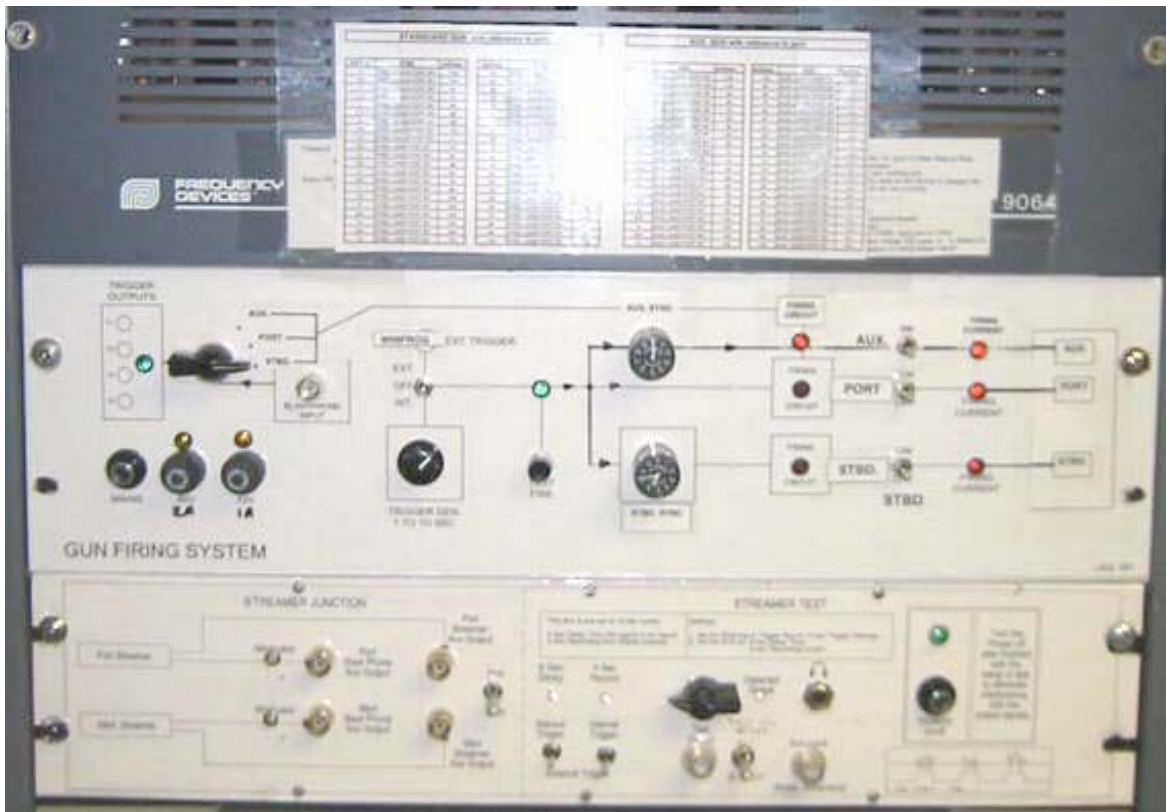


GUN FIRING SYSTEM

Modified and Installed Leg 197

NOTES

Updated Nov. 2003



FUNCTIONAL DESCRIPTION

The system was designed to fire three solenoids. The AUX, PORT and STBD. firing ccts. are triggered from a common source. The AUX. And STBD. gun can both be advanced or retarded by plus/minus 100 milliseconds with respect to the PORT gun. This makes it possible for the guns to be synchronized, and also to fire guns with multiple solenoids with time differences. (see timing table at end of document)

- The guns can be triggered from either an internal or external source, selectable from the front-panel.
- The internal source provides triggering pulses continuously variable from 2 to 10 second intervals.
- The external source could typically be a device like WinFrog, and needs to output a positive-going pulse.

The firing-circuit consists of a 50mS pulse generating circuit, which drives a Power MosFET, switching current to the solenoids.

Relays reverse the current through the solenoids after every two shots to stop the solenoids from becoming permanently magnetized.

Firing current to the solenoids are monitored by LEDS, and will only emit light in the presence of solenoid current.

The guns can be switched off individually.

A "Trigger Outputs" circuit provides triggers to external devices like; EPC / SUN
This circuit is triggered by either the AUX, PORT and STBD. firing pulses, or a BLASTPHONE and is front-panel selectable.

4 X trigger output pulses are available:
2 X 7V Positive 50mS pulses.
2 X open collector NPN opto transistor outputs.

TECHNICAL DESCRIPTION

FIRING CIRCUIT:

TRIGGER SOURCES

The trigger for the firing circuit is provided by either an internal pulse generator IC4, time adjusted from the frontpanel, or an external source (for example Winfrog).

The internal generator IC4a is configured as an astable multivibrator.

R4, VR-2 and C1 provide timing cycles variable between 1 and 10 seconds.

A selector switch SW-3 on the frontpanel connects the selected input to the input of Optocoupler IC-1. The trigger potential must be positive with respect to ground and of amplitude sufficient to forward bias the opto-coupler LED. When the Opto-transistor conducts, a short negative going pulse is generated by the action of R2 and C3.

By depressing the "Test Firing" switch, a negative going pulse is generated in the same way as described above.

THE 556 MONOSTABLE

A negative-going signal applied to the "TRIGGER" of the monostable will change the "OUTPUT" from 0V to VCC for a predetermined time, before reverting back to 0V

PORT FIRING CCT.

IC2a and b are both configured as monostable multivibrators.

The trigger pulse from IC1 to IC2a pin 6 will cause the output of IC2a pin 5 to rise to VCC.

After 120 milliseconds, timed by R3 and C4, the output will revert back to 0V. This will generate a negative-going pulse, triggering IC2b pin8, causing its output pin9 to rise to VCC for 50 milliseconds, timed by R8 and C11, before reverting back to 0V.

This 50 millisecond pulse will forwardbias Optocoupler IC5, and switch current to the PORT solenoid via the mosfet, "Firing Current" resistor and "Current Reversal" relay.

STBD. FIRING CCT.

The STBD. Firing circuit operates exactly as the PORT, except for IC3a which has a variable time, from 20 to 220 milliseconds, provided by R4, VR1 and C5.

AUX.. FIRING CCT.

The AUX. Firing circuit operates exactly as the STBD. Circuit. IC 11a has a variable time, from 20 to 220 milliseconds, provided by R50, VR3 and C50.

CURRENT REVERSAL RELAYS

IC10 has two JK flip-flops configured as a divide by four counter.

The firing pulse at the output of IC2a pin9 clocks the JK.

The output of JK IC10 pin 15 is at 0V for two pulses and then changes to VCC for two firing pulses. This output switches the relays, RL-1, RL-2 and RL-3 via a time-delay and MOSFET switch.

The delay is provided by R40, C40 and IC9b, a NAND SCHMITT and ensures that the firing cycle is completed before the relays are switched.

TRIGGER OUTPUTS T1, T2, T3, T4

IC4b is configured as a monostable with a 50-millisecond period, timed by R32 and C21. It is triggered via a selector switch SW2 from either IC-11 pin 5 (AUX.), IC-3 pin 5 (PORT), IC2 pin 5 (STBD.), or from a blastphone signal, conditioned by IC9a, a NAND SCHMITT. The output, pin9 of IC4b, Provides positive going 50millisecond pulses via R33 and R45 to T3 and T4 respectively. It also drives two optocouplers, IC7 and IC 8, providing isolated trigger output pulses, T1 and T2.

POWERSUPPLIES

50V / 15V SUPPLY

The solenoids require 10 Amps for 50 milliseconds, at worse once every 4 seconds. This dutycycle allows us to have a relatively small 50V supply, charging a 35 000 uF capacitor to provide high currents for short periods when needed.

The 15V Supply is derived off the 50V Supply. A 15V Zener provides current to the transistor sections of Opto-isolator IC5 and IC6. The Vce ratings of these components were less than 50V and therefore the 15V Supply was incorporated.

Fuse F2 (2A) provides protection to the bridge rectifier and upstream wiring. The 1 Ohm resistor limits the current drawn by 35 000UF Cap on initial switch-on.

Fuse F4 (5A), Protects the 35 000uf Cap and downstream wiring against short-circuit conditions. This supply floats and is not grounded.

12V / 7V SUPPLY

The 12V supplies current to the Current Reversal Relays.

The 7V Supply was derived of the 12V by making use of a 7806 regulator with two diodes in the common leg to increase the output to 7V. A 8V Regulator was not available on ship at the time. The 7Volt Supply provides current to the Control-card. The Control-card has a 11V Zener diode D15 providing Overvoltage and ReversePolarity Protection to this board.

Fuse F3 (1Amp) Provides short cct. Protection to this circuit.

The common of this supply is grounded.

SPECIFICATIONS:

Input: 115V AC

TRIGGERS:

Trigger Inputs:

EXT. TRIG. IN Positive-going pulse of sufficient amplitude to forward-bias Opto-LED.

INTERNAL TRIG. Free-running osc. providing firing pulses every two to ten seconds adjustable from the front-panel.

Trigger-outputs:

Trigger source is front-panel selectable and does not contain any delay.

T1 and T2 are 50mS, 7V positive pulses.

T3 and T4 are open collector NPN Transistors, optically driven.

Solenoid outputs:

All three outputs are 50V Pulses, 50 mS wide.

If all three pulses are fired at the same time at a rate higher than once every four Sec, the pulse voltage will be of an amplitude less than 50V, a function of the delay.

The Start time of both the AUX. and STBD. Pulses can be varied plus or minus 100mS with respect to the PORT pulse. (see timing table at end of document)

ADJUSTABLE DELAY TYABLE

STARBOARD GUN with reference to port

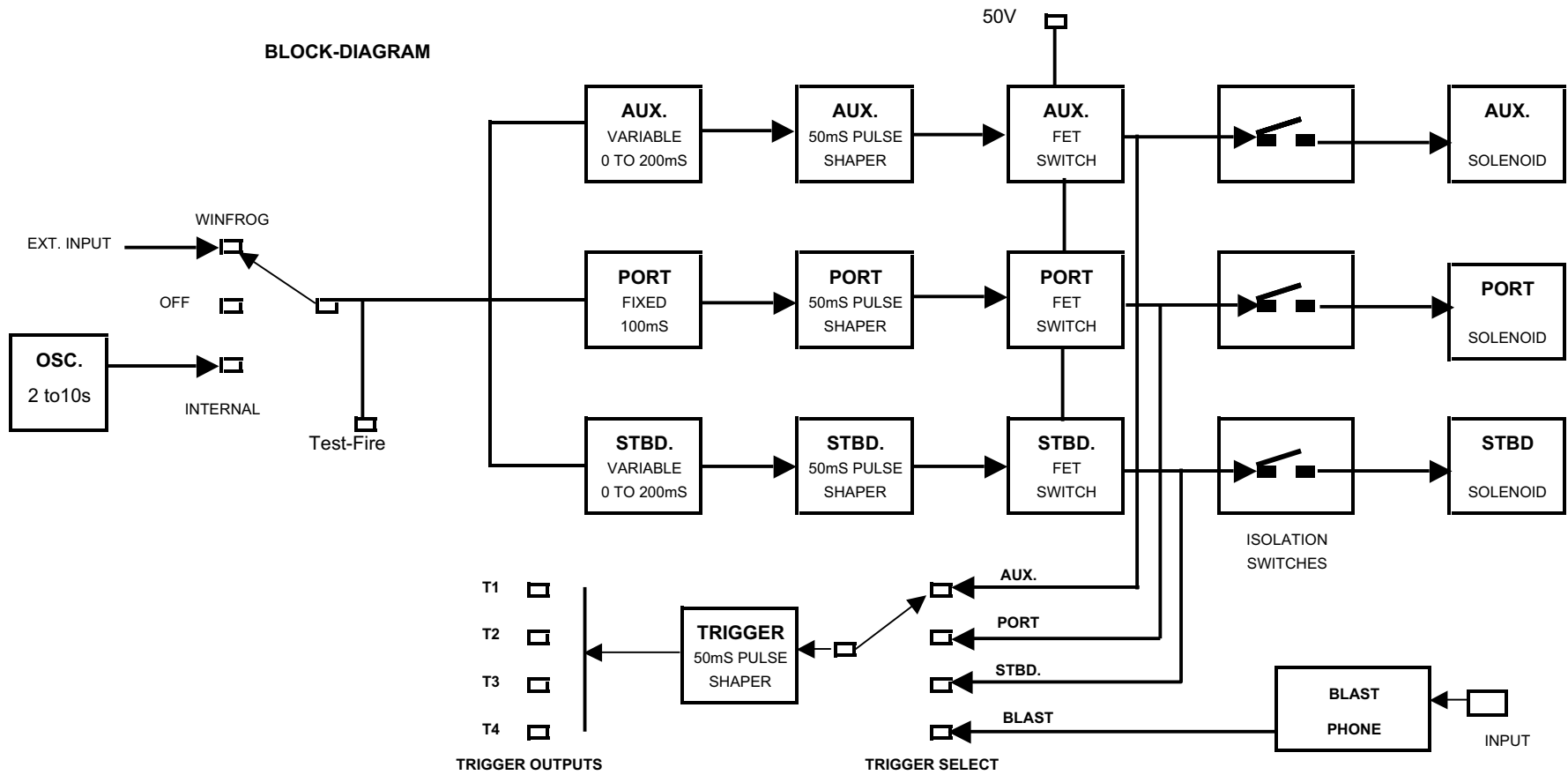
Pot Pos.	STBD.	millisec.	millisec.	STBD.	Pot Pos.
0	STBD. LEADS PORT BY	116	100	STBD. LEADS PORT BY	0.5
0.5	STBD. LEADS PORT BY	100	90	STBD. LEADS PORT BY	0.9
1	STBD. LEADS PORT BY	85	80	STBD. LEADS PORT BY	1.2
1.5	STBD. LEADS PORT BY	70	70	STBD. LEADS PORT BY	1.5
2	STBD. LEADS PORT BY	60	60	STBD. LEADS PORT BY	2
2.5	STBD. LEADS PORT BY	45	50	STBD. LEADS PORT BY	2.2
3	STBD. LEADS PORT BY	28	40	STBD. LEADS PORT BY	2.6
3.5	STBD. LEADS PORT BY	13	30	STBD. LEADS PORT BY	2.9
4	STBD. LEADS PORT BY	0	20	STBD. LEADS PORT BY	3.2
4.5	STBD. LAGS PORT BY	15	10	STBD. LAGS PORT BY	3.5
5	STBD. LAGS PORT BY	30	0	STBD. LAGS PORT BY	4
5.5	STBD. LAGS PORT BY	48	10	STBD. LAGS PORT BY	4.2
6	STBD. LAGS PORT BY	60	20	STBD. LAGS PORT BY	4.7
6.5	STBD. LAGS PORT BY	75	30	STBD. LAGS PORT BY	5
7	STBD. LAGS PORT BY	90	40	STBD. LAGS PORT BY	5.3
7.5	STBD. LAGS PORT BY	105	50	STBD. LAGS PORT BY	5.6
8	STBD. LAGS PORT BY	120	60	STBD. LAGS PORT BY	6
8.5	STBD. LAGS PORT BY	130	70	STBD. LAGS PORT BY	6.3
9	STBD. LAGS PORT BY	150	80	STBD. LAGS PORT BY	6.7
9.5	STBD. LAGS PORT BY	160	90	STBD. LAGS PORT BY	7
10	STBD. LAGS PORT BY	170	100	STBD. LAGS PORT BY	7.3

See next page for AUX. GUN

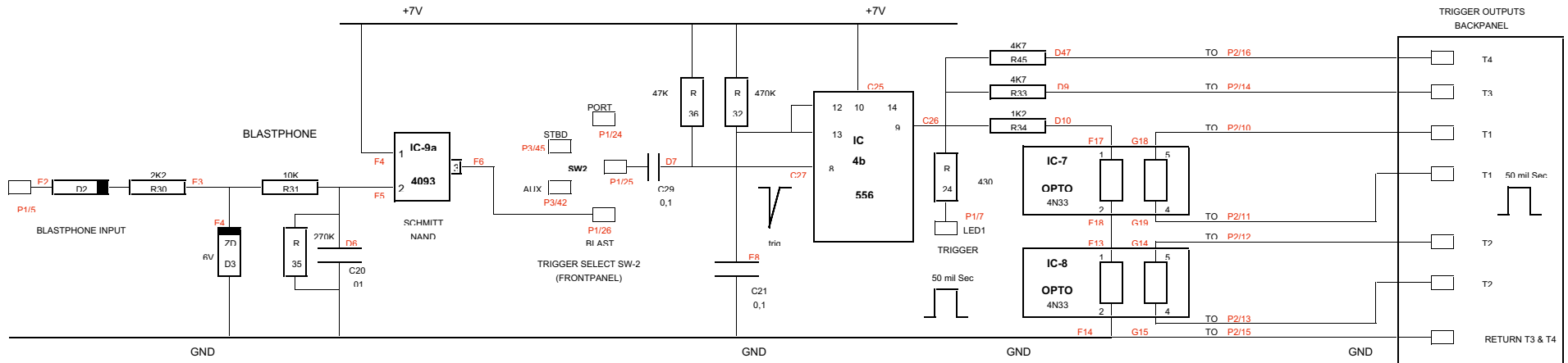
AUX. GUN with reference to port

Pot Pos.	AUX.	millisec.	millisec.	AUX.	Pot Pos.
0	AUX. LEADS PORT BY	120	100	AUX. LEADS PORT BY	0.5
0.5	AUX. LEADS PORT BY	100	90	AUX. LEADS PORT BY	1.1
1	AUX. LEADS PORT BY	85	80	AUX. LEADS PORT BY	1.5
1.5	AUX. LEADS PORT BY	80	70	AUX. LEADS PORT BY	2
2	AUX. LEADS PORT BY	70	60	AUX. LEADS PORT BY	2.3
2.5	AUX. LEADS PORT BY	55	50	AUX. LEADS PORT BY	2.7
3	AUX. LEADS PORT BY	40	40	AUX. LEADS PORT BY	3
3.5	AUX. LEADS PORT BY	30	30	AUX. LEADS PORT BY	3.5
4	AUX. LEADS PORT BY	20	20	AUX. LEADS PORT BY	4
4.5	AUX. LEADS PORT BY	5	10	AUX. LEADS PORT BY	4.2
5	AUX. LAGS PORT BY	10	0	AUX. LAGS PORT BY	4.6
5.5	AUX. LAGS PORT BY	20	10	AUX. LAGS PORT BY	5
6	AUX. LAGS PORT BY	34	20	AUX. LAGS PORT BY	5.5
6.5	AUX. LAGS PORT BY	50	30	AUX. LAGS PORT BY	5.7
7	AUX. LAGS PORT BY	60	40	AUX. LAGS PORT BY	6.1
7.5	AUX. LAGS PORT BY	75	50	AUX. LAGS PORT BY	6.5
8	AUX. LAGS PORT BY	84	60	AUX. LAGS PORT BY	7
8.5	AUX. LAGS PORT BY	100	70	AUX. LAGS PORT BY	7.3
9	AUX. LAGS PORT BY	125	80	AUX. LAGS PORT BY	7.6
9.5	AUX. LAGS PORT BY	130	90	AUX. LAGS PORT BY	8.1
10	AUX. LAGS PORT BY	140	100	AUX. LAGS PORT BY	8.5

BLOCK-DIAGRAM



TRIGGER OUTPUTS



STARBOARD GUN with reference to port

Pot Pos.	STBD.	millisec.
0	STBD. LEADS PORT BY	116
0.5	STBD. LEADS PORT BY	100
1	STBD. LEADS PORT BY	85
1.5	STBD. LEADS PORT BY	70
2	STBD. LEADS PORT BY	60
2.5	STBD. LEADS PORT BY	45
3	STBD. LEADS PORT BY	28
3.5	STBD. LEADS PORT BY	13
4	STBD. LEADS PORT BY	0
4.5	STBD. LAGS PORT BY	15
5	STBD. LAGS PORT BY	30
5.5	STBD. LAGS PORT BY	48
6	STBD. LAGS PORT BY	60
6.5	STBD. LAGS PORT BY	75
7	STBD. LAGS PORT BY	90
7.5	STBD. LAGS PORT BY	105
8	STBD. LAGS PORT BY	120
8.5	STBD. LAGS PORT BY	130
9	STBD. LAGS PORT BY	150
9.5	STBD. LAGS PORT BY	160
10	STBD. LAGS PORT BY	170

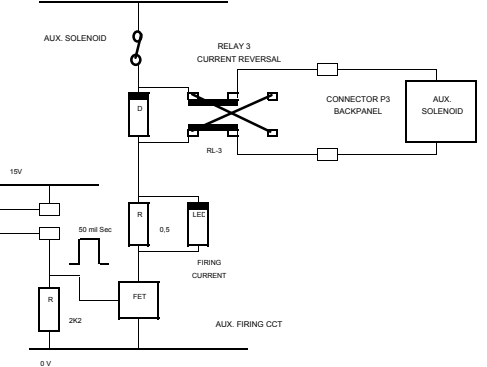
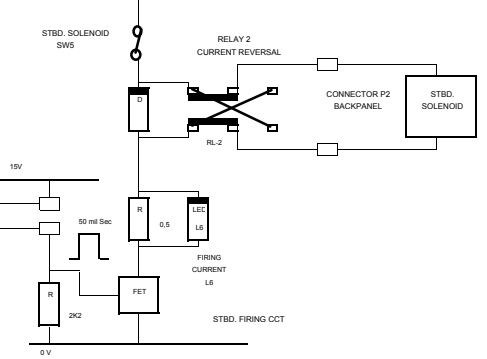
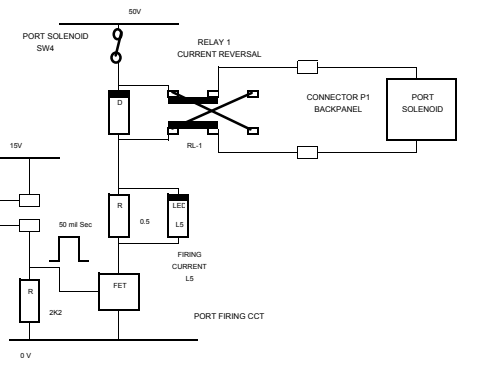
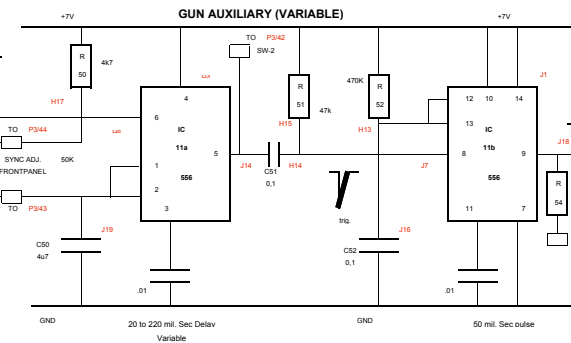
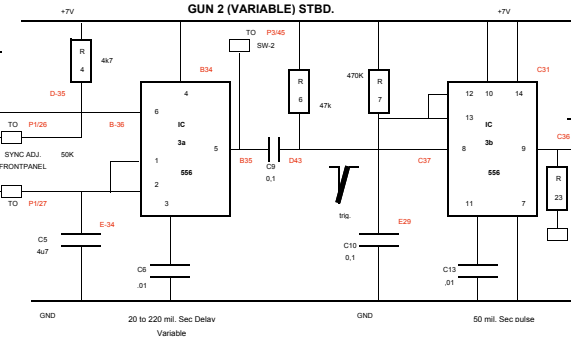
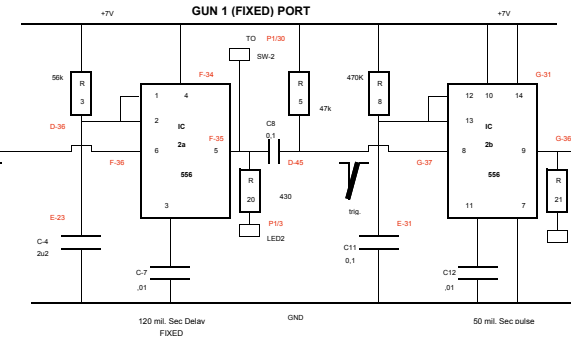
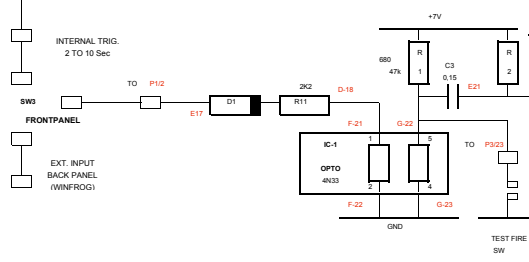
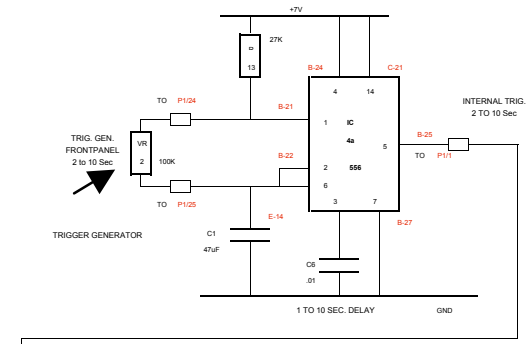
millisec.	STBD.	Pot Pos.
100	STBD. LEADS PORT BY	0.5
90	STBD. LEADS PORT BY	0.9
80	STBD. LEADS PORT BY	1.2
70	STBD. LEADS PORT BY	1.5
60	STBD. LEADS PORT BY	2
50	STBD. LEADS PORT BY	2.2
40	STBD. LEADS PORT BY	2.6
30	STBD. LEADS PORT BY	2.9
20	STBD. LEADS PORT BY	3.2
10	STBD. LAGS PORT BY	3.5
0	STBD. LAGS PORT BY	4
10	STBD. LAGS PORT BY	4.2
20	STBD. LAGS PORT BY	4.7
30	STBD. LAGS PORT BY	5
40	STBD. LAGS PORT BY	5.3
50	STBD. LAGS PORT BY	5.6
60	STBD. LAGS PORT BY	6
70	STBD. LAGS PORT BY	6.3
80	STBD. LAGS PORT BY	6.7
90	STBD. LAGS PORT BY	7
100	STBD. LAGS PORT BY	7.3

AUX. GUN with reference to port

Pot Pos.	AUX.	millisec.
0	AUX. LEADS PORT BY	120
0.5	AUX. LEADS PORT BY	100
1	AUX. LEADS PORT BY	85
1.5	AUX. LEADS PORT BY	80
2	AUX. LEADS PORT BY	70
2.5	AUX. LEADS PORT BY	55
3	AUX. LEADS PORT BY	40
3.5	AUX. LEADS PORT BY	30
4	AUX. LEADS PORT BY	20
4.5	AUX. LEADS PORT BY	5
5	AUX. LAGS PORT BY	10
5.5	AUX. LAGS PORT BY	20
6	AUX. LAGS PORT BY	34
6.5	AUX. LAGS PORT BY	50
7	AUX. LAGS PORT BY	60
7.5	AUX. LAGS PORT BY	75
8	AUX. LAGS PORT BY	84
8.5	AUX. LAGS PORT BY	100
9	AUX. LAGS PORT BY	125
9.5	AUX. LAGS PORT BY	130
10	AUX. LAGS PORT BY	140

millisec.	AUX.	Pot Pos.
100	AUX. LEADS PORT BY	0.5
90	AUX. LEADS PORT BY	1.1
80	AUX. LEADS PORT BY	1.5
70	AUX. LEADS PORT BY	2
60	AUX. LEADS PORT BY	2.3
50	AUX. LEADS PORT BY	2.7
40	AUX. LEADS PORT BY	3
30	AUX. LEADS PORT BY	3.5
20	AUX. LEADS PORT BY	4
10	AUX. LEADS PORT BY	4.2
0	AUX. LAGS PORT BY	4.6
10	AUX. LAGS PORT BY	5
20	AUX. LAGS PORT BY	5.5
30	AUX. LAGS PORT BY	5.7
40	AUX. LAGS PORT BY	6.1
50	AUX. LAGS PORT BY	6.5
60	AUX. LAGS PORT BY	7
70	AUX. LAGS PORT BY	7.3
80	AUX. LAGS PORT BY	7.6
90	AUX. LAGS PORT BY	8.1
100	AUX. LAGS PORT BY	8.5

FIRING CIRCUIT



POWER SUPPLY

