

1. Introduction

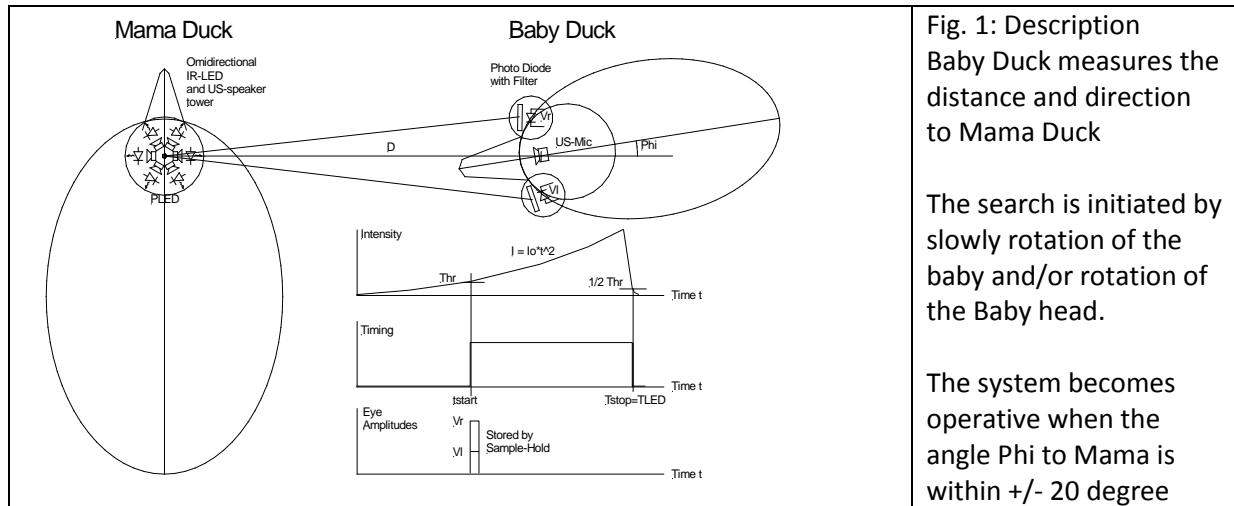


Fig. 1: Description Baby Duck measures the distance and direction to Mama Duck

The search is initiated by slowly rotation of the baby and/or rotation of the Baby head.

The system becomes operative when the angle Phi to Mama is within +/- 20 degree

Definition of the parameters

Param	Unit	ca.Value	Description
PLED	Watt	0-15	Power of LED Mama Duck, increasing during TLED
TLED	msec	20	Time Duration of LED emission Mama Duck
fcl	kHz	15.6	LED Clock Frequency, 312 pulses Mama Duck
Vl	V	0-1	Voltage left Photo System Baby
Vr	V	0-1	Voltage right Photo System Baby
Thr	V	1	Threshold Photo System Baby
tstart	msec	0-20	Start time at $(V_r + V_l) > Thr$ at the momentary distance
tstop	msec	20	Stop time at $(V_r + V_l) < Thr/2 = TLED$
Dmax	m	13	Maximum detectable distance at full LED Power
kd	m/msec	0.65	Calibration factor distance, $kd = D_{max}/TLED$
D	m	0.3-13	Distance Baby-Mama, $t_{start} \cdot kd$, to $t_{stop} - TLED$
kp	Deg/V	ca.15	Calibration factor angle
Phi	Deg	+/-20	Angle to Mama, $((V_l - V_r)/(V_l + V_r)) \cdot kp$

Table 1. Definition of the Parameters

Example:

Distance: $t_{start} = 7.7 \text{ msec}$: calculated distance $D = 5 \text{ m}$;

Direction: $V_l = 0.2 \text{ V}$, $V_r = 0.8 \text{ V}$: calculated angle $\Phi = -9 \text{ Deg}$ (Nonlinear, but good zero crossing!)

Application notes:

- 1.) This system does not need any RC-Link between Papa, Mama and Baby Duck
- 2.) The present angular capture range is limited to about +/-30 deg, but at high sensitivity.
- 3.) Wide angle capture range up to +/-60 deg is possible using PSD, but at less sensitivity
- 4.) Omidirectional capture range would be possible with omidirectional photo diodes at the Baby head. This would deliver the distance information, however a more sophisticated scanning system would be required to obtain the angular information !

2. Timing Diagram

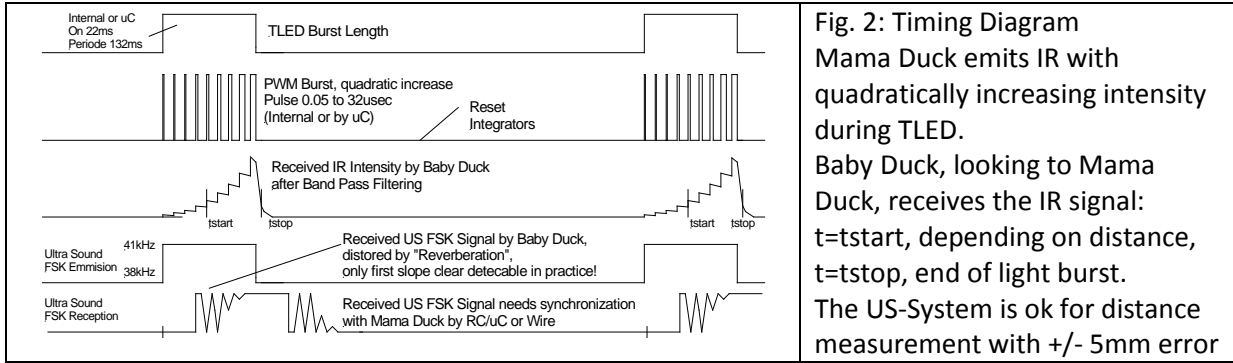


Fig. 2: Timing Diagram
Mama Duck emits IR with quadratically increasing intensity during TLED. Baby Duck, looking to Mama Duck, receives the IR signal: $t=t_{start}$, depending on distance, $t=t_{stop}$, end of light burst. The US-System is ok for distance measurement with +/- 5mm error

3. Basic Circuit

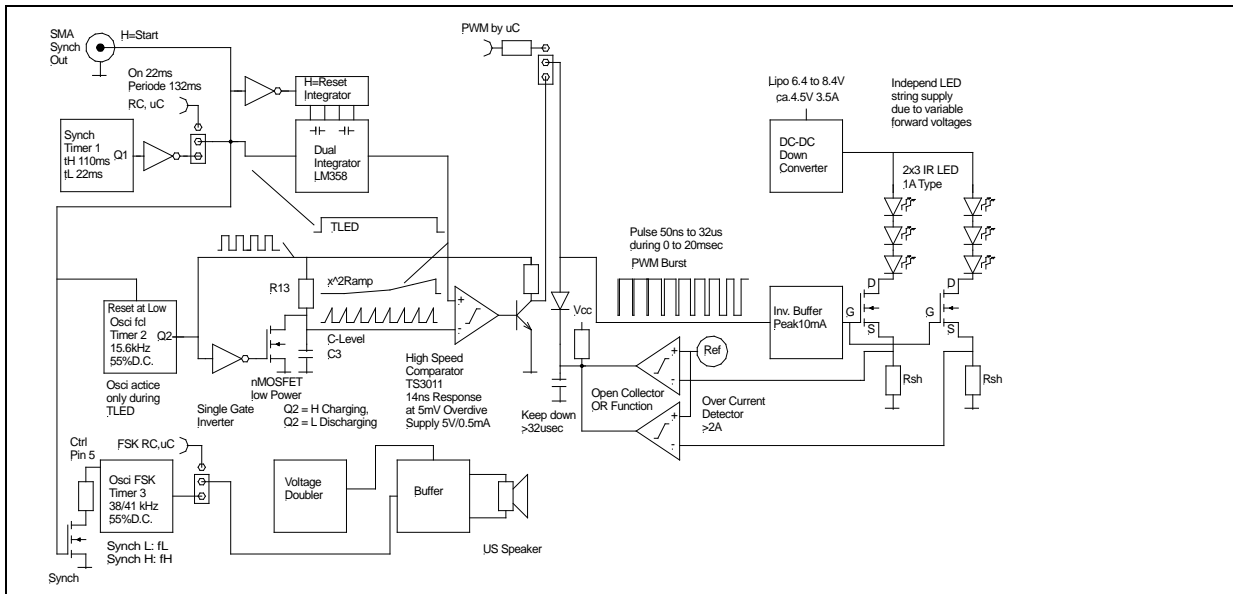
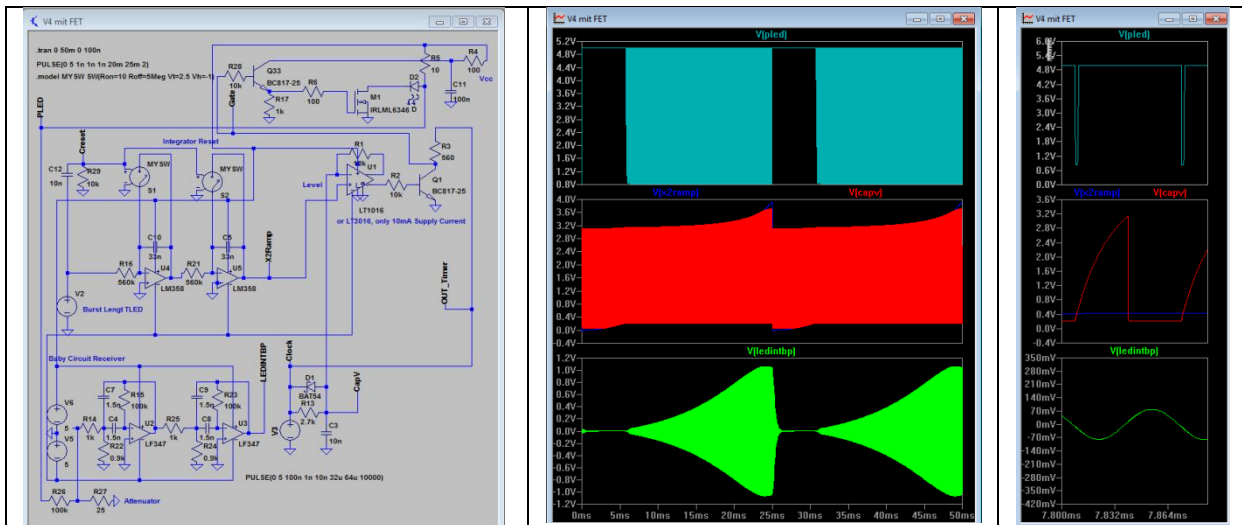


Fig.3. Schematic Circuit

4. Simulations

4.1. Circuit here with Synch Timer 22/25msec for demonstration



Circuit

Full range 0 to 50msec

Seq. 70usec

Fig. 4: Simulation of received PWM Burst with TLED 20msec, but 25msec period for demo. 1st: PWM PLED; 2nd: x^2 Ramp and Level at C3; 3rd: Optosignal processed by Baby

4.2. Signals at start and stop within the PWM Burst Period TLED

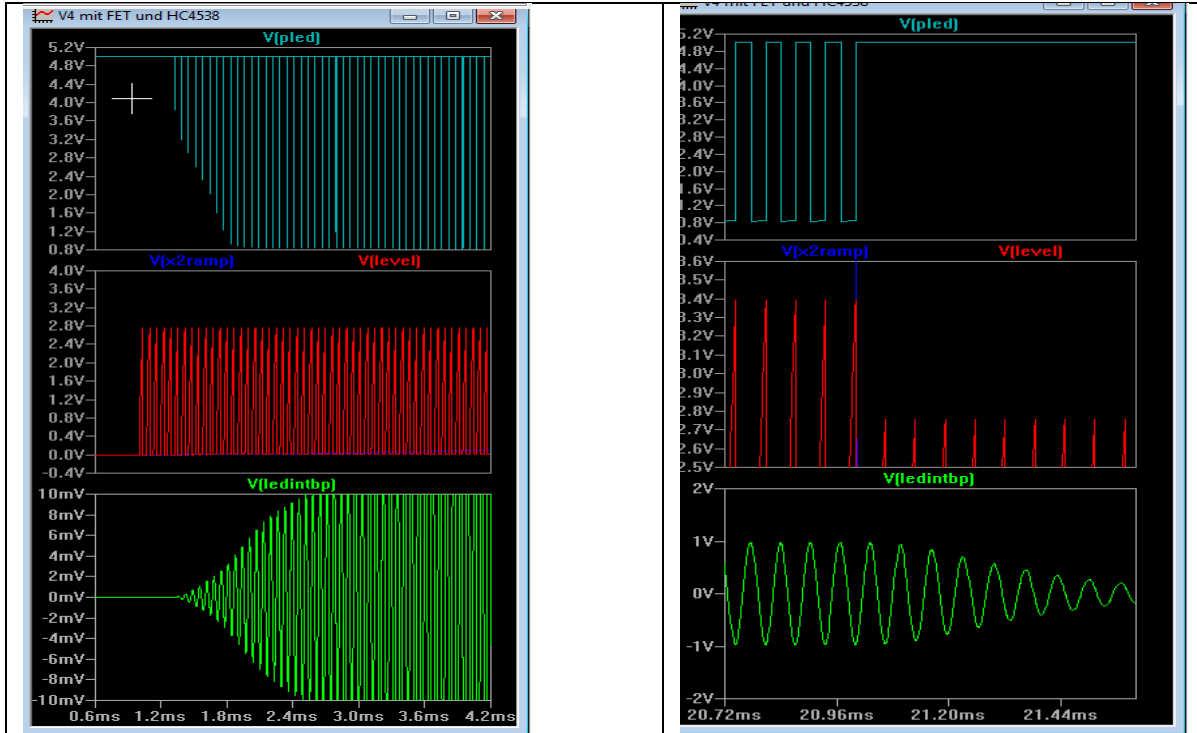


Fig. 5a: Start, BP-Signal less than 1mV

Fig. 5B: Stop, BP-Signal more than 1V

Top: Voltage at +LED; (5V= no LED current, 0.8V= maximum LED Current)
 Middle: Voltage x^2 Ramp by Integrator and Voltage Level at charging capacity C3
 Below: Processed optical Signal by Baby Circuit

Comment: Dynamic Range : 1000, Pulses 0.03usec to 32usec

Estimated detectable distance range: Maximum 13m, Minimum 0.4m

4.2. FET Drive

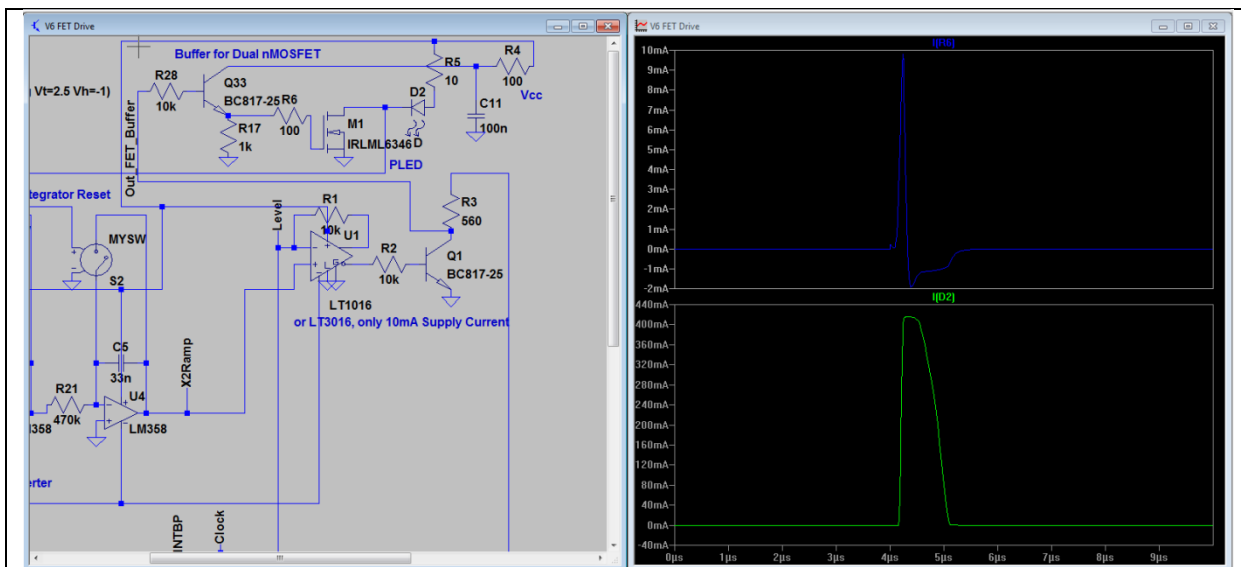
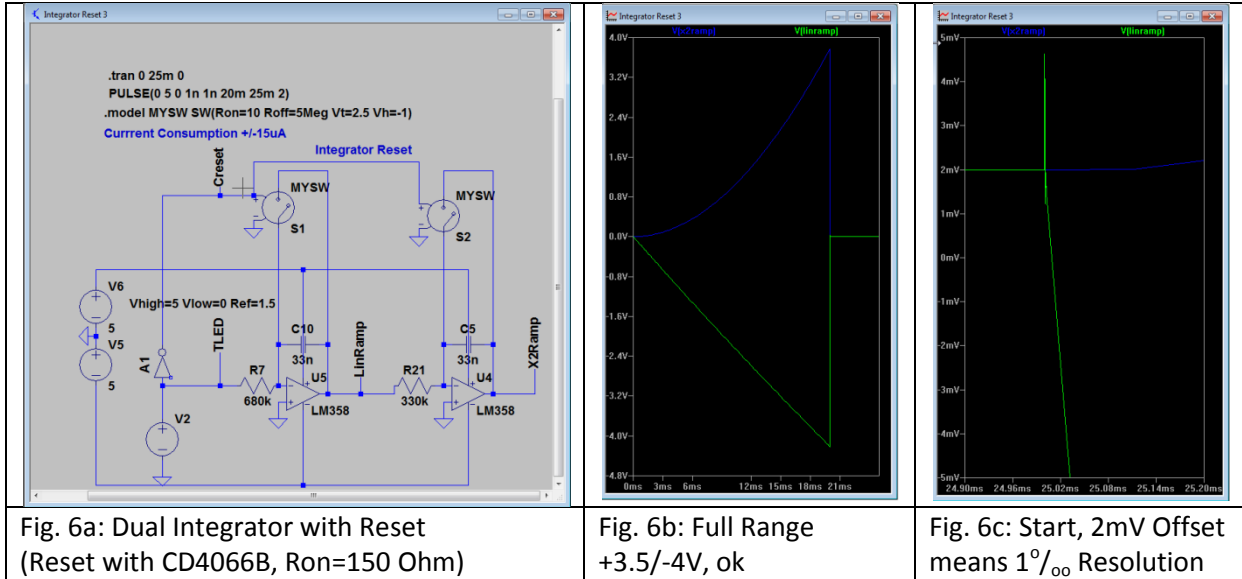


Fig. 6: Buffer for nMOSFET, t_{start} = 3msec, very short pulse, about 0.4usec here

Top: Gate Current, about 10mA peak; Below: Current into LED

4.3. Dual Integrator

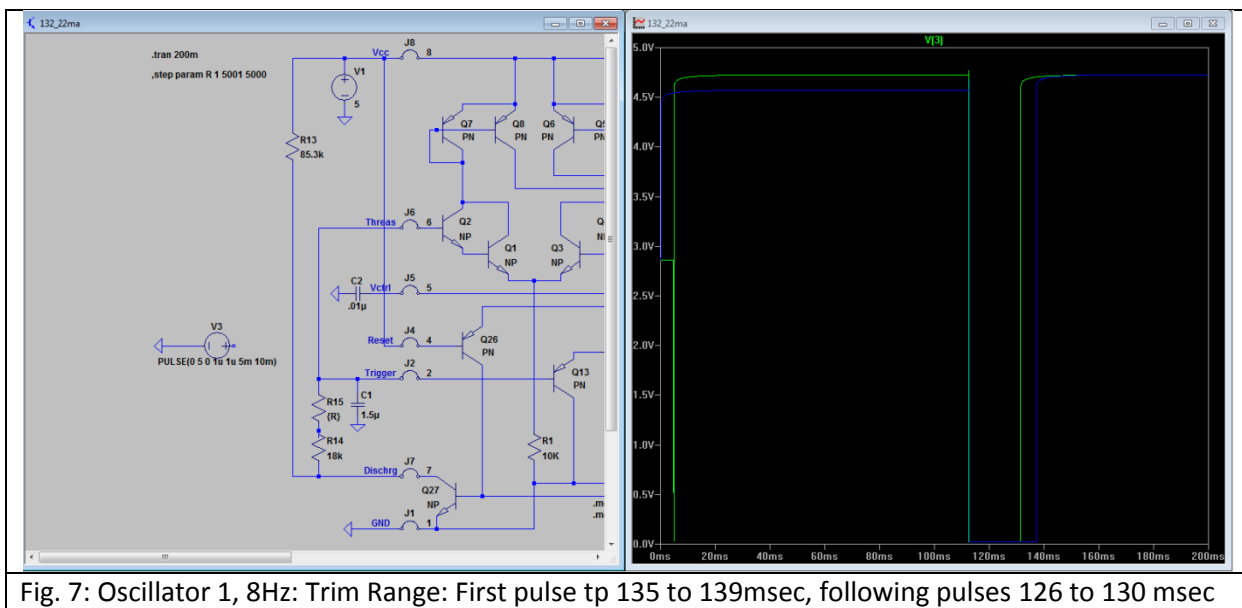


4.4. Timer Calculation and Simulation

		Osci 1	Osci 2	Osci 3
Parameter	Unit	132/22 ms	15.6 kHz	40 kHz
C	uF	1.50	0.0047	0.00047
RBo	Ohm	18'000	8'200	33'000
RBtrim	Ohm	5'000	2'000	10000
RAo	Ohm	85'300	1'200	3'000
tLmid	msec	21.310	0.030	0.012
tHmid	msec	109.979	0.034	0.013
tpmid	msec	131.289	0.064	0.026
fmid	kHz	0.008	15.664	38.863

Tab. 1: Selected Components. See Report: 80.Calculation for Timer 555

Timing Results: Trimmer set to middle position 50 %



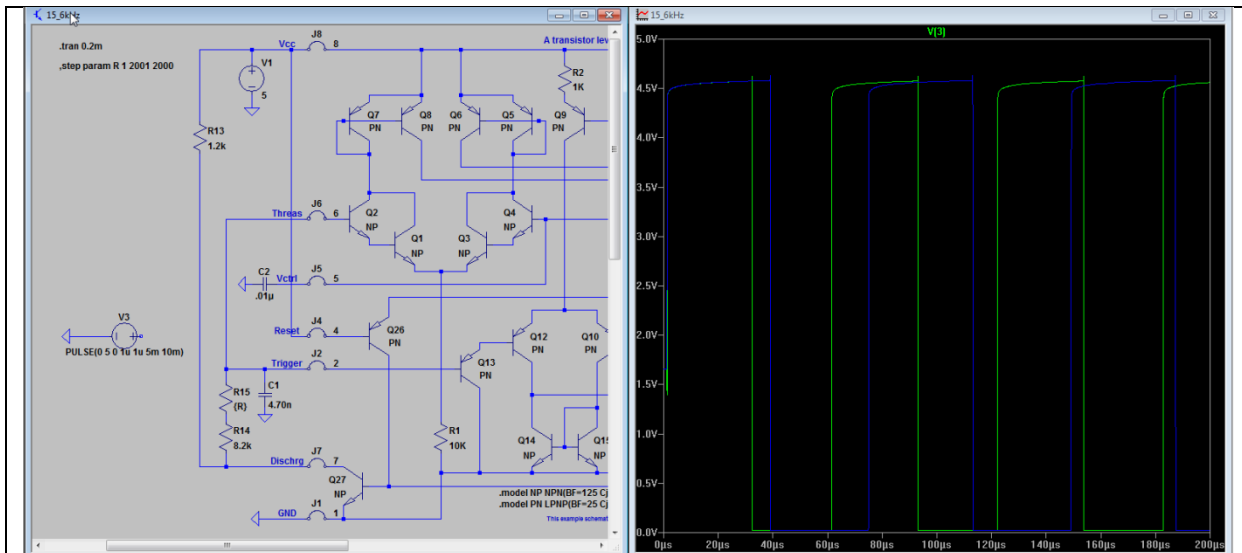


Fig. 8: Oscillator 2, 15.6kHz: Trim Range: First pulse tp 62 to 75usec, following pulses 60 to 72 usec

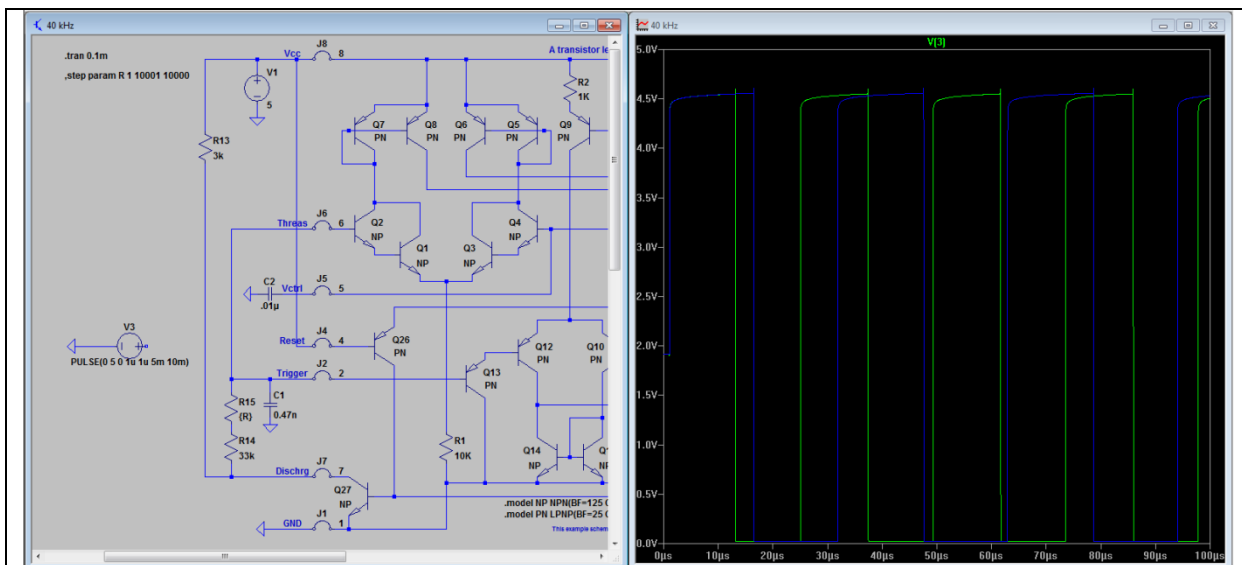
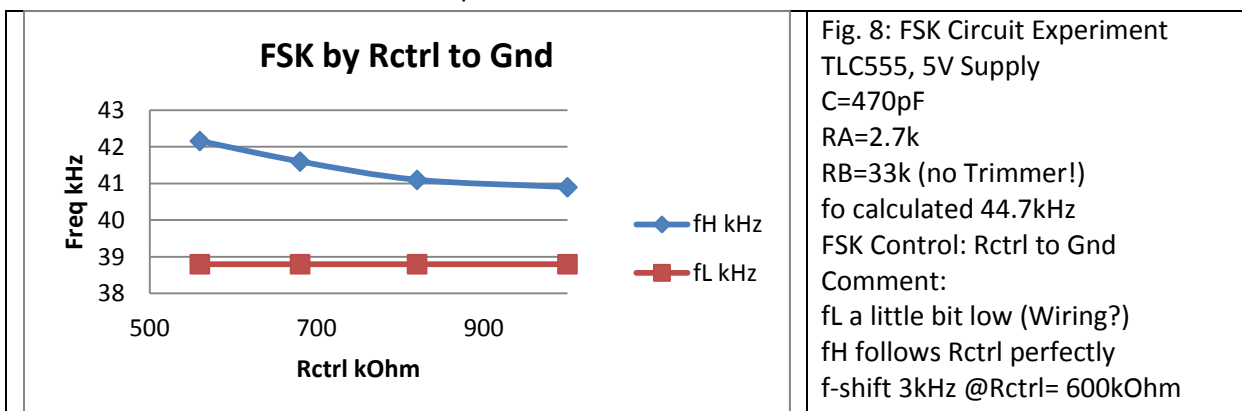


Fig. 9: Oscillator 3, 38-41kHz: Trim Range: First pulse tp 25 to 32usec, following pulses 23 to 31 usec

4.5. FSK with Resistor at Timer Ctrl Input to Gnd



5. Circuit Transmitter

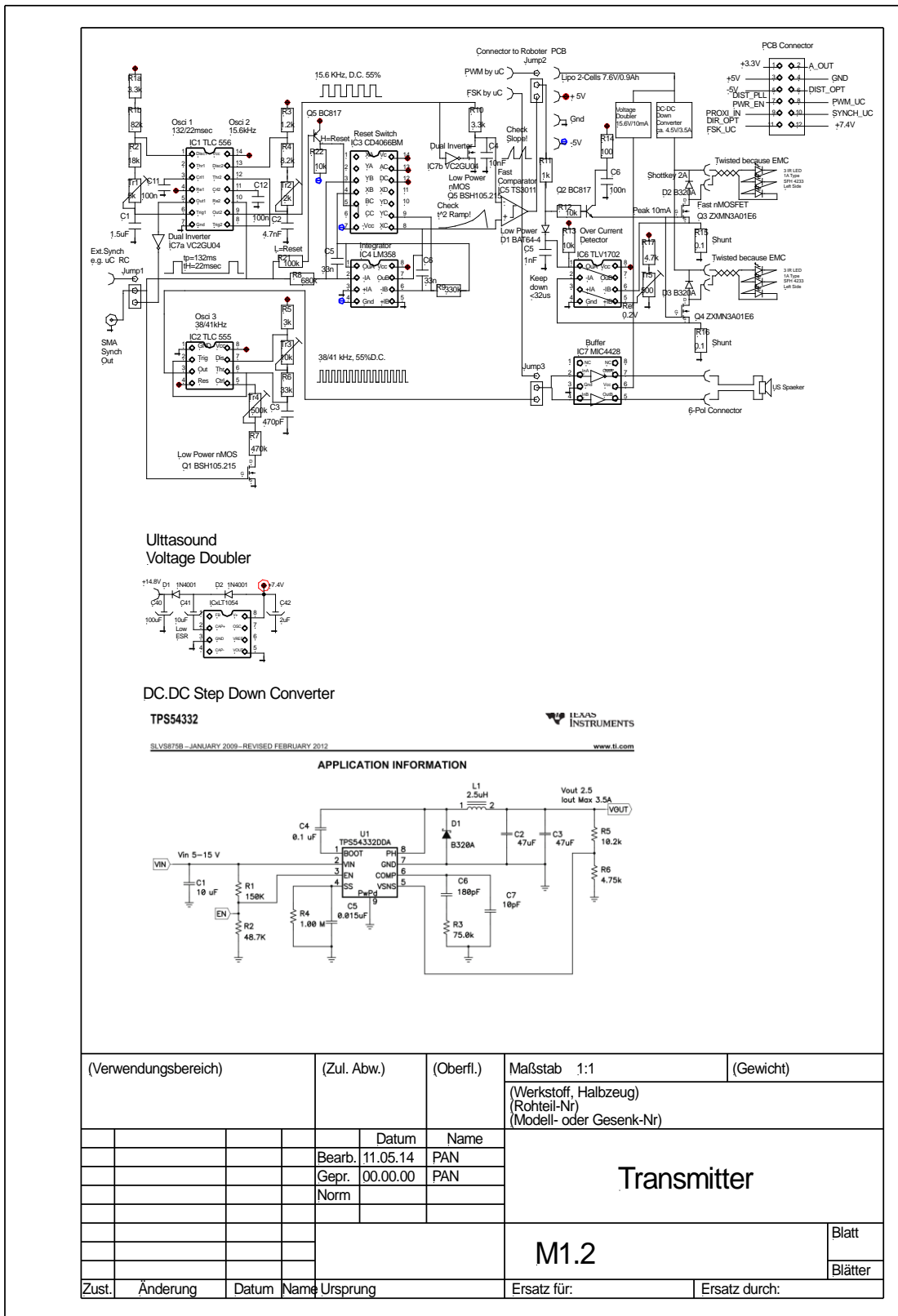


Fig. 9: Circuit Transmitter not yet tested, error with PWM Polarity

5. Circuit Receiver

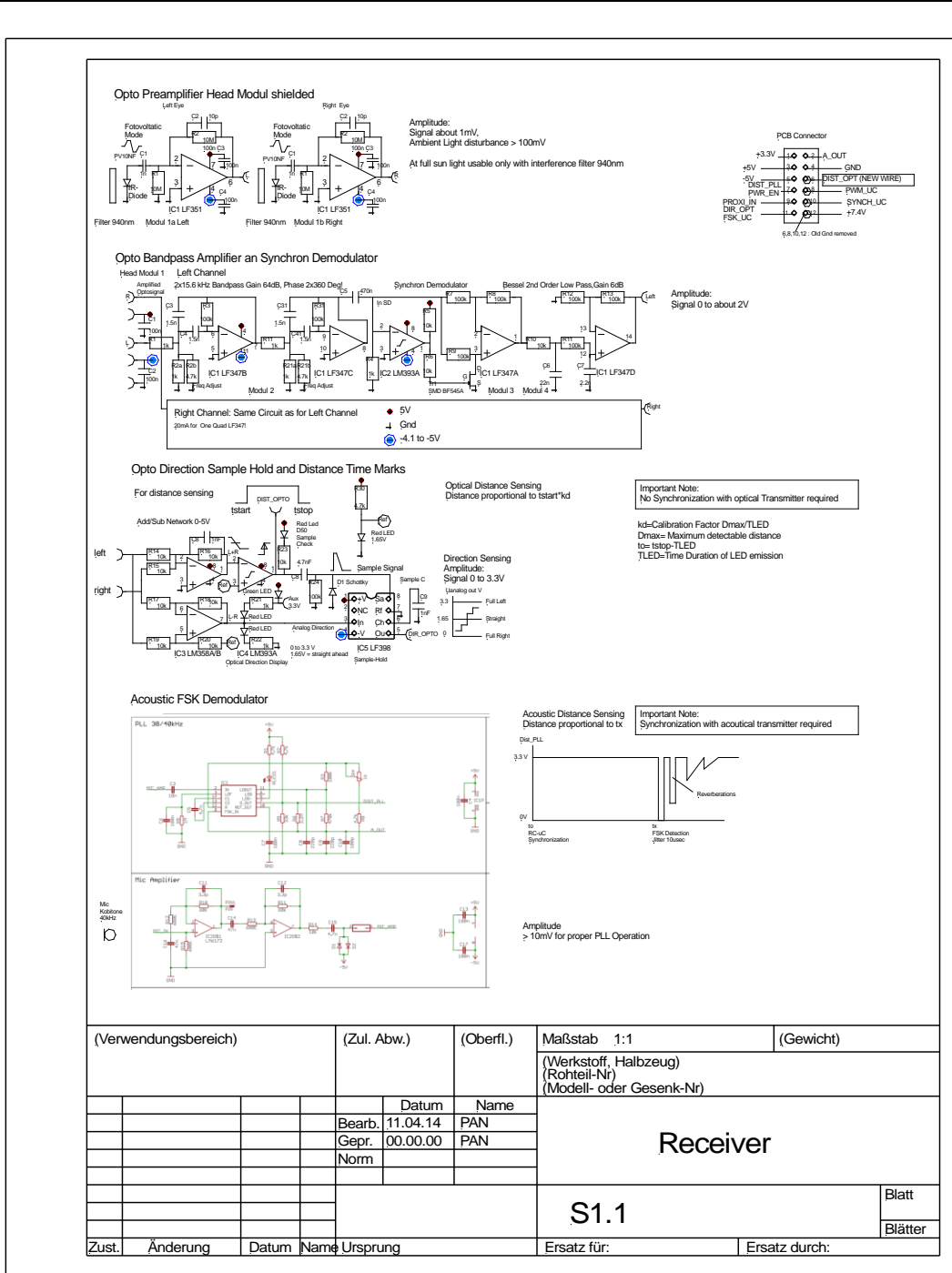


Fig. 10: Circuit Receiver with Comments, not yet tested