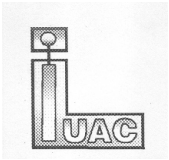

Technical Report on
Multiplicity & OR logic modules of NAND array

Abstract

Specifications

Descriptions

Logic diagram

Panel Layouts

Schematic diagrams

Bill of material

Developed by:

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Inter-University Accelerator Centre

(An Autonomous Inter-University Centre of UGC)

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TECHNICAL REPORT

TITLE : Technical Report on “Multiplicity & OR logic” modules

AUTHORS : S.Venkataramanan, Sugathan P

CATEGORY : Instrumentation (Nuclear Electronics)

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Multiplicity & OR logic modules of NAND array

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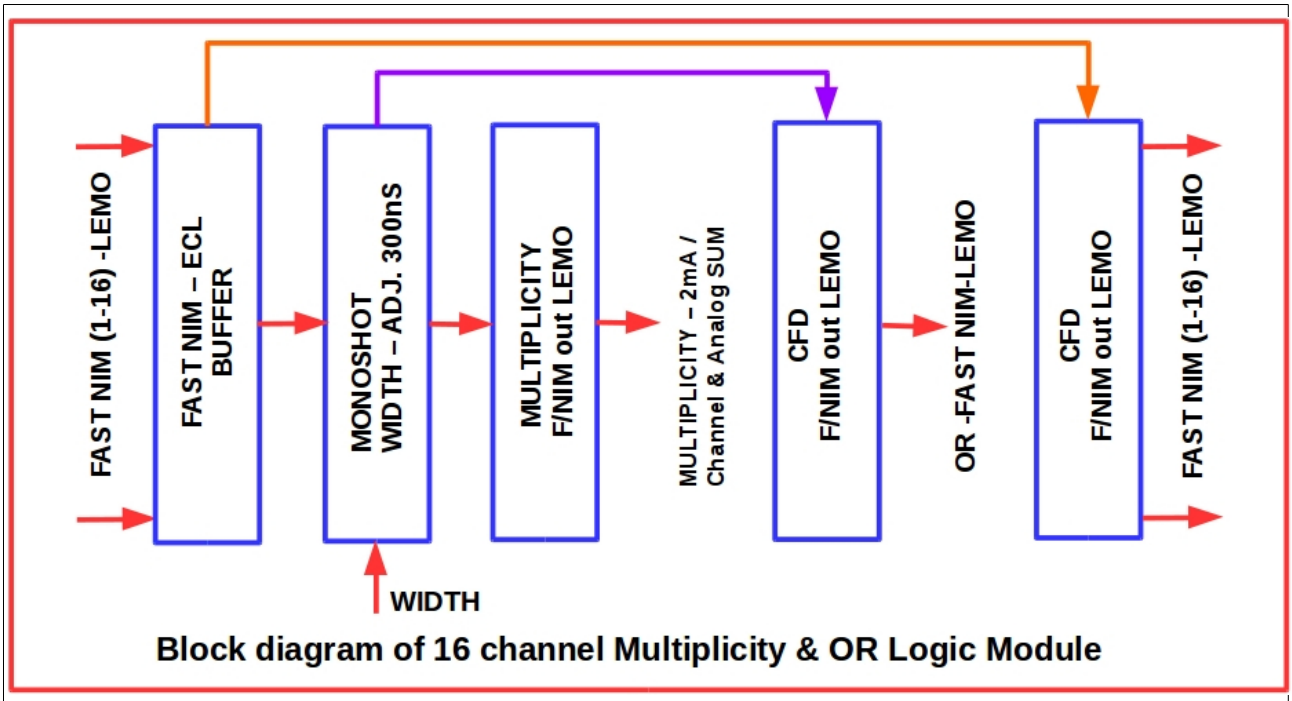
Abstract: *The NAND array consists of 100 nos. of neutron detectors and ancillary detectors. The signals from these detectors are processed in numerous dual channel PSD (Pulse Shape Discriminator) electronics module, further signal conversion and data processing are done in VME based data acquistion system. The data collection efficiency depends upon the useful data gathered. In order to improve the data collection efficiency, we have developed multiplicity logic module and coeesponding master logic modules. All 100 detector "time" marking signals (CFD) from individual PSD modules are used to generate "multiplicity logic" and "OR" logic signals as shown in the block diagrams. Seven numbers of 16 channel "Multiplicity & OR logic" module and a single "Master Multiplicity& OR" logic module are fabricated to use with NAND array.*

Specifications	**:**	**Multiplicity & OR logic module of NAND array**
Form factor	:	single wdith NIM cabinet
Input DC supply	:	+6V / 0.1A, -6V / 1.5A
Connectors	:	LEMO_00 SERIES
Multiplicity Logic section		
Number of channels	:	16 (common with below)
Input level	:	Fast NIM logic (-16mA / 50 ohms)
Width of output	:	CFD (as input)_rear panel
Inspection time	:	300 nS (internally adjustable on PCB)
Output level	:	-2mA/channel_front panel (Σ), analog summing sunction
Indicator	:	LED (5mS) blink
OR Logic section		
Number of channels	:	16 (common with above)
Input level	:	Fast NIM logic (-16mA / 50 ohms)
Inspection time	:	300 nS (internally adjustable on PCB)
Output level	:	Fast NIM logic (-16mA / 50 ohms)_front panel (OR)
Indicator	:	LED (5mS) blink



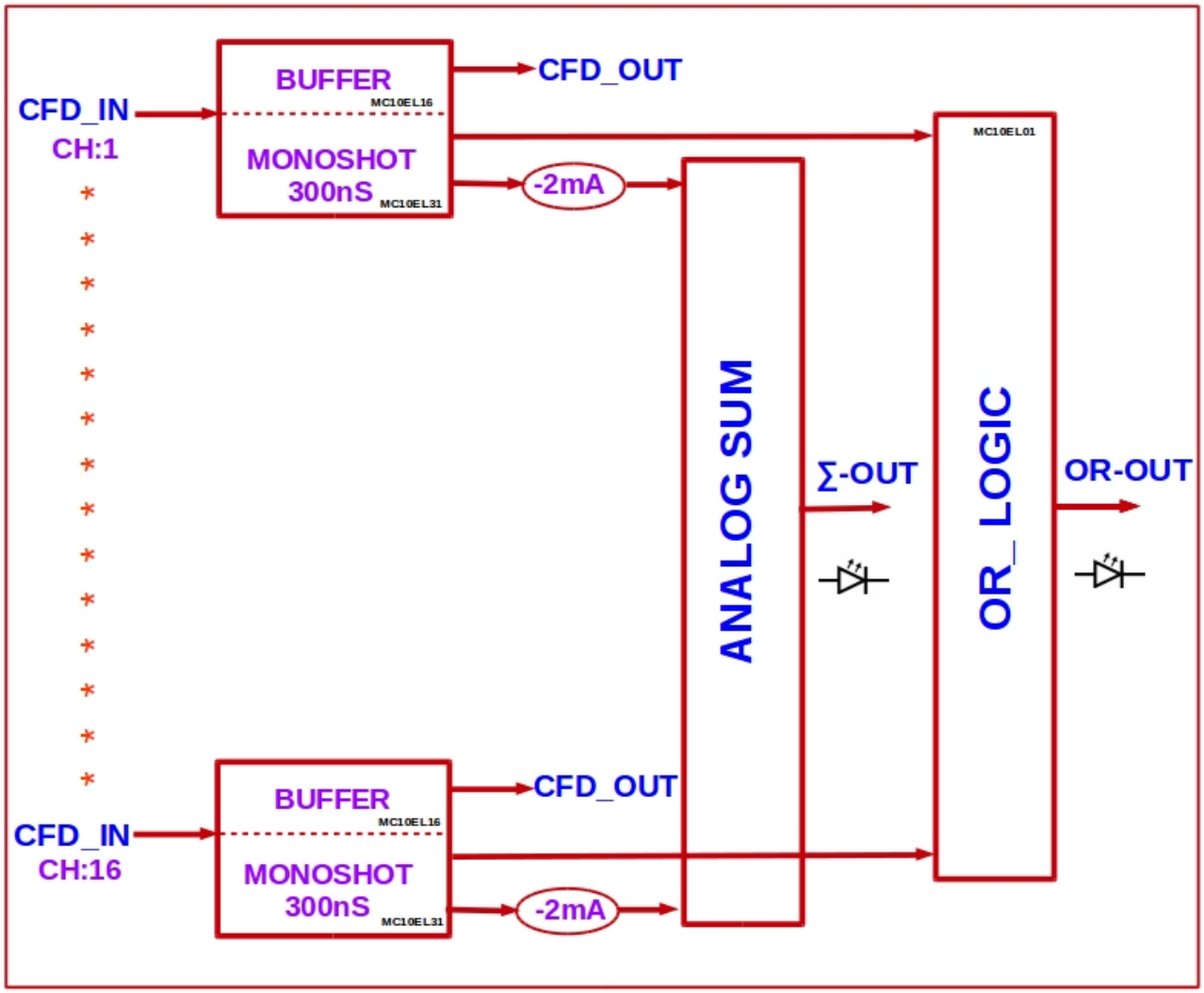
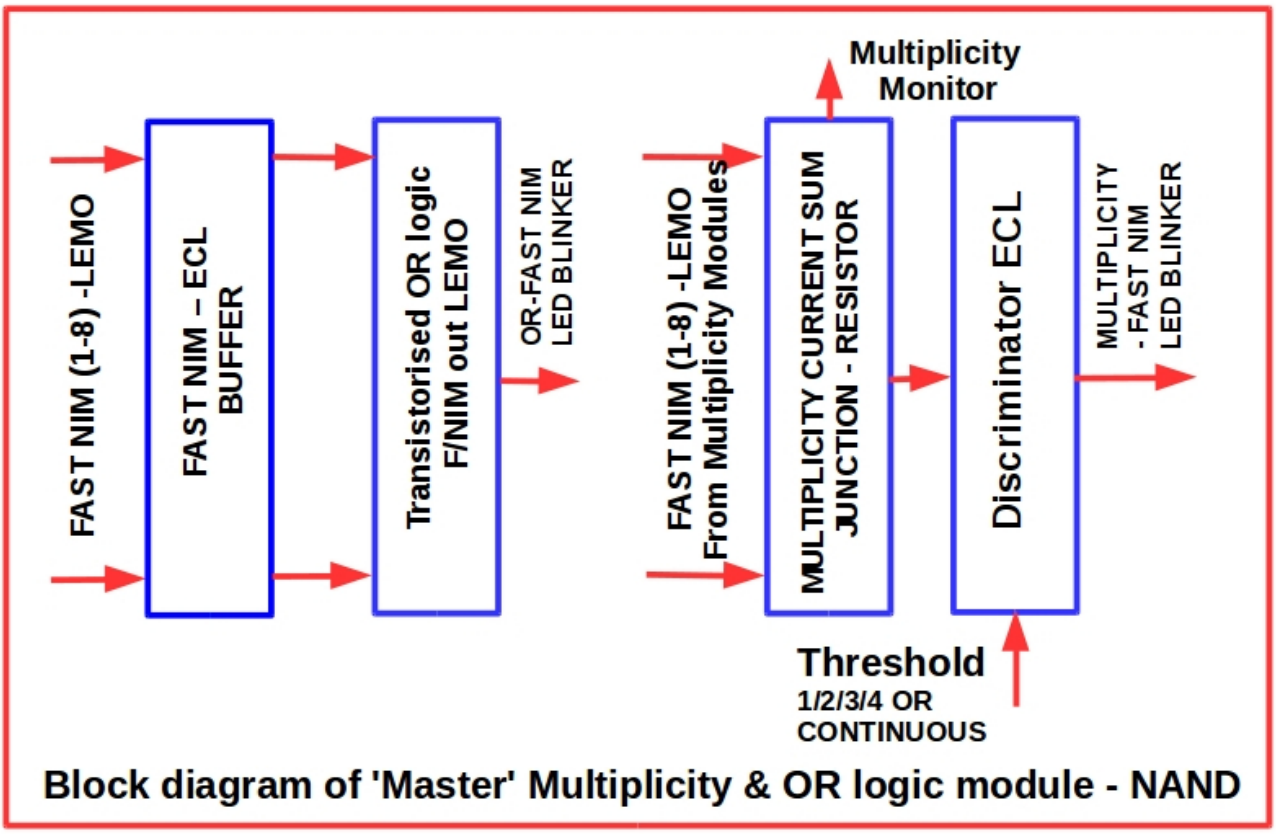


Fig.1.: Block diagrams of Multiplicity & OR logic module

Specifications	**:**	**Master Multiplicity & OR logic module of NAND**
Form factor	:	single wdith NIM cabinet
Input DC supply	:	+6V / 0.1A, -6V / 1.5A, +/-12V, 0.03A
Connectors	:	LEMO_00 SERIES
Master Multiplicity Logic section		
Number of channels	:	8
Input level	:	Fast NIM logic (-16mA / 50 ohms)
Width of output	:	300 nS (adjustable on PCB)
Low Level Discriminator	:	select above >1,2,3,4 or continuous (on PCB)
		-50mV / detector
Output level	:	Fast NIM logic (-16mA / 50 ohms)
Monitor	:	Buffered (clamped) output
Indicator	:	LED (5mS) blink
Master OR Logic section		
Number of channels	:	8
Input level	:	Fast NIM logic
Output level	:	Fast NIM logic _ front panel (OR)
Indicator	:	LED (5mS) blink



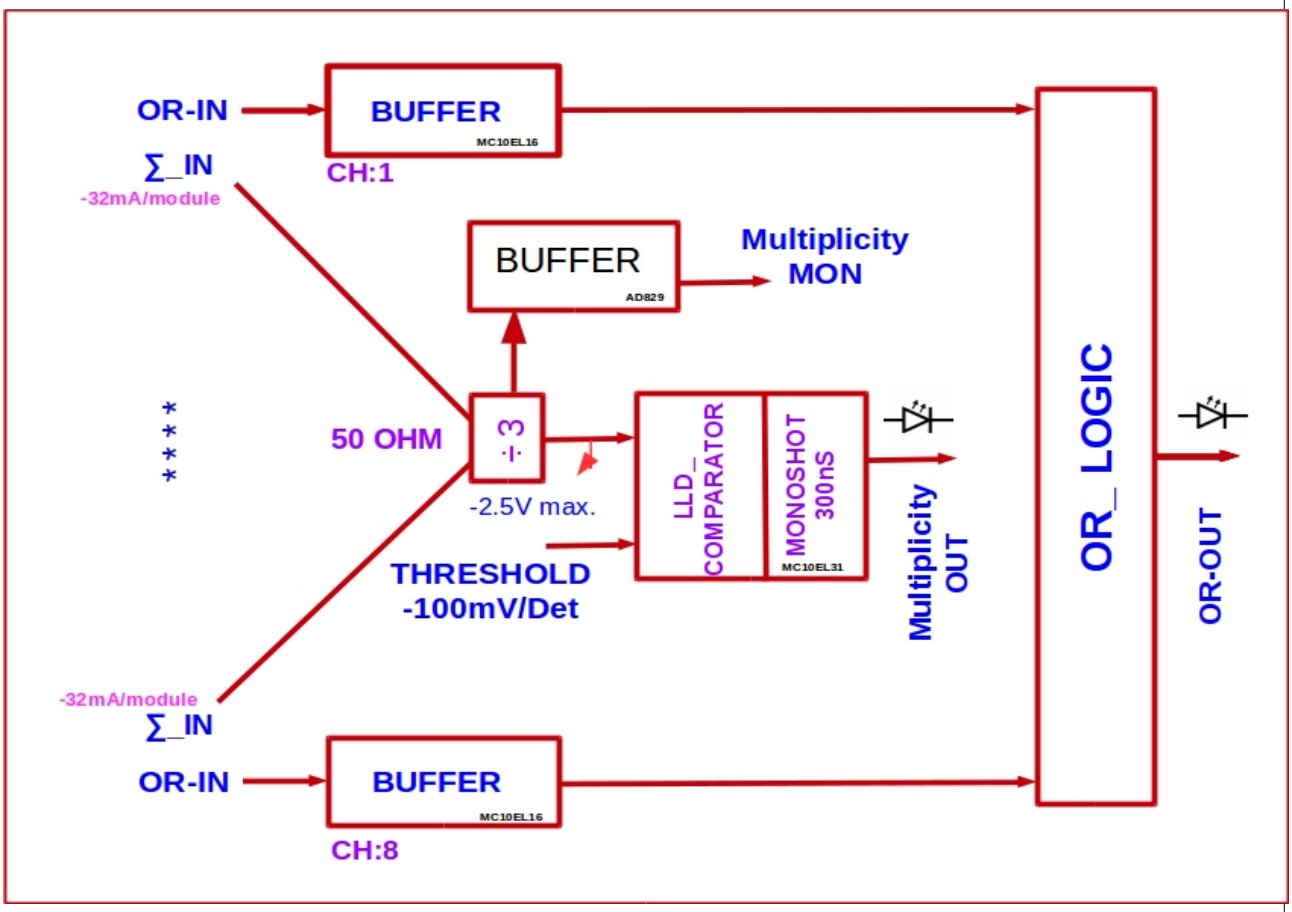


Fig.2.: Block diagrams of Multiplicity Master module

Descriptions

The entire multiplicity and OR logic module for NAND array has been realised in a set of NIM modules (8 nos. in total). 16 channel multiplicity modules accommodate more than 100 channels of CFD signals from PSD modules, and a dedicated module called Master multiplicity and OR logic module is a decision making module to generate final “Multiplicty” signal, which can handle up to 8 numbers of multiplicity modules. The standard CFD signal (time maker) from individual PSD channel is utilised for this purpose.

In a Multiplicity & OR logic module, Individual CFD signal is buffered, level converted and made available with original width at rear panel for further use. The buffered (MC100EL16) CFD signal is further shaped with 250ns (+/-5%) width (monostable multi-vibrator), which is also called inspection time, utilised for both OR and multiplicity signal generation. All 16 monostable multi-vibrators width can be adjusted with a single control available on PCB. The OR logic is simple and straight forward. The ECL signals are OR-ed in multiple quad OR (MC10EL01) gates. The OR output is made available through ECL-Fast NIM converter circuit. The Multiplicity logic essentially involves, analog summing of -2mA (250ns duration) per channel at a common node called SUM point. This point is made available through LEMO_00 connector (∑) on front panel. When terminated across 50 ohms (characteristic impedance), multiplicity summing can be seen on CRO.

The signals from indivual Multiplicity & OR module are processed further in Master Multiplicity & OR module. The OR signals is buffered and logic OR-ed with transistor differential pair. The final OR-ed signal is available as Fast NIM signal on front panel along with LED blinker.

The current SUM signal from each module is further summed across 50ohms (characteristic impedance) to develop a suitable voltage signal. This signal is suitably attenuated and clamped for further processing in a low level discriminator (ECL Comparator MAX9691) to generate final Multiplicity signal. Depending upon the user requirement, the low level discriminator level corresponding to number of signals accepted to generate Multiplicity can be jumper selected on PCB. Typically 1/2/3/4 or continuously adjustable on PCB can be selected depends upon complexity of experiment. A level -100mV per detector is usually adopted for such application. The comparator generated signal is further processed with a 250nS monostable multi-vibrator and made available on the front panel along with LED blinker circuit.

The entire circuit is fabricated on a 4 layer PCB. State of the art, ultrafast 10EL, 100EL series emitter coupled logic chips are used for processing the signal. Ultra wide band transistor (BFM 505,115) circuits are used in ECL-Fast NIM conversion circuit to retain the bandwidth of the signal.

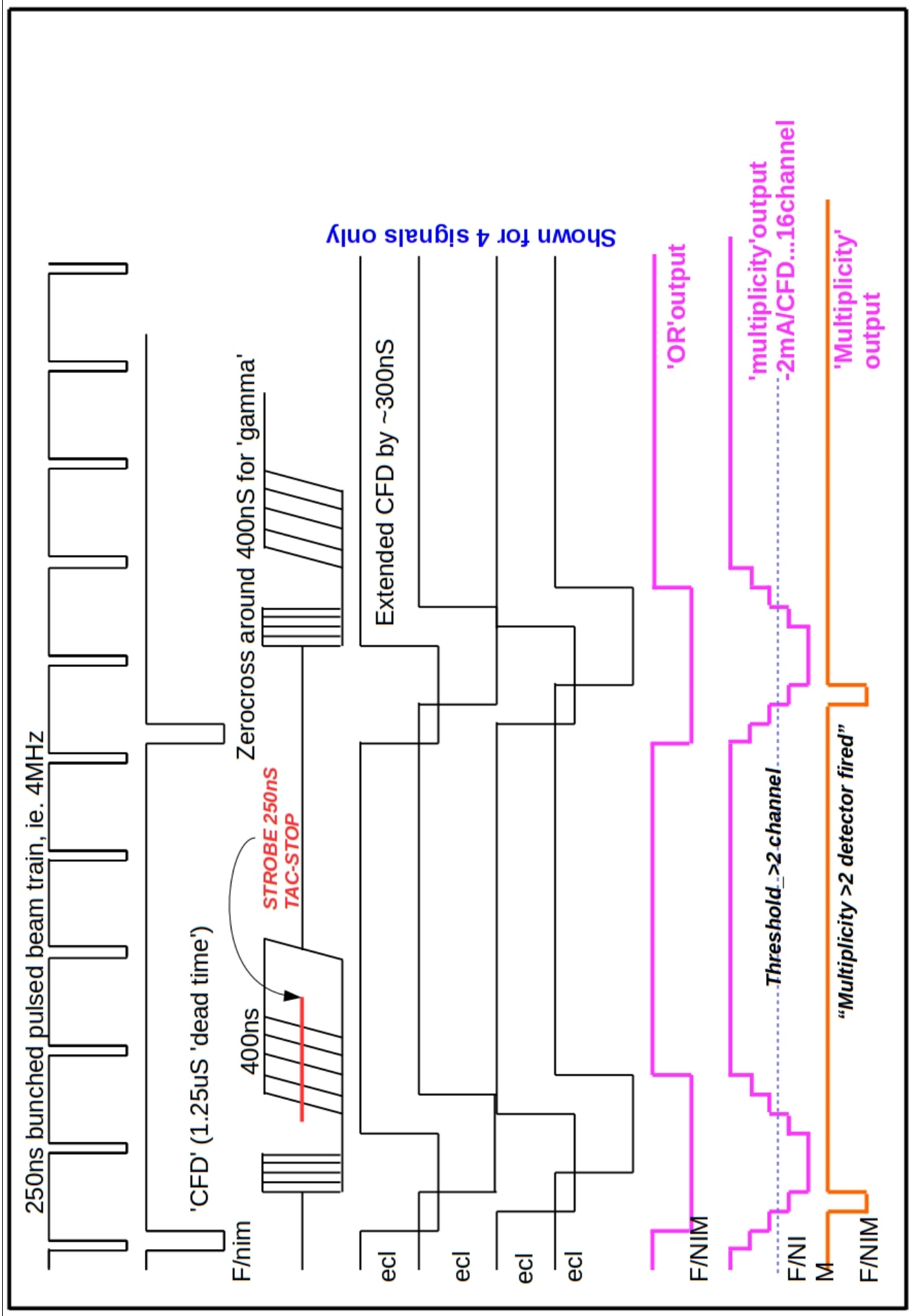


Fig:3 Simplified Logic diagram of Multiplicity & OR logic of NAND array

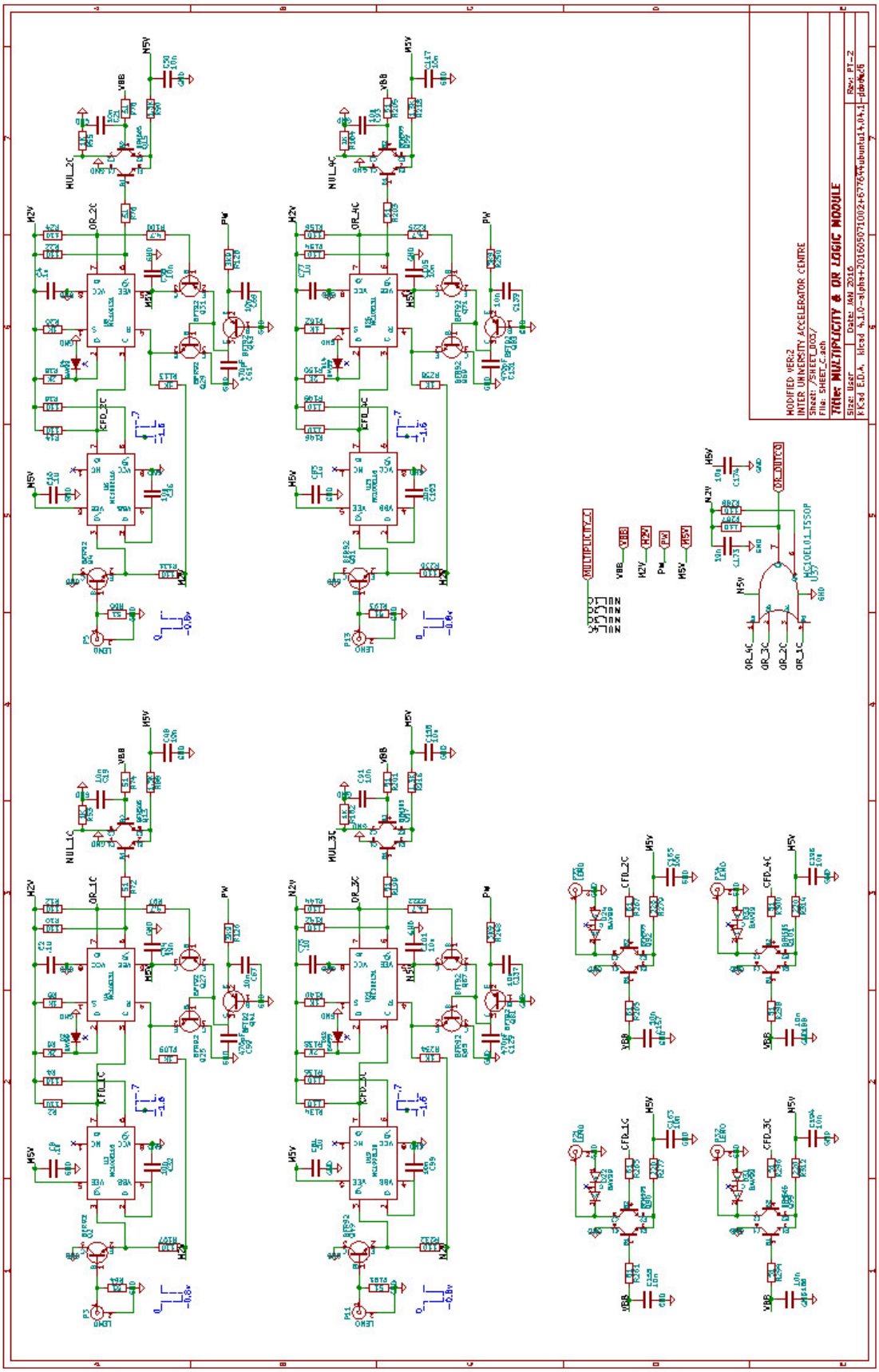


Fig.4.: Reprentative circuit diagram of Multiplicity & OR logic

Bill of Materials Multiplicity Logic Module _ June 2016

Id	Designator	Package	Qty	Designation	Supplier
1	Q10,Q9,Q88	TO92PN	3	2N3904A	Fairchild
2	mh2,mh1,mh2,mh3,mh4	mhsq_3.3mm_5.6mm	5	MH_3.3	local
3	C1,C2,C3,C4,C5,C6,C7,C8,C9,C11,C13,C14,C15,C26,C27,C28,C55,C56,C74,C75,C76,C77,C78,C79,C80,C81,C82,C83,C84,C85,C86,C87,C88,C89,C147,C122,C123,C125,C181,C183,C151,C148,C10,C12,C16,C179	MYSM_C_0805	46	.1u	Multicomp
4	C17,C18,C19,C20,C21,C22,C23,C24,C25,C31,C32,C33,C34,C35,C36,C38,C39,C40,C41,C42,C43,C44,C45,C46,C47,C48,C49,C50,C52,C53,C54,C57,C66,C67,C68,C69,C70,C71,C72,C73,C90,C91,C92,C93,C94,C95,C96,C97,C98,C99,C100,C101,C102,C103,C104,C105,C106,C107,C109,C110,C111,C112,C114,C115,C116,C117,C118,C119,C108,C113,C141,C143,C155,C156,C157,C158,C159,C160,C161,C162,C163,C164,C165,C166,C167,C168,C169,C171,C174,C175,C177,C120,C121,C126,C172,C173,C176,C178,C182,C185,C186,C187,C188,C189,C190,C191,C192,C193,C194,C195,C196,C197,C198,C199,C200,C137,C139,C136,C140,C152,C138,C142,C154,C37,C51	MYSM_C_0805	125	10n	Multicomp
5	C29,C149,C146,C144	MYSM_C_0805	4	10nF	Multicomp
6	C30,C170	MYSM_C_0805	2	1nF	Multicomp
7	C58,C59,C60,C61,C62,C63,C64,C65,C129,C130,C131,C134,C135,C128,C132,C133	MYSM_C_0805	16	470pF	Multicomp
8	D3,D4,D5,D6,D7,D8,D10,D11,D13,D14,D15,D16,D17,D21,D28,D31,D33,D34,D35,D36,D37,D18,D22,D23,D24,D25,D26,D27,D30,D32,D1,D2,D12	SOT-23	33	BAV99	nxp
9	P1	BNC_COAX	1	RAW_OR LOGIC	Lemo_00
10	P2,P3,P4,P8,P9,P10,P11,P13,P14,P15,P16,P17,P31,P32,P23,P24,P33,P34,P35,P36,P37,P38,P20,P21,P22,P25,P26,P27,P5,P6,P7,P12	BNC_COAX	32	LEMO	Lemo_00
11	Q1,Q5,Q6,Q8,Q25,Q29,Q32,Q34,Q36,Q49,Q50,Q53,Q64,Q65,Q68,Q2,Q3,Q4,Q24,Q28,Q48,Q51,Q52,Q69,Q72,Q74,Q76,Q78,Q7,Q11,Q38,Q54,Q55	SOT-23	33	BFR92	nxp
12	Q26,Q30,Q31,Q33,Q35,Q66,Q67,Q80,Q81,Q82,Q84,Q85,Q86,Q87,Q27,Q37,Q46,Q47,Q73,Q75,Q77,Q79,Q83,Q39,Q40,Q41,Q42,Q43,Q44,Q45,Q70,Q71	SOT-23	32	BFT92	nxp
13	R1,R2,R3,R4,R9,R10,R11,R12,R13,R14,R15,R16,R21,R22,R23,R24,R25,R26,R29,R30,R31,R32,R35,R36,R37,R38,R41,R42,R43,R44,R47,R48,R61,R62,R106,R107,R110,R111,R114,R116,R118,R120,R133,R134,R135,R136,R141,R142,R143,R144,R145,R146,R147,R148,R153,R154,R155,R156,R157,R158,R161,R162,R163,R164,R167,R168,R169,R170,R173,R174,R175,R176,R179,R180,R231,R232,R235,R236,R239,R241,R243,R245,R285,R286,R287,R288,R289,R290,R291,R292	SM_R_0805	90	110	Multicomp
14	R5,R6,R17,R18,R27,R33,R39,R45,R137,R138,R149,R150,R159,R165,R171,R177	SM_R_0805	16	2K	Multicomp
15	R7,R8,R19,R20,R28,R34,R40,R46,R52,R53,R54,R55,R56,R57,R58,R59,R108,R109,R112,R113,R115,R117,R119,R121,R122,R139,R140,R151,R152,R160,R166,R172,R178,R181,R182,R183,R184,R185,R186,R187,R188,R233,R234,R237,R238,R240,R242,R244,R246,R257,R258,R284,R310	SM_R_0805	53	1K	Multicomp

16	R49	SM_R_0805	1	150	Multicomp
17	R50	SM_R_0805	1	332	Multicomp
18	R51,R255	SM_R_0805	2	511	Multicomp
19	R60	SM_R_0805	1	330	Multicomp
20	R63,R64,R65,R66,R67,R68,R69,R70,R71,R72,R73,R74,R75,R76,R77,R78,R79,R80,R81,R82,R83,R84,R85,R86,R190,R191,R192,R193,R194,R195,R196,R197,R198,R199,R200,R201,R202,R203,R204,R205,R206,R207,R208,R209,R211,R212,R213,R214,R260,R261,R262,R263,R264,R265,R266,R267,R268,R269,R270,R271,R272,R273,R274,R293,R294,R295,R296,R297,R298,R299,R300,R301,R302,R303,R304,R305,R306,R307,R308,R275	SM_R_0805	80	51	Multicomp
21	R87,R88,R89,R90,R91,R92,R98,R101,R215,R216,R217,R218,R219,R220,R223,R226	SM_R_0805	16	1.3K	Multicomp
22	R93	SM_R_0805	1	10M	Multicomp
23	R94,R95	SM_R_0805	2	100	Multicomp
24	R96,R97,R99,R100,R102,R103,R104,R105,R221,R222,R224,R225,R227,R228,R229,R230	SM_R_0805	16	4.7	Multicomp
25	R123	SM_R_0805	1	1K6	Multicomp
26	R124,R276,R277,R278,R279,R280,R281,R282,R283,R311,R312,R313,R314,R315,R316,R317,R318	SM_R_0805	17	220	Multicomp
27	R125,R126,R127,R128,R129,R130,R131,R132,R247,R248,R249,R250,R251,R252,R253,R254	SM_R_0805	16	6K8	Multicomp
28	R189,R210	SM_R_0805	2	?	Multicomp
29	R256	SM_R_0805	1	22	Multicomp
30	R259	SM_R_0805	1	4.7K	Multicomp
31	RV1	BOURNS-3386W	1	10K	Multicomp
32	R309	SM_R_0805	1	221	Multicomp
33	P18	BNC_COAX	1	MULTIPLICITY	Multicomp
34	Q13,Q14,Q61,Q12,Q15,Q18,Q56,Q57,Q58,Q59,Q60,Q98,Q99,Q100,Q101,Q102,Q103,Q104,Q105,Q16,Q17,Q19,Q23,Q62,Q63,Q89,Q90,Q91,Q92,Q93,Q94,Q95,Q96	SOT-363	33	BFM505	nxp
35	L1,L2,L3	44_woundbead_TH	3	L_Small	fairrite
36	W1	tp_j	1	VBB	local
37	W2,W3,W4,W5,W6	tp	5	TP	local
38	C145,C150	MY_TAN_B	2	3.3uF	AVX
39	C184	MY_TAN_B	1	10uF	AVX
40	D9	SIP-2	1	LED	ELEMENT14
41	D19	Diode-SMC	1	S5AB	Diodes Inc
42	D20,D29	Diode-SMC	2	S8KC	Diodes Inc
43	D38	SOT-23	1	BZX84C2V7	nxp
44	P19	tp	1	P6V	Local
45	P28	tp	1	M6V	Local
46	P29,P30	tp	2	GND	Local
47	Q20	SOT-143	1	BSS83	nxp
48	Q21,Q22	TO92PN	2	2N3906	Fairchild
49	Q97	TO126-123-TH	1	BD140	Fairchild
50	U35	SO8E	1	ADR03/SO	Adi
51	U34	SO8E	1	MC1458	TI
52	U1,U2,U5,U6,U9,U11,U13,U15,U18,U19,U22,U23,U26,U28,U30,U32	TSSOP-8m	16	MC100EL16	onsemi
53	U3,U4,U7,U8,U10,U12,U14,U20,U21,U24,U25,U27,U29,U31,U33,U16	TSSOP-8m	16	MC10EL31	onsemi
54	U17,U36,U37,U38,U39	TSSOP-8m	5	MC10EL01	onsemi
55	C153	CAP_TANT_6032	1	10uF	AVX
56	C127	MY_TAN_C	1	10uF	AVX
57	C180,C124	MY_TAN_C	2	10u/25V	AVX

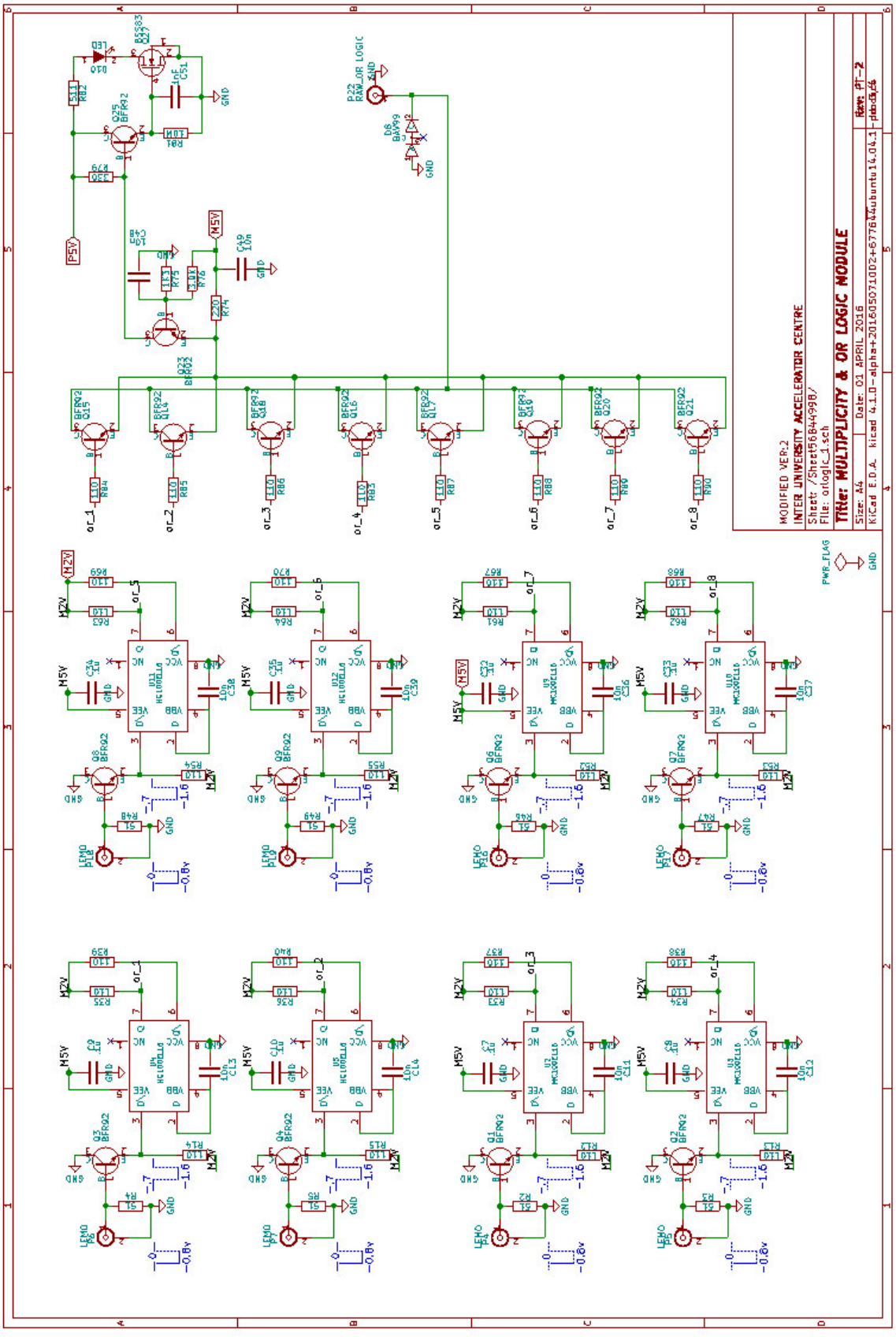
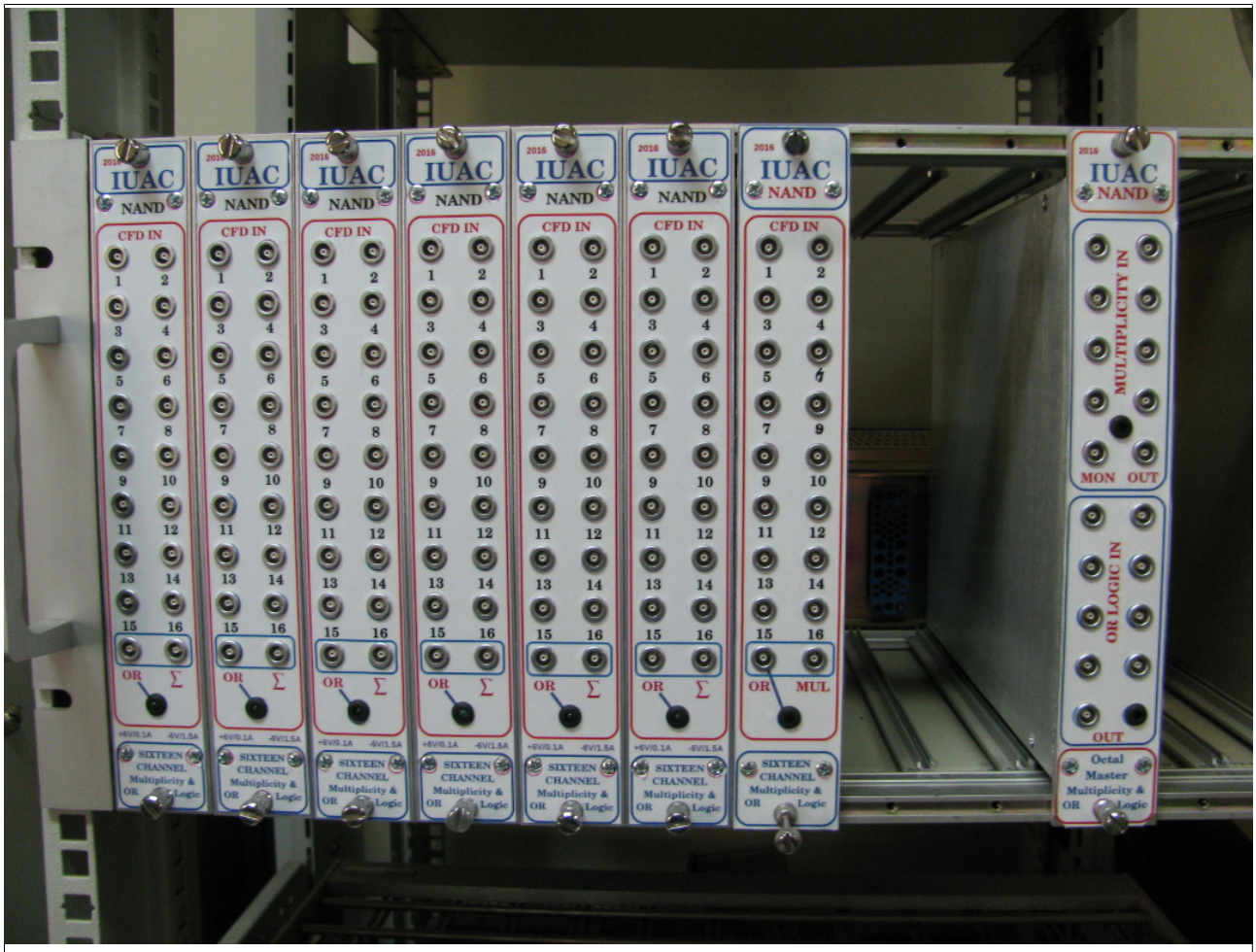
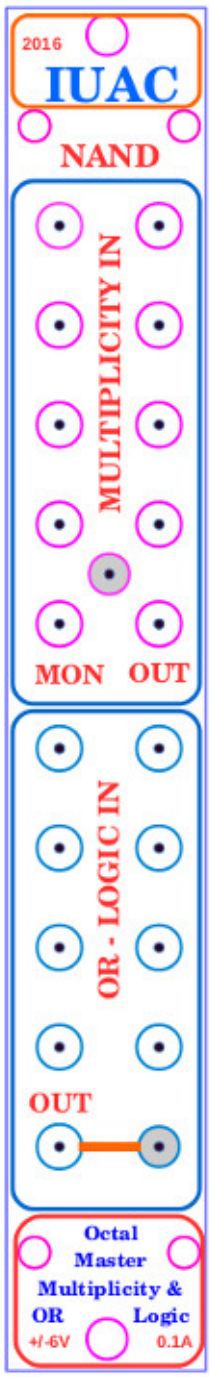


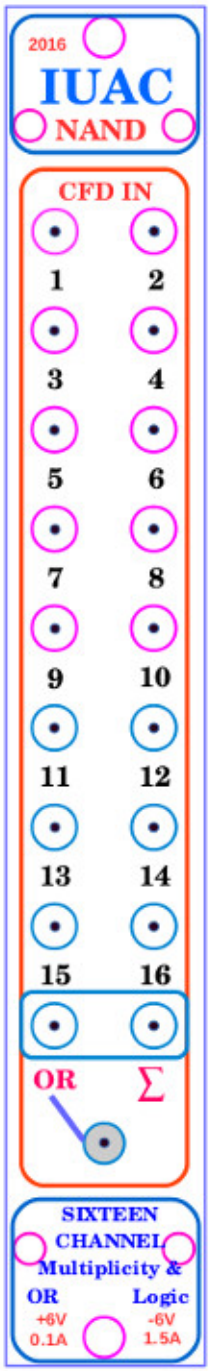
Fig.5.: Representative circuit diagram of "Multiplicity Master" logic

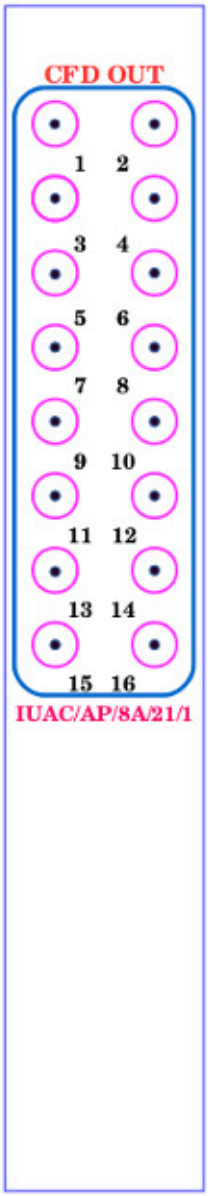
Bill of material_ master Multiplicity & OR logic

Id	Designator	Package	Qty	Designation	Supplier and ref
1	mh1,mh1,mh2,mh3,mh4	mhsq_3.3mm_5.6 mm	5	MH_3.3	local
2	R74,R73	SM_R_0805	2	220	Multicomp
3	R40,R12,R13,R14,R15,R33,R34,R35,R36,R37,R38,R39,R44,R50,R52,R53,R54,R55,R60,R61,R62,R63,R64,R65,R67,R68,R69,R70,R83,R84,R85,R86,R87,R88,R89,R90	SM_R_0805	36	110	Multicomp
4	C1,C7,C8,C9,C10,C15,C16,C17,C19,C24,C25,C26,C28,C32,C33,C34,C35,C41,C43,C44,C46	MYSM_C_0805	21	.1u	Multicomp
5	C3,C11,C12,C13,C14,C21,C27,C36,C37,C38,C39,C42,C45,C47,C48,C49,C52	MYSM_C_0805	17	10n	Multicomp
6	C4	MYSM_C_0805	1	10pF	Multicomp
7	C5,C20,C31	MYSM_C_0805	3	10nF	Multicomp
8	C29	MYSM_C_0805	1	470pF	Multicomp
9	C50,C51	MYSM_C_0805	2	1nF	Multicomp
10	D1,D5,D7,D8	SOT-23	4	BAV99	NXP
11	D4	SOT-23	1	BZX84C2V7	NXP
12	P4,P5,P6,P7,P8,P9,P10,P11,P12,P13,P14,P16,P17,P19,P18,P23	BNC_COAX	16	LEMO	Lemo_00
13	Q1,Q6,Q7,Q8,Q9,Q10,Q15,Q16,Q17,Q18,Q19,Q20,Q25,Q2,Q3,Q4,Q13,Q14,Q21,Q22,Q23,Q24	SOT-23	22	BFR92	NXP
14	Q11,Q12	SOT-23	2	BFT92	NXP
15	R1,R7,R45	SM_R_0805	3	22	Multicomp
16	R2,R3,R4,R5,R42,R46,R47,R48,R49	SM_R_0805	9	51	Multicomp
17	R6,R17,R27	SM_R_0805	3	??	Multicomp
18	R8,R9,R10,R11	SM_R_0805	4	150K	Multicomp
19	R16	SM_R_0805	1	33	Multicomp
20	R18,R19,R20,R21,R22,R23,R24,R66,R91	SM_R_0805	9	4.7	Multicomp
21	R25,R32,R41,R80,R82	SM_R_0805	5	511	Multicomp
22	R26	SM_R_0805	1	10K	Multicomp
23	R28,R71,R72	SM_R_0805	3	100	Multicomp
24	R29,R31,R43,R51,R56,R58	SM_R_0805	6	1K	Multicomp
25	R30	SM_R_0805	1	1.3K	Multicomp
26	R57	SM_R_0805	1	2K	Multicomp
27	R59	SM_R_0805	1	6K8	Multicomp
28	R75	SM_R_0805	1	1K3	Multicomp
29	R76	SM_R_0805	1	750	Multicomp
30	R77,R79	SM_R_0805	2	330	Multicomp
31	R78,R81	SM_R_0805	2	10M	Multicomp
32	P20	BNC_COAX	1	MULTIPLICITY	Lemo_00
33	P21	BNC_COAX	1	MULTIPLICITY_LOGIC	Lemo_00
34	P22	BNC_COAX	1	RAW_OR LOGIC	Lemo_00
35	U2,U3,U4,U5,U9,U10,U11,U12	TSSOP-8	8	MC100EL16	Onsemi
36	U8	TSSOP-8	1	MC10EL31	Onsemi
37	L1,L2,L3	44_woundbead_TH	3	L_Small	Fairrite
38	JP1,JP2,JP3,JP4	SIP-2	4	Jumper_NC_Small	local
39	W2,GND,W4,W5,W1,W3	tp	6	TP	local
40	C2,C22	MY_TAN_C	2	10u/25V	AVX
41	C6,C23,C30	MY_TAN_B	3	10uF	AVX
42	C18,C40	MY_TAN_B	2	3.3uF	AVX
43	D2,D3	Diode-SMC	2	S8KC	DIODE Inc
44	D6	Diode-SMC	1	S5AB	DIODE Inc
45	D9,D10	SIP-2	2	LED	NXP
46	P1	tp	1	M6V	local
47	P2,P3	tp	2	GND	local
48	P15	tp	1	P6V	local
49	Q5	TO126-123-TH	1	BD140	FAIRCHILD
50	Q26,Q27	SOT-143	2	BSS83	NXP
51	U1	SO8E	1	ADR03/SO	Adi
52	U6	SO8E	1	MAX9691	Maxim
53	U7	SO8E	1	MC1458	TI
54	RV1	BOURNS-3386W	1	10K	element14


IUAC
NAND
CFD IN
OR
Σ
SIXTEEN CHANNEL Multiplicity & OR Logic
IUAC
NAND
CFD IN
OR
MUL
SIXTEEN CHANNEL Multiplicity & OR Logic
IUAC
NAND
MULTIPLICITY IN
MON OUT
OR LOGIC IN
OUT
Octal Master Multiplicity & OR Logic


2016
IUAC
NAND
MULTIPLICITY IN
MON
OUT
OR - LOGIC IN
OUT
Octal
Master
Multiplicity &
OR
Logic
+/-6V
0.1A


2016
IUAC
NAND
CFD IN
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
OR
Σ
SIXTEEN
CHANNEL
Multiplicity &
OR
Logic
+6V
0.1A
-6V
1.5A


CFD OUT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
IUAC/AP/8A/21/1