DROID TECHNOLOGIES

Revision 1
Author Oleksii Fedorets
Date 2 Nov 2018

Talking Fiber.Rev.1.00
Power consumption Review Report

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Object of report

The document contains review notes for improve schematic Talking Fiber Rev.1.0

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Review Notes

1. The MCU STM32F215RET is low power controller in sleep or standby mode. Use this mode for decrease current consumption when processor waiting for measurement:

Table 23. Typical and maximum current consumptions in Standby mode

Symbol	Parameter	Conditions	Typ			Max(1)		Unit
			T_A = 25 °C			T_A = 85 °C	T_A = 105 °C	
			V_{DD} = 1.8 V	V_{DD}= 2.4 V	V_{DD} = 3.3 V	V_{DD} = 3.6 V		
I_{DD_STBY}	Supply current in Standby mode	Backup SRAM ON, low-speed oscillator and RTC ON	3.0	3.4	4.0	15.1	25.8	µA
		Backup SRAM OFF, low-speed oscillator and RTC ON	2.4	2.7	3.3	12.4	20.5	
		Backup SRAM ON, RTC OFF	2.4	2.6	3.0	12.5	24.8	
		Backup SRAM OFF, RTC OFF	1.7	1.9	2.2	9.8	19.2	

1. Guaranteed by characterization results, not tested in production.

Table 21. Typical and maximum current consumption in Sleep mode

Symbol	Parameter	Conditions	f_{HCLK}	Typ	Max(1)		Unit
				T_A = 25 °C	T_A = 85 °C	T_A = 105 °C	
I_{DD}	Supply current in Sleep mode	External clock(2), all peripherals enabled(3)	120 MHz	38	51	61	mA
			90 MHz	30	43	53	
			60 MHz	20	33	43	
			30 MHz	11	25	35	
			25 MHz	8	21	31	
			16 MHz	6	19	29	
			8 MHz	3.6	17.0	27.0	
			4 MHz	2.4	15.4	25.3	
			2 MHz	1.9	14.9	24.7	
		External clock(2), all peripherals disabled	120 MHz	8	21	31	
			90 MHz	7	20	30	
			60 MHz	5	18	28	
			30 MHz	3.5	16.0	26.0	
			25 MHz	2.5	16.0	25.0	
			16 MHz	2.1	15.1	25.0	
			8 MHz	1.7	15.0	25.0	
			4 MHz	1.5	14.6	24.6	
			2 MHz	1.4	14.2	24.3	

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But in RUN and STOP mode current consumption a lot:

Table 20. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory (ART accelerator disabled)

Symbol	Parameter	Conditions	f_{HCLK}	Typ	Max(1)		Unit
				T_A = 25 °C	T_A = 85 °C	T_A = 105 °C	
I_{DD}	Supply current in Run mode	External clock(2), all peripherals enabled(3)	120 MHz	61	81	93	mA
			90 MHz	48	68	80	
			60 MHz	33	53	65	
			30 MHz	18	38	50	
			25 MHz	14	34	46	
			16 MHz(4)	10	30	42	
			8 MHz	6	26	38	
			4 MHz	4	24	36	
			2 MHz	3	23	35	
		External clock(2), all peripherals disabled	120 MHz	33	54	66	
			90 MHz	27	47	59	
			60 MHz	19	39	51	
			30 MHz	11	31	43	
			25 MHz	8	28	41	
			16 MHz(4)	6	26	38	
			8 MHz	4	24	36	
			4 MHz	3	23	35	
			2 MHz	2	23	34	

Table 22. Typical and maximum current consumptions in Stop mode

Symbol	Parameter	Conditions	Typ	Max			Unit
			T_A = 25 °C	T_A = 25 °C	T_A = 85 °C	T_A = 105 °C	
I_{DD_STOP}	Supply current in Stop mode with main regulator in Run mode	Flash in Stop mode, low-speed and high-speed internal RC oscillators and high-speed oscillator OFF (no independent watchdog)	0.55	1.2	11.00	20.00	mA
		Flash in Deep power down mode, low-speed and high-speed internal RC oscillators and high-speed oscillator OFF (no independent watchdog)	0.50	1.2	11.00	20.00	
	Supply current in Stop mode with main regulator in Low-power mode	Flash in Stop mode, low-speed and high-speed internal RC oscillators and high-speed oscillator OFF (no independent watchdog)	0.35	1.1	8.00	15.00	
		Flash in Deep power down mode, low-speed and high-speed internal RC oscillators and high-speed oscillator OFF (no independent watchdog)	0.30	1.1	8.00	15.00	

For decrease these parameters use low power microcontroller. For example STM32L151xE has these parameters in 5-10 times less:

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Table 17. Current consumption in Run mode, code with data processing running from Flash

Symbol	Parameter	Conditions		f_{HCLK}	Typ	Max(1)	Unit
I_{DD} (Run from Flash)	Supply current in Run mode, code executed from Flash	f_{HSE} = f_{HCLK} up to 16 MHz included, f_{HSE} = f_{HCLK}/2 above 16 MHz (PLL ON)(2)	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	1 MHz	225	500	µA
				2 MHz	420	750	
				4 MHz	780	1200	
			Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	4 MHz	0.98	1.6	mA
				8 MHz	1.85	2.9	
				16 MHz	3.6	5.2	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	8 MHz	2.2	3.5	
				16 MHz	4.4	6.5	
				32 MHz	8.6	12	
		HSI clock source (16 MHz)	Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	16 MHz	3.6	5.2	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	32 MHz	8.7	12.3	
		MSI clock, 65 kHz	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	65 kHz	42	145	µA
		MSI clock, 524 kHz		524 kHz	135	250	
		MSI clock, 4.2 MHz		4.2 MHz	820	1200	

Table 19. Current consumption in Sleep mode

Symbol	Parameter	Conditions		f_{HCLK}	Typ	Max(1)	Unit
I_{DD} (Sleep)	Supply current in Sleep mode, Flash OFF	f_{HSE} = f_{HCLK} up to 16 MHz included, f_{HSE} = f_{HCLK}/2 above 16 MHz (PLL ON)(2)	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	1 MHz	51	220	µA
				2 MHz	81	300	
				4 MHz	140	380	
			Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	4 MHz	175	500	
				8 MHz	330	700	
				16 MHz	625	1100	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	8 MHz	395	800	
				16 MHz	760	1250	
				32 MHz	1700	2700	
		HSI clock source (16 MHz)	Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	16 MHz	670	1100	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	32 MHz	1750	2700	
		MSI clock, 65 kHz	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	65 kHz	19	92	
		MSI clock, 524 kHz		524 kHz	33	110	
		MSI clock, 4.2 MHz		4.2 MHz	150	273	
	Supply current in Sleep mode, Flash ON	f_{HSE} = f_{HCLK} up to 16 MHz included, f_{HSE} = f_{HCLK}/2 above 16 MHz (PLL ON)(2)	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	1 MHz	63	250	
				2 MHz	93	300	
				4 MHz	155	380	
			Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	4 MHz	190	500	
				8 MHz	340	700	
				16 MHz	640	1120	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	8 MHz	410	800	
				16 MHz	770	1300	
				32 MHz	1750	2700	
		HSI clock source (16 MHz)	Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	16 MHz	690	1160	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	32 MHz	1750	2800	
	Supply current in Sleep mode, Flash ON	MSI clock, 65 kHz	Range 3, V_{CORE}=1.2V VOS[1:0] = 11	65 kHz	31	105	
		MSI clock, 524 kHz		524 kHz	45	125	
		MSI clock, 4.2 MHz		4.2 MHz	160	290	

And this controller has LOW-POWER RUN mode:

Table 20. Current consumption in Low-power run mode

Symbol	Parameter	Conditions			Typ	Max(1)	Unit
$I_{DD\ (LP\ Run)}$	Supply current in Low-power run mode	All peripherals OFF, code executed from RAM, Flash switched OFF, V_{DD} from 1.65 V to 3.6 V	MSI clock, 65 kHz f_{HCLK} = 32 kHz	T_A = -40 °C to 25 °C	11	16	µA
				T_A = 85 °C	36.2	40	
				T_A = 105 °C	65.4	102	
			MSI clock, 65 kHz f_{HCLK} = 65 kHz	T_A =-40 °C to 25 °C	16.5	23	
				T_A = 85 °C	41.9	48	
				T_A = 105 °C	72.1	108	
			MSI clock, 131 kHz f_{HCLK} = 131 kHz	T_A = -40 °C to 25 °C	30	45	
				T_A = 55 °C	36.1	48	
				T_A = 85 °C	55.7	66	
				T_A = 105 °C	86.6	125	
		All peripherals OFF, code executed from Flash, V_{DD} from 1.65 V to 3.6 V	MSI clock, 65 kHz f_{HCLK} = 32 kHz	T_A = -40 °C to 25 °C	26	40.5	
				T_A = 85 °C	53.2	67	
				T_A = 105 °C	92.1	120	
			MSI clock, 65 kHz f_{HCLK} = 65 kHz	T_A = -40 °C to 25 °C	33	49	
				T_A = 85 °C	60.2	75	
				T_A = 105 °C	95.6	130	
			MSI clock, 131 kHz f_{HCLK} = 131 kHz	T_A = -40 °C to 25 °C	48.5	71	
				T_A = 55 °C	54.7	75	
				T_A = 85 °C	76.1	95	
				T_A = 105 °C	112	140	
I_{DD} max (LP Run)	Max allowed current in Low-power run mode	V_{DD} from 1.65 V to 3.6 V	-	-	-	200	

2. Why operation amplifier is 500 MHz max operation frequency? The ADC in microcontroller can't make more that 6MSPS (6MHz). And signal from photodiode around tens kHz. In this case, it is possible put low power operational amplifier (TLV2701–7uA, MAX40006—4.5uA).
3. AFBR-2310Z (Fiber-Optic Receiver for Multi GHz Analog Links) cannot consume less than 40mA, consequently these part can't be improve for decrease current consumption. Turn ON it only when measuring.
4. Based on theoretical data, it is possible to consume about 0.5 -1 mA / h (normalized by time). The STM32F215RET should be in standby mode and wake up for measurement. On the diagram below shown average battery discharge current (red line).

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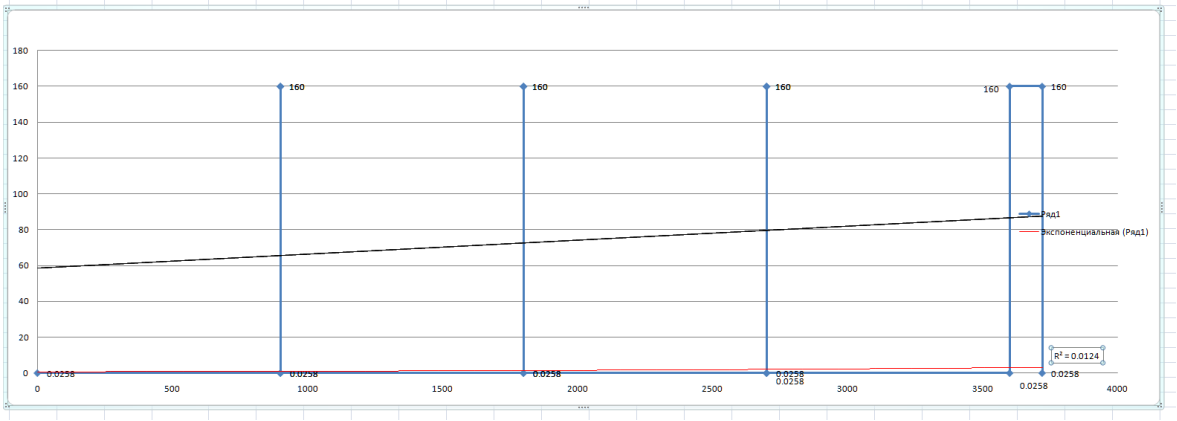
time	s		0min	15min			30min				45min				60min			
			0	899.99	900	900.44	900.45	1800.43	1800.44	1800.87	1800.88	2700.87	2700.88	2701.31	2701.32	3601.31	3601.32	3721.75	3721.76
Current of controller in standby mode	mA	0.0258	0.0258	0.0258	0	0	0.0258	0.0258	0	0	0.0258	0.0258	0	0	0.0258	0.0258	0	0	0.0258
Current of controller in RUN mode	mA	20	0	0	20	20	0	0	20	20	0	0	20	20	0	0	20	20	0
Current of photosensor	mA	40	0	0	40	40	0	0	40	40	0	0	40	40	0	0	40	40	0
Current of operational amplifier	mA	40	0	0	40	40	0	0	40	40	0	0	40	40	0	0	40	40	0
Current of modem	mA	60	0	0	60	60	0	0	60	60	0	0	60	60	0	0	60	60	0
Total current	mA		0.0258	0.0258	160	160	0.0258	0.0258	160	160	0.0258	0.0258	160	160	0.0258	0.0258	160	160	0.0258

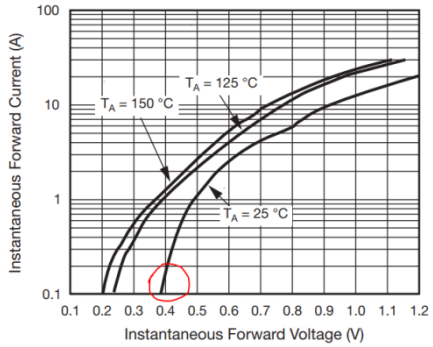


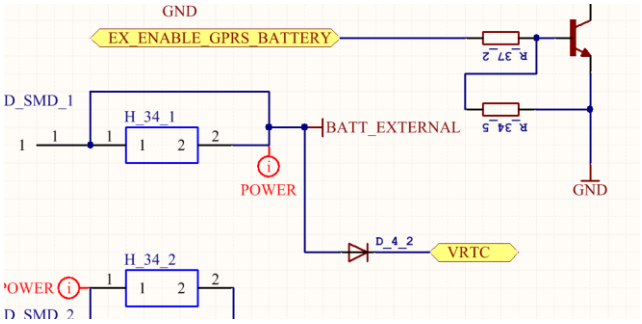
5. When battery is discharge around 3.3V, the buck converter pass this voltage directly to load. This can cause the entire system to crash. For solve this problem should be use buck-boost converters with low quiescent current and power save mode. Example TPS63805.

6. Q_10_2 scheme is unnecessarily, because module M95 can be turn off by the software and pulse on PWRKEY

7. Module M95 required 3.4V minimum and 4V nominal power. It is recommend use Buck-boost converter for power this module.

8. D_4_2 has drop forward voltage 0.4V. When battery full (around 4.2V) VRTC will be 3.8V. it is a lot for STM32F215RET.





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Conclusion

On the basis of theoretical data, it is possible to obtain a current consumption of 0.2 - 1 mA/h. To achieve this goal it is necessary improve schematic and software.