

Author	:	Thom van der Klis
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Ridder SmartDrive -- nRF52840 operational description

1. Introduction

Ridder SmartDrive is equipped with the Nordic Semiconductor nRF52840 Bluetooth 2.4 GHz transceiver, which is programmed for Bluetooth Low Energy configuration.

The Nordic Semiconductor nRF52840 is built around the 32-bit ARM® Cortex™-M4 CPU featuring a 2.4 GHz Transceiver, 2 Mbps, 1 Mbps, Long Range, Bluetooth Low Energy, Bluetooth mesh.

2. Technical description

- Bluetooth® 5, IEEE 802.15.4-2006, 2.4 GHz transceiver:
 - -95 dBm sensitivity in 1 Mbps Bluetooth low energy mode
 - -103 dBm sensitivity in 125 kbps Bluetooth® low energy mode (long range)
 - -20 to +8 dBm TX power, configurable in 4 dB steps
- Supported data rates:
 - Bluetooth®5: 2 Mbps, 1 Mbps, 500 kbps, and 125 kbps
- Temperature and voltage ranges:

Symbol	Parameter	Notes	Min.	Nom.	Max.	Units
VDD	VDD supply voltage, independent of DCDC enable		1.7	3.0	3.6	V
VDD _{POR}	VDD supply voltage needed during power-on reset		1.75			V
VDDH	VDDH supply voltage, independent of DCDC enable		2.5	3.7	5.5	V
VBUS	VBUS USB supply voltage		4.35	5	5.5	V
t _{R_VDD}	Supply rise time (0 V to 1.7 V)				60	ms
t _{R_VDDH}	Supply rise time (0 V to 3.7 V)				100	ms
TA	Operating temperature		-40	25	85	°C

Figure 1: Temperature and voltage ranges

2.1. Frequencies, channels

2.1.1. Programmed channel map

The programmed channel map in the nRF52840 is set to Default 2400 – 2500 MHz in order to choose the standard BLE-channels.

Address offset: 0x508

Frequency

Bit number				31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0																															
ID				B A A A A A A A																															
Reset 0x00000002				0 1 0																															
ID	Accs	Field	Value ID	Value	Description																														
A	RW	FREQUENCY		[0..100]	Radio channel frequency																														
					Frequency = 2400 + FREQUENCY (MHz).																														
B	RW	MAP			Channel map selection.																														
			Default	0	Channel map between 2400 MHz .. 2500 MHz																														
			Low	1	Channel map between 2360 MHz .. 2460 MHz																														
					Frequency = 2360 + FREQUENCY (MHz)																														

Figure 2: default channel map

2.1.2. Used channels

The used channels in the Ridder SmartDrive application are located in the 2.4GHz ISM band and are limited to the Bluetooth Low Energy channels 0 to 39, frequencies between 2402 MHz and 2480 MHz:

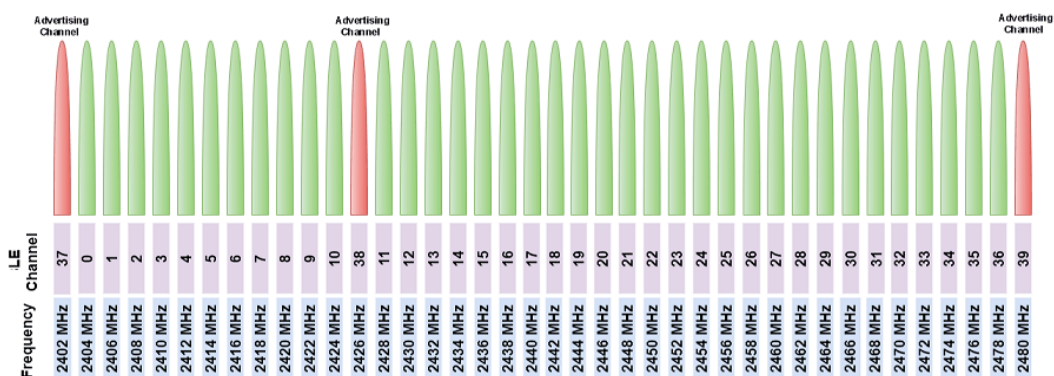


Figure 3: BLE channels used by the SmartDrive application

2.2. Supported bandwidths and data rate

The configured data rate and mode is 1 Mbit/s BLE

Address offset: 0x510

Data rate and modulation

Bit number				31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0				
ID																																				A	A	A	A
Reset 0x00000000				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
ID	Acces Field	Value ID	Value	Description																																			
A	RW	MODE		Radio data rate and modulation setting. The radio supports frequency-shift keying (FSK) modulation.																																			
		Nrf_1Mbit	0	1 Mbit/s Nordic proprietary radio mode																																			
		Nrf_2Mbit	1	2 Mbit/s Nordic proprietary radio mode																																			
		Ble_1Mbit	3	1 Mbit/s BLE																																			
		Ble_2Mbit	4	2 Mbit/s BLE																																			
		Ble_LR125Kbit	5	Long range 125 kbit/s TX, 125 kbit/s and 500 kbit/s RX																																			
		Ble_LR500Kbit	6	Long range 500 kbit/s TX, 125 kbit/s and 500 kbit/s RX																																			
		ieee802154_250Kbit	15	IEEE 802.15.4-2006 250 kbit/s																																			

Figure 4: configured BLE mode

Resulting frequency deviation is ± 250 kHz:

Symbol	Description	Min.	Typ.	Max.	Units
f_{OP}	Operating frequencies	2360		2500	MHz
$f_{PLL,CH,SP}$	PLL channel spacing		1		MHz
$f_{DELTA,1M}$	Frequency deviation @ 1 Mbps		± 170		kHz
$f_{DELTA,BLE,1M}$	Frequency deviation @ BLE 1 Mbps		± 250		kHz
$f_{DELTA,2M}$	Frequency deviation @ 2 Mbps		± 320		kHz
$f_{DELTA,BLE,2M}$	Frequency deviation @ BLE 2 Mbps		± 500		kHz
f_{skBPS}	On-the-air data rate	125		2000	kbps
$f_{chip, IEEE 802.15.4}$	Chip rate in IEEE 802.15.4 mode		2000		kchip/s

Figure 5: resulting frequency deviation

2.3. Power levels

Power level of the nRF52840 SoC in the SmartDrive application is set to 0 dBm, while a 3dB attenuator on the PCBA further reduces the transmit power to -3dBm.

Bit number		31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0																														
ID		A A																														
Reset 0x00000000		0 0																														
ID	Accs Field	Value ID		Value		Description																										
A	RW	TXPOWER				RADIO output power																										
						Output power in number of dBm, i.e. if the value -20 is specified the output power will be set to -20dBm.																										
		Pos8dBm		0x8		+8 dBm																										
		Pos7dBm		0x7		+7 dBm																										
		Pos6dBm		0x6		+6 dBm																										
		Pos5dBm		0x5		+5 dBm																										
		Pos4dBm		0x4		+4 dBm																										
		Pos3dBm		0x3		+3 dBm																										
		Pos2dBm		0x2		+2 dBm																										
		0dBm		0x0		0 dBm																										
		Neg4dBm		0xFC		-4 dBm																										
		Neg8dBm		0xF8		-8 dBm																										

Figure 6: programmed power level in the application is 0dBm

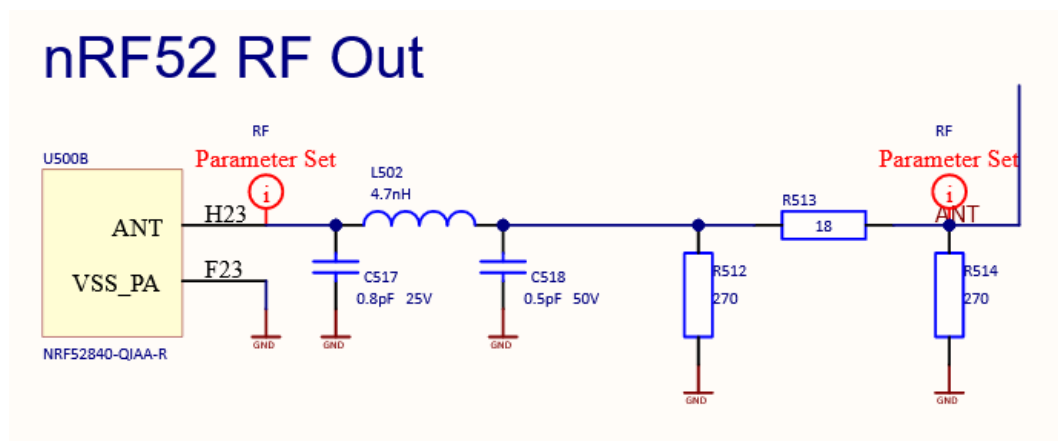
2.4. Antenna information

The antenna is a quarter wavelength monopole, and was taken over from nrf52840-development-kit---hardware-files-3_0_0 that can be found on the Nordic Semiconductor website.

The antenna was tuned to the frequency 2440 MHz during the design work.

The transmission line contains a Pi-configuration low pass filter around L502 and a 3dB attenuator for matching purposes with R512, R513, R514.

2.4.1. Schematic implementation



2.4.2. Physical implementation

