Purpose:

Quick technical description of the 310MHz transmitter; 10HBLPUSL009-C-0.

Overview:

The PCBA is divided into the following sub circuits:

1) Battery connection
2) Micro controller
3) RF transmitter + antenna
4) Key-matrix
5) Programming interface
6) Backlight
7) LED

Ref:

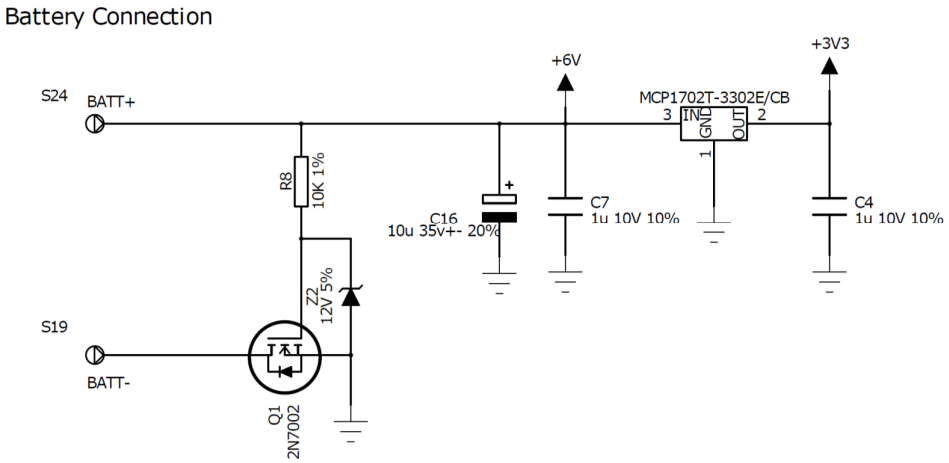
- Circuit diagram for HC20 board – 10907483-C.
- Block Diagram

Note:

The HC20 PCBA (10907483-C) used in HC20 and HBBRIO RF handsets is reused in this 310Mhz transmitter to L&P. All the sub-circuits are reused, except the antenna-matching circuit, which is adjusted to the new transmitting frequency.

Sub circuit description

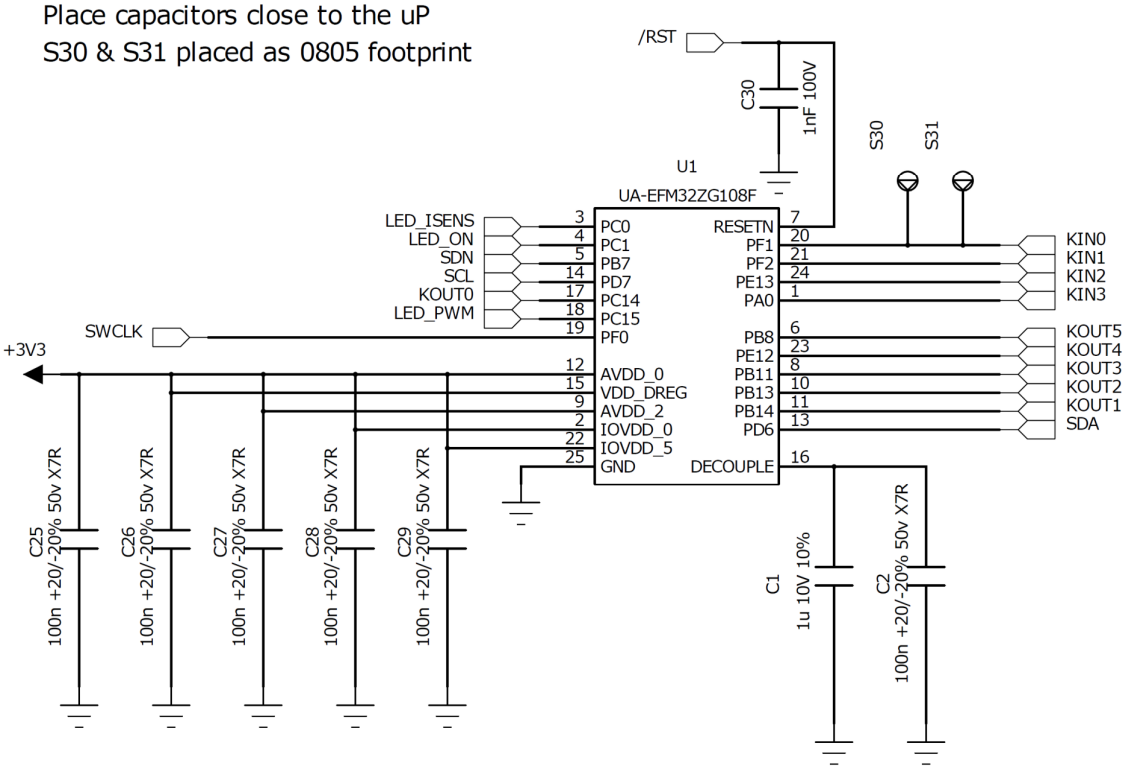
Battery connection



4 x AAA (LR03) batteries are connected in series to S24(+) and S19(-). Q1, Z2 and R8 work as a protection against wrong polarization.
The MCP1702T step down the input voltage to 3.3VDC. Caps are mainly for stabilization.

Micro controller

uC For layout!
Pins PC0 and PC1 can be swaped with each other.
Pins PC14 and PC15 can be swaped with each other.
Place capacitors close to the uP
S30 & S31 placed as 0805 footprint



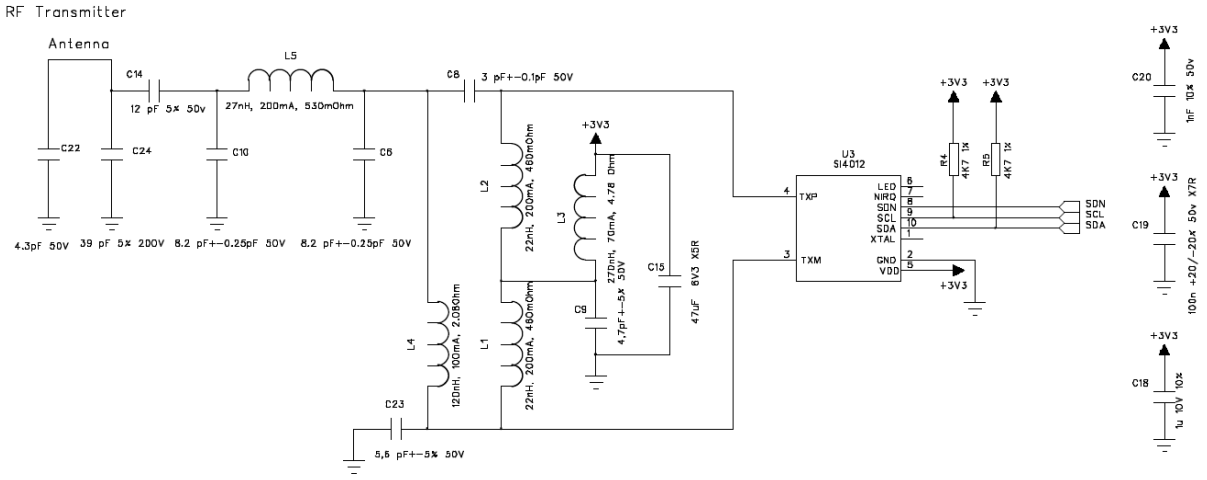
The uC handles all key scan, Backlight and LED operation and of cause setup and data stream to the RF transmitter.
When the handset is not used, the microcontroller (uC) enters a low-power mode where all external clock frequencies are switched off. It wakes up and scans the key matrix to see if a button have been pressed and then power down again.
If a button is pressed down, the uC wakes up and start communicating with the RF transmitter on the I2C bus. It starts by initializing the transmitter and afterwards it start transmitting the actual data packages to the buffer of the RF transmitter.

RF transmitter+antenna

The antenna-matching circuit is changed to fulfil the requirements for the 310MHz circuit.
In the following table, it is possible to find the new components, for obtaining a transmitting frequency at 310 MHz.

433,92MHz					310MHz				
Transmitting frequency; 433,92MHz	Partnumber	Qty	Partnavn	Position	Transmitting frequency; 310MHz	Partnumber	Qty	Partnavn	Position
6,8pF	1073128	2	SMD0603 C 6.8pF +-0.25p NP050V	C6,C10	8,2pF	1073368	2	SMD0603 CAP 8.2pF +-0.25p NP0 50V	C6,C10
22pF	1073159	1	SMD 0603 CAP 22pF 200V	C24	39pF	1073369	1	SMD0603 CAP 39pF 5% NP0 50V	C24
2,7pF	1073355	1	0603 2.7pF +-0.1pF 50V C0G	C9	4,7pF	1073119	1	SMD 0603 CAP 4.7pF 5% NP0 50V	C9
1,8pF	1073354	2	0603 1.8pF +-0.1pF 50V C0G	C22,C8	4,3pF	1073356	1	0603 4.3pF +-0.1pF 50V C0G	C22
					3pF	1073370	1	SMD0603 CAP 3pF +-0.1p NP0 50V	C8
4,3pF	1073356	1	0603 4.3pF +-0.1pF 50V C0G	C23	5,6pF	1073122	1	SMD 0603 C 5.6pF 0.5pF NP0 50V	C23
270pF	1073357	1	0603 270pF +-2% 50V C0G	C14	12pF	1073192	1	0603 CER 12pF 5% 50V C0G	C14
220nH	1075115	1	SMD 220nH RF 0402	L3	270nH	1075122	1	SMD Inductor 0402 270nH 5% RF 70mA	L3
18nH	1075117	3	SMD 18nH RF 0402	L1,L2,L5	22nH	1075123	2	SMD Inductor 0402 22nH 5% RF 200mA	L1,L2
					27nH	1075124	1	SMD Inductor 0402 27nH 5% RF 200mA	L5
56nH	1075118	1	SMD 56nH RF 0402	L4	120nH	1075125	1	SMD Inductor 0402 120nH 5% RF 100mA	L4

Comparison table for components for transmitting frequencies at 433.92 MHz and 310MHz.



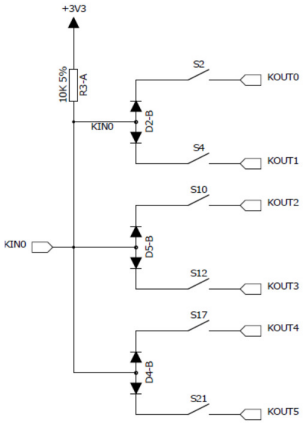
The RF transmitter is actually a SI4010 but preloaded with specific supplier software and therefore named SI4012.

The modulation scheme is the simplest form of ASK modulation called OOK. The data bit rate is 4 kbit/s (each bit having a length of 250 us). The coding scheme is Manchester so each bit consist of a high period of 125 us and a low period of 125 us. Thus the signal will always have a duty cycle of 50% (constant DC component) regardless of the data content. Data is transmitted in packets.
For a more detailed description of the coding and data scheme refer to the “RF-protocol description”.

When a button is pressed and the micro controller wakes up from sleep state it starts setting up the RF transmitter. First it send the setup package telling the transmitter the transmitting frequency (310MHz), transmit power, modulation type, to use internal oscillator, how the impedance network on the output is configured ect. Second it send a “clear FIFO” command to clear the internal transmit buffer.

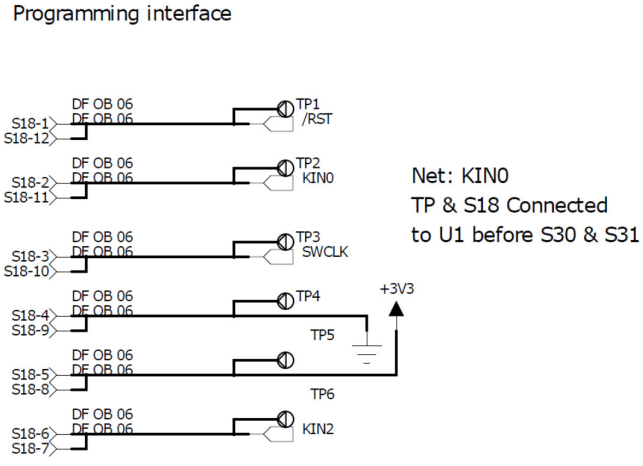
When the setup is complete, the microcontroller send the actual data package according to the RF-protocol.

Key-matrix

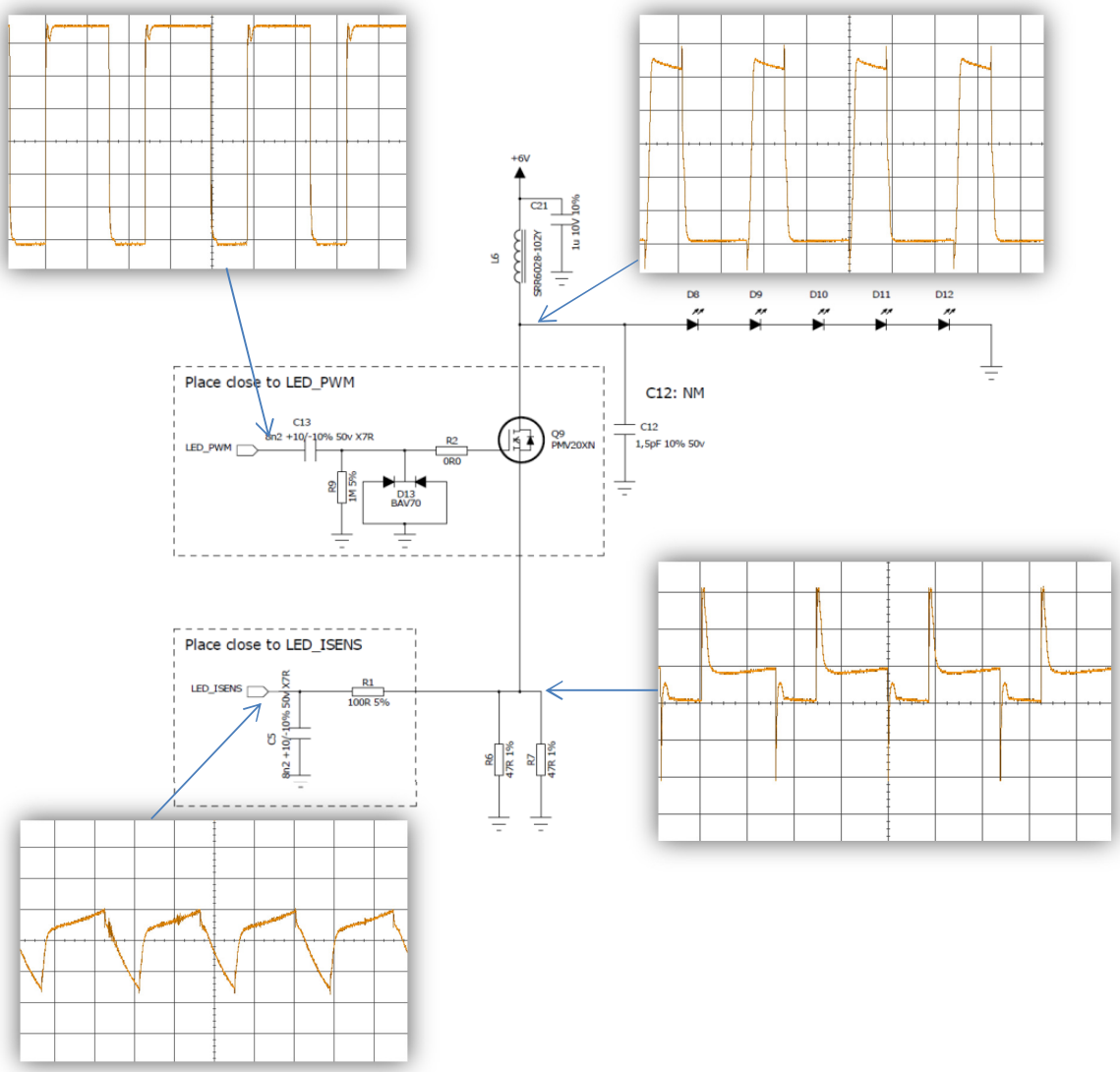


The key-matrix (example above) detects if a key is pressed. The uC has KOUTx set to 0. In turn it threstates KINx and listen. KINx is per default “HIGH” (above 0.7xVcc). If KINx is detected as being less than 0.3xVcc it measures KOUTx and thus detects which key is pressed. This information tells the software which data package to transmit.

Programming interface



Backlight

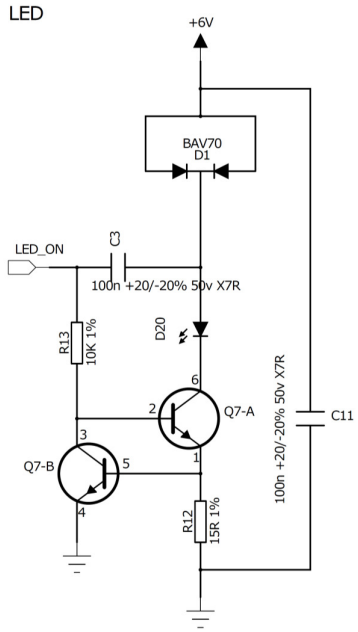


The backlight is controlled by the microcontroller (uC). When the backlight is turned off the LED_PWM is high and because of the capacitor C13 the gate on Q9 will be pulled down by R9. A voltage of 6V will be on the diodes. This is not enough to make the diodes light up and only a small current will run through them.

When the backlight is turned on the uC will put out a variable PWM frequency based on the feedback LED_SENSE. When LED_PWM goes LOW it will turn off Q9. This will enable the inductor L6 to build up a charge across the LEDs. The PWM will stay low for a predefined timeslot that is adapted to the green diodes. Doing this timeslot the voltage on the diodes is high enough to turn them ON and the current is approximately 20mA.
Once the LOW timeslot is over the LED_PWM will go high. This will turn on Q9 and discharge the inductor through R6 and R7. This discharge current is measured through LED_SENSE and compared to a predefined level inside the uC. When the level is reached, the LED_PWN will go LOW and the diodes will light up again.

The LED_PWM frequency is maximum 400KHz and can be as low as 40kHz.

LED



The circuitry for the torch/transmit indicatior LED is a constant current generator. It is controlled by the u-controller that generates a 100kHz PWM signal with 50% duty-cycle. The LED is turned on ether when the handset is transmitting (HBBRIO) or when a specific button is pressed (HC20). C3 boost the voltage for the diode to approximately 8.2VDC. The current, and thereby the light intensity, is defined by Vbe on Q7-b and R12.