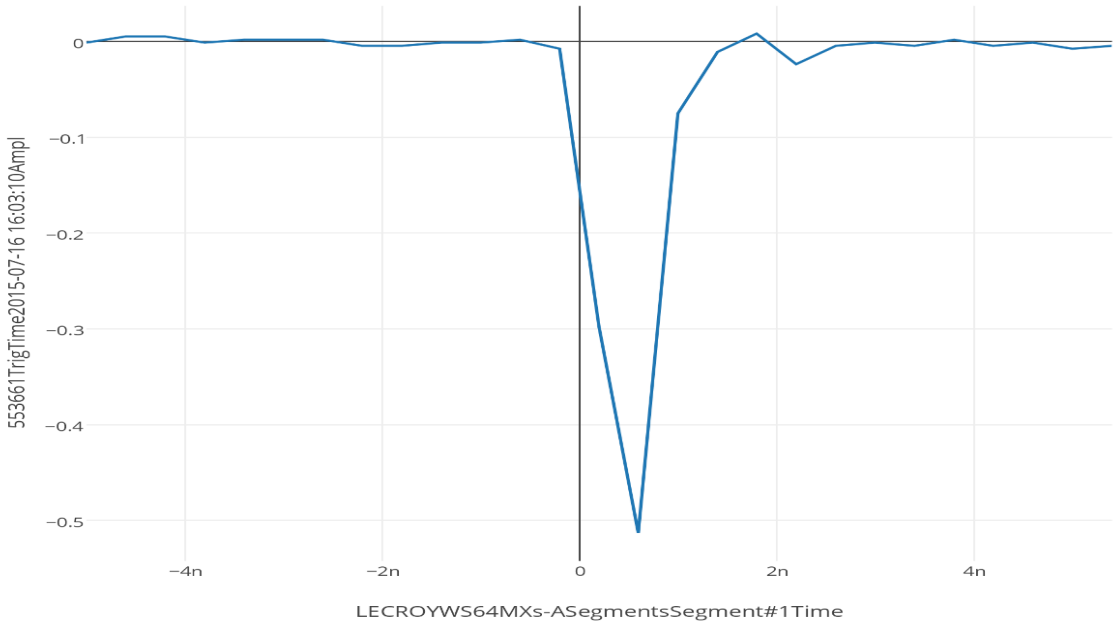
Fig:4 Front view of NIM module



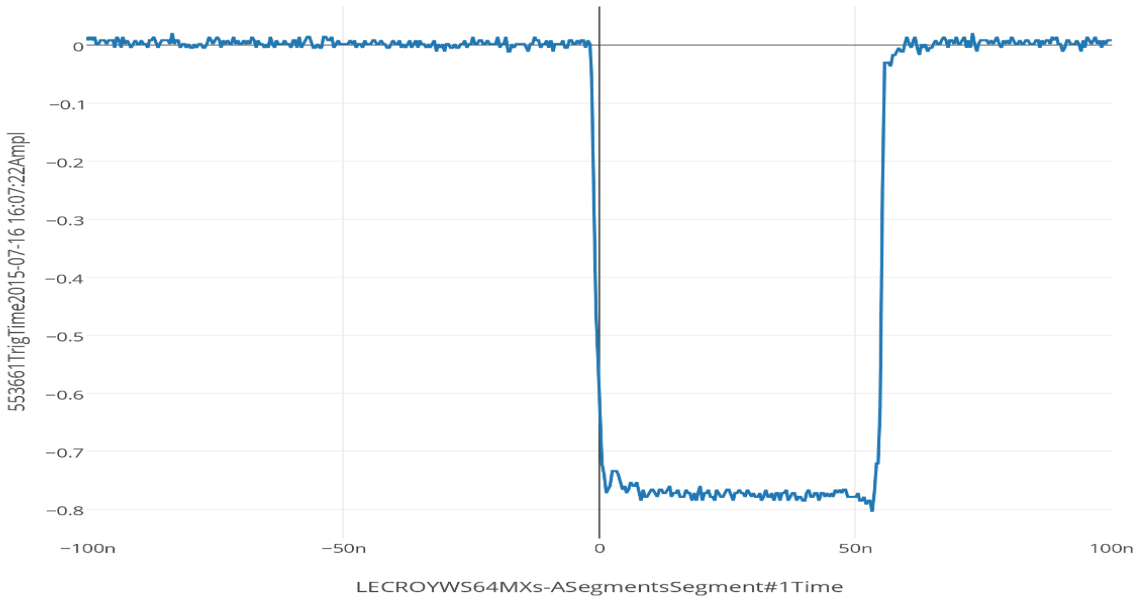
Plot: 1 Transfer characteristics of upc1678 MMIC Amplifier



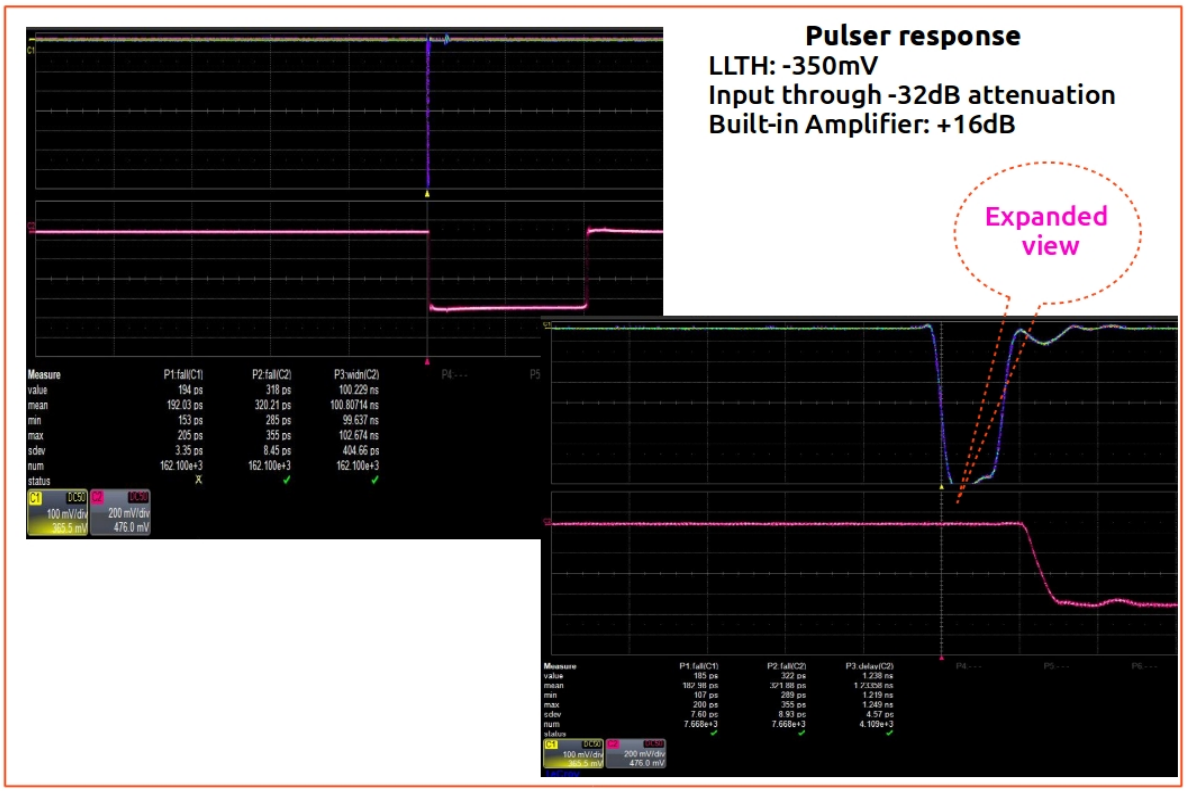
Plot: 2 Typical output of Avalanche Pulser and Pulser circuit



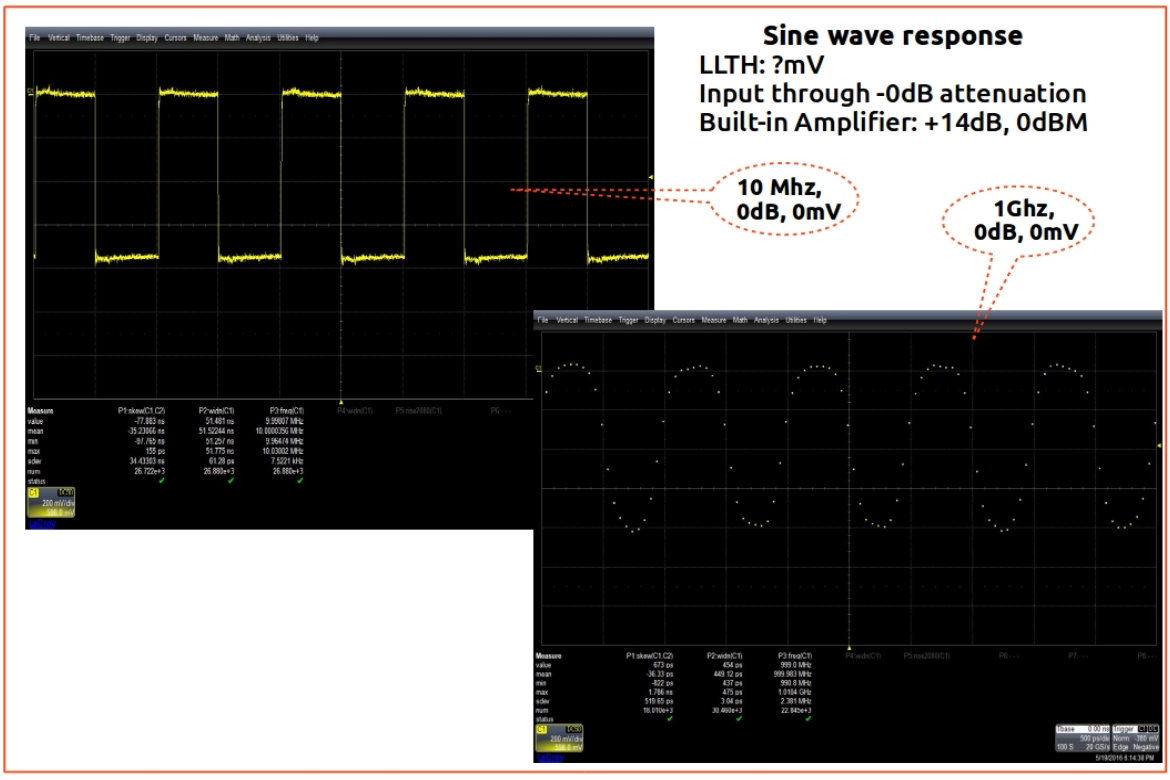
Plot: 3 Preamplifier signal from charge pick-off



Plot: 4 Fast NIM Shaped output for above



Plot: 5 Typical response to Pulser signal, raw and shaped outputs



Plot: 6 Typical response to sinusoidal wave 10MHz, and 1000Mhz signals