

Author	:	Thom van der Klis
Date	:	21-3-2023
Version	:	V1.0

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
V _{BUS}	V _{BUS} 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	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
Reset 0x00000002	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	1	0	
ID	Acc Field	Value ID	Value	Description																												
A	RW FREQUENCY	[0..100]	Radio channel frequency																													
			Frequency = 2400 + FREQUENCY (MHz).																													
B	RW MAP	Default	0	Channel map selection.																												
				Frequency = 2400 + FREQUENCY (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:

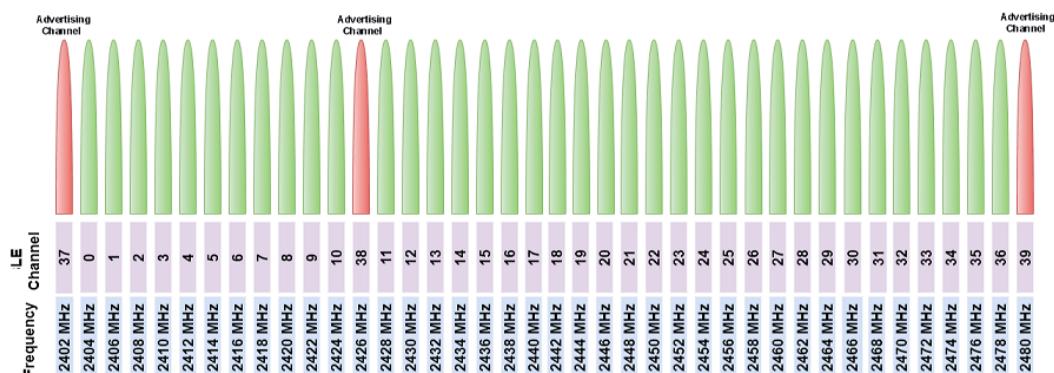


Figure 3: BLE channels used by the SmartDrive application

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	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	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		
ID	Acce	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	2500	MHz
$f_{PLL,CH,SP}$	PLL channel spacing		1	1	MHz
$f_{\Delta,1M}$	Frequency deviation @ 1 Mbps		± 170	± 170	kHz
$f_{\Delta,BLE,1M}$	Frequency deviation @ BLE 1 Mbps		± 250	± 250	kHz
$f_{\Delta,2M}$	Frequency deviation @ 2 Mbps		± 320	± 320	kHz
$f_{\Delta,BLE,2M}$	Frequency deviation @ BLE 2 Mbps		± 500	± 500	kHz
$f_{\text{fsk},\text{bps}}$	On-the-air data rate	125	2000	2000	kbps
$f_{\text{chip},\text{IEEE 802.15.4}}$	Chip rate in IEEE 802.15.4 mode		2000	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	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		
ID	Acc 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

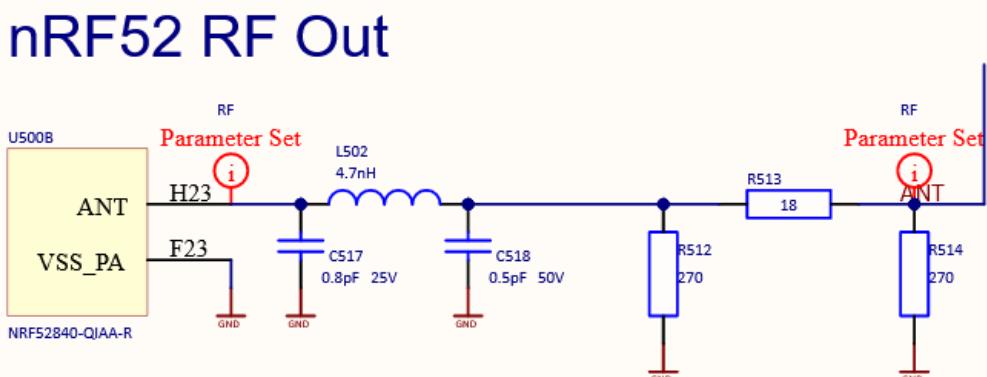
2.4. Antenna information

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

