TEK 2.0 HAND-HELD BASIC FUNCTIONAL DESCRIPTION

The Hand-Held unit block diagram description

Processor

The processor type is AT3345 with AMR Cortex-A8 core.

- Clock speed is 800MHz
- Android operating system

Main functions of the processor are next:

- Make terrain map calculations, rotations and visualize maps via LCD display
- User interface via rotary encoder and switches
- Measure own navigation coordinates and speed via GPS / GLONASS module
- Receive GPS-collar location messages via RF-receiver and visualize objects to the LCD display
- Transmit stimulation commands to the GPS-collar via RF-transmitter
- Transmit own geological location to another Hand Held units in same group via RF-transmitter
- Power management controlling via power management IC
- Battery recharge control via power management IC
- Two way communication via Bluetooth module
- Two way communication via USB 2.0
- Generate audio signals and sounds via audio codec IC
- Measure ambient light level for adjust the LCD display back light level
- Save / read data from the memories
- Save / read user settings to / from the memory

Memory

- LPDDR1 memory with 200MHz bus for the RAM memory usage
- eMMC memory for the map memory
- uSD card memory for the user special maps and files
- EEPROM for settings and calibration data

User Interface

- Rotary encoder for move cursor in menu
- Switches for make selections and settings
- Side switches for send stimulation commands to the GPS-collar unit´s
- Vibration module for the alarms and warnings

RF-section

- Si4463 Transceiver IC works from 866 to 915MHz band. Modulation GFSK, data speed 4800bit/s. Channel separation 25kHz.
- SAW filters dedicated for each frequency band. Reduce spurious emissions and provide out-of-band interference rejection.

- Power amplifier RF6569 (PA) for amplify Si4463 Tx RF signal from 10-20mW to 0.5W or 1W. The Tx/Rx RF-switch is integrated to the PA
- Low pass filter is designed for reduce spurious emissions of the PA
- Low Noise Amplifier (LNA) amplify received signal from the whip antenna

GPS / GLONASS

- Parallel GPS / GNSS receiver. 99 channels for search and 33 for tracking

Bluetooth

- The Bluetooth module with the integrated stack.
- Class 1 or 2

Audio codec

- Audio codec is for generate sounds and play the MP3 files.
- Integrated 1W speaker amplifier

Power Management IC (PMIC)

- The PMIC regulate all used voltages for the Processor and accessories
- Integrated linear re-charger for the Lithium-ion battery

Ambient light Sensor

- Sensor for the ambient light level measure from the environment. By using this information the processor will adjust the LCD display back light brightness via the PMIC

USB

- The USB 2.0 connector is for recharge the battery and communication interface to the another devices

Li-ion Battery

- 4400mAh Li-ion battery with the integrated safety circuit and the NTC resistor

Antennas

- All antennas are matched to the used frequency and impedance

The TEK 2.0 866/915 Hand-Held unit has four different frequency band versions.

1. The FCC / IC version works in frequency band 902 – 916 MHz (FCC, CFR 47. §15.247 / IC, RSS-210, Annex 8) 28dBm, 50 Rx + 50 Tx (25 kHz) channel, frequency hopping.
2. The AU version works in frequency band 915 – 916 MHz (AS NZS 4268-2008) 28dBm, 20 Rx + 20 Tx (25 kHz) channel, frequency hopping.
3. The CE version works in frequency band 869,400 - 869,650 MHz (EN 300 220-1) 27dBm, 5 Rx + 5 Tx (25 kHz) channel, frequency hopping.
4. The NZ version works in frequency band 864,000 – 868,000MHz (EN 300 220-1) 28dBm, 20 Rx + 20 Tx (25 kHz) channel, frequency hopping.

Hand-Held unit utilizes the frequency band as a communication link and also includes a GPS engine to acquire location coordinates and exact GPS time. The user is not able to configure the Hand-Held unit to different frequencies what are programmed in the Hand-Held unit frequency tables.

Note: See sample frequency tables and end of this document.

Each unit has user ID. The user can change or modify user ID. The user ID will match the GPS collars to the Hand-Held units.

Synchronize of the used receiver frequency at the time will be done by checking GPS time. The Hand-Held and GPS-collar units will change frequency channel every 215ms (RX window). GPS-collar transmission time is around 142ms every 3rd second. GPS-collar transmission period will be change randomly a little every time for the Listen Before Talk. Nominal transmission period is around 3 second but transmission period will change randomly few +/- ms every time for avoid over lapping.

The Hand-Held unit send own position information to another Hand-Held units every xx seconds by using same protocol.

The hopped frequency channels are used to receive GPS coordinate data from the GPS-collar unit or the Hand-Held units. The GPS-collar and Hand-Held units synchronized to same frequency hopping algorithm by using the GPS time. That makes possible communication between the units at the time.

If the user has the optional trainer module, E-collar module in the GPS-collar, the Hand-Held unit can be used as a transmitter by using hopping channels for remote control training purposes. Timing of training transmission hopping will based to the internal timers. Synchronize between the Hand-Held and E-collar units will happen from transmitted and received data frames. Received data frame will start up internal timer in the E-collar for time to change next used frequency.

Tx timings for the Handheld unit (FCC & IC).

Spectrum Access Techniques	
Minimum transmitter Off-time, (included LBT and Dead time)	32.5ms
LBT Minimum Listening Time	5ms - 10ms
Dead Time between LBT and Tx on time	2 - 3ms
Maximum Transmitter On-	82.5ms

time	
Transmit timeout Min	5.75s (50CH)
Transmit timeout Max	11.5s (50CH * 2)
Transmit logout min between stimulation commands	5s

Tx timings for the Handheld unit (AU, CE & NZ).

Spectrum Access Techniques	
Minimum transmitter Off-time (included LBT and Dead time)	65ms
LBT Minimum Listening Time	5ms - 10ms
Dead Time between LBT and Tx on time	2 - 3ms
Maximum Transmitter On-time	165ms
Transmit timeout Max	11s
Transmit logout min between stimulation commands	5s

TEK HAND-HELD RF FUNCTIONAL DESCRIPTION

Upon user power-up of the unit, the 32MHz TCXO is enabled. The TCXO provides a precise frequency reference source for the fractional_N PLL used in the Silicon Labs Transceiver IC Si4463.

Receive Mode (Tracking)

When in receive mode, the processor configures the integrated TX/RX switch to connect the antenna input to the LNA, first stage of the receiver chain. This is followed by a SAW bandpass filter to provide out-of-band interference rejection. The receiver section of the Si4463 has an IF frequency of 500 kHz with the LO located at channel frequency – 500 kHz…low side LO. Used frequencies are ordered from hopping frequency table.

Transmit Mode (Training)

The transmit mode is used when the user wishes to send a training stimulus command to the E-collar unit. When the user initiates a training command, the Hand-Held unit checks the start channel for the traffic. Before each transmission has Listen Before Talk (LBT) period for check that used channel is not in use. If the channel is not in use, the processor configures TX/RX switch and transmit data packets and return back to receive mode. If TX button is still hold down, unit will hop to the next frequency channel and check that channel is available (LBT). If next channel is available, the second packages will be transmitted. The frequency hopping TX/RX sequence will be continuing similar until user releases the TX button or the maximum transmit time of 11 seconds is reached. When all hopping frequencies from the table are used once, transmission will be return back to start channel and start over again as previous time.

If some of the used frequencies are not available, the Hand-Held unit will wait until channel is available (LBT) or it hop to next calculated channel.

If user releases Hand-Held TX button before all frequencies from table are used, the action depends on the frequency band. For EU, AU and NZ, units return to start channel and if user initiates a training command again, start sequence from the start channel again. For FCC/IC, the transmitter will always transmit on every channel in the table before stopping.

The data is sent using GFSK modulation with +/- 1.2 kHz deviation at a data rate of 3000 bps. The RF Power Amplifier provides a signal level of approximately +27dBm CE and FCC/IC, AU and NZ +29dBm. This is followed by a Lowpass Matching Circuit which attenuates harmonics to acceptable levels.

Pairing mode

When user makes new pairing, Hand-Held unit will transmit four data package to the GPS-collar. Data packages have used ID-number for calculating pseudo randomly ordered hopping frequencies of table. Regular user makes new pairing normally only at once and pairing information will stay in EEPROM.

Transmission will happen by using lowest channel of the used frequency band. Time for one package is around 75ms. Before each pairing package has LBT to check that channel is available.

The data is sent using GFSK modulation with +/- 1.2 kHz deviation at a data rate of 3000 bps. The RF Power bias control is off. Provided output power is <1mW (0dBm). This is followed by a Lowpass Matching Circuit which attenuates harmonics to acceptable levels.

Table 1, Sample FCC/IC frequency table

NA

GPS-unit Tx frequency		**Handheld unit Tx frequency**	
Ch	**Frequency (MHz)**	**Ch**	**Frequency (MHz)**
10	915.2625	60	916.5125
12	915.3125	62	916.5625
22	915.5625	72	916.8125
9	915.2375	59	916.4875
24	915.6125	74	916.8625
2	915.0625	52	916.3125
31	915.7875	81	917.0375
26	915.6625	76	916.9125
19	915.4875	69	916.7375
21	915.5375	71	916.7875
18	915.4625	68	916.7125
27	915.6875	77	916.9375
29	915.7375	79	916.9875
36	915.9125	86	917.1625
5	915.1375	55	916.3875
25	915.6375	75	916.8875
46	916.1625	96	917.4125
0	915.0125	50	916.2625
49	916.2375	99	917.4875
20	915.5125	70	916.7625
16	915.4125	66	916.6625
23	915.5875	73	916.8375
14	915.3625	64	916.6125
42	916.0625	92	917.3125
37	915.9375	87	917.1875
40	916.0125	90	917.2625
1	915.0375	51	916.2875
3	915.0875	53	916.3375
4	915.1125	54	916.3625
32	915.8125	82	917.0625
41	916.0375	91	917.2875
39	915.9875	89	917.2375
35	915.8875	85	917.1375
33	915.8375	83	917.0875
11	915.2875	61	916.5375
48	916.2125	98	917.4625
43	916.0875	93	917.3375
15	915.3875	65	916.6375
30	915.7625	80	917.0125
47	916.1875	97	917.4375
13	915.3375	63	916.5875
17	915.4375	67	916.6875
6	915.1625	56	916.4125
44	916.1125	94	917.3625
34	915.8625	84	917.1125
7	915.1875	57	916.4375
28	915.7125	78	916.9625
8	915.2125	58	916.4625
45	916.1375	95	917.3875
38	915.9625	88	917.2125

Table 2, Sample AU frequency table

AU

GPS-unit Tx frequency		Handheld unit Tx frequency	
Ch	Frequency (MHz)	Ch	Frequency (MHz)
7	915.1875	27	915.6875
10	915.2625	30	915.7625
16	915.4125	36	915.9125
8	915.2125	28	915.7125
15	915.3875	35	915.8875
5	915.1375	25	915.6375
1	915.0375	21	915.5375
0	915.0125	20	915.5125
13	915.3375	33	915.8375
11	915.2875	31	915.7875
4	915.1125	24	915.6125
9	915.2375	29	915.7375
18	915.4625	38	915.9625
6	915.1625	26	915.6625
12	915.3125	32	915.8125
19	915.4875	39	915.9875
17	915.4375	37	915.9375
14	915.3625	34	915.8625
3	915.0875	23	915.5875
2	915.0625	22	915.5625

Table 3, Sample NZ frequency table

NZ

GPS-unit Tx frequency		Handheld unit Tx frequency	
Ch	Frequency (MHz)	Ch	Frequency (MHz)
7	866.4375	27	866.9375
10	866.5125	30	867.0125
16	866.6625	36	867.1625
8	866.4625	28	866.9625
15	866.6375	35	867.1375
5	866.3875	25	866.8875
1	866.2875	21	866.7875
0	866.2625	20	866.7625
13	866.5875	33	867.0875
11	866.5375	31	867.0375
4	866.3625	24	866.8625
9	866.4875	29	866.9875
18	866.7125	38	867.2125
6	866.4125	26	866.9125
12	866.5625	32	867.0625
19	866.7375	39	867.2375
17	866.6875	37	867.1875
14	866.6125	34	867.1125
3	866.3375	23	866.8375
2	866.3125	22	866.8125

Table 4, Sample CE frequency table

CE

GPS-unit Tx frequency		Handheld unit Tx frequency	
Ch	Frequency (MHz)	Ch	Frequency (MHz)
1	869.4375	6	869.5625
3	869.4875	8	869.6125
4	869.5125	9	869.6375
0	869.4125	5	869.5375
2	869.4625	7	869.5875

Brian,

Here are explanation for the FCC frequency hopping.

Thanks,
Harri

From: Jason Edwards
Sent: 28. elokuuta 2014 15:32
To: Harri Piltonen
Cc: Randy Wacasey
Subject: RE: Pseudo-random hopping sequence

Both units use these channel tables created with a random number generator and the one used depends on the particular frequency band (FCC=50):

```
/*
// OUTPUT FROM RANDOM PROGRAM

Random 5 Channels:
   1   3   4   0   2

Random 10 Channels:
   2   6   8   3   0   7   9   5   1   4

Random 20 Channels:
   7  10  16   8  15   5   1   0  13  11
   4   9  18   6  12  19  17  14   3   2

Random 50 Channels:
  10  12  22   9  24   2  31  26  19  21
  18  27  29  36   5  25  46   0  49  20
  16  23  14  42  37  40   1   3   4  32
  41  39  35  33  11  48  43  15  30  47
  13  17   6  44  34   7  28   8  45  38
*/
```

The G collar uses transmit windows of 150 ms and the GPS RTC for timing and each window represents a different index into this channel table. If the collar has data to TX it uses the time to get an index and transmits. It also has code to prevent re-using an index until every value in the table has been used.

The HH uses transmit windows of 115 ms to send E data. This one is simpler, it simply goes around the table N number of times.

Both schemes allow the user to set a value (1-5) in a menu that offsets their index for purposes of staggering one system from another.

Jason