nRF Connect *Bluetooth[®]* low energy

User Guide



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Revision history

Date	Version	Description
June 2018	2.2	Added support for nRF52840 Dongle PCA10059
February 2018	2.1	Server setup can be applied multiple times with adapter reset
July 2017	2.0	 Application ported to new framework Added support for multiple custom properties in advertisement data Added support for Buttonless DFU Service
January 2017	1.1	Added Secure DFUAdded support for nRF52 Development Kit PCA10056
July 2016	1.0	First release



1 nRF Connect *Bluetooth* low energy

nRF Connect *Bluetooth*[®] low energy is an app for the nRF Connect desktop application for getting familiar with, developing, and testing *Bluetooth* low energy devices. It allows you to set up a local device, connect it to advertising devices and discover their services, maintain the connection and the connection parameters, pair the devices, and change the server setup for your local device. It also offers a detailed log for troubleshooting purposes.

Supported devices

- PCA10056 nRF52 Development Kit
- PCA10040 nRF52 Development Kit
- PCA10059 nRF52 USB Dongle
- PCA10028 nRF51 Development Kit
- PCA10031 nRF51 Dongle

Supported operating systems

- Microsoft Windows 7, 8, and 10
- OS X 10.10 and above
- Ubuntu Linux 14.04, 16.04, and 18.04



2 Installing nRF Connect *Bluetooth* low energy

This section describes the installation procedure for the nRF Connect *Bluetooth* low energy app.

To install the app, you need to have the nRF Connect desktop application installed.

After installing nRF Connect, you can install the nRF Connect *Bluetooth* low energy app:

- 1. Open nRF Connect.
- 2. Click Add/remove apps.
- 3. Click Install next to Bluetooth low energy.

After starting the nRF Connect *Bluetooth* low energy app, a window consisting of the following main elements is displayed:

- Main view in the center: Initially empty, but will be populated with local and remote *Bluetooth* low energy devices
- Navigation bar at the top: Selecting device and application screen
- Three-dash button on the top-left corner of the navigation bar: Opening the nRF Connect app manager
- Discovered devices view on the right side: Starting scan and viewing discovered devices
- Log view at the bottom: Viewing the most important log events tagged with a timestamp



Figure 1: Application window



Establishing serial port connection to a local device

The nRF Connect *Bluetooth* low energy app requires a serial port connection to a local development kit or dongle. The nRF SoC (System on Chip) on the device is controlled by the app which sends serialized commands to it over a serial port.

To set up a local device, complete the following steps:

- 1. Connect a development kit or dongle to the computer with USB.
- 2. In the navigation bar, click on the Select device menu.
- 3. Select a device by clicking on its name in the drop-down list.

When the serial port is selected, the Select device menu shows the name of the selected port.

If the device has not been used with the nRF Connect *Bluetooth* low energy app before, you may be asked to update the J-Link firmware and connectivity firmware for the device. You need to have the correct connectivity firmware on the nRF SoC to continue. When the nRF SoC has been programmed with the correct firmware, the nRF Connect *Bluetooth* low energy app proceeds to connect to it over UART. When the connection is established, the device appears in the main view.

Important: When using OS X, an issue with the SEGGER J-Link OB firmware leads to the corruption of long packets over UART. See www.nordicsemi.com/nRFConnectOSXfix for more information.

InRF Connect v2.0.0 - Bluetooth low energy	– 🗆 X
E 000660653905 - Connection Map - Server Setup	NORDIC
nRF5x 07254600.08418 Generic Access Generic Attribute	Discovered devices
Log Can started Can started Can stopped Ca	

Figure 2: Local device view



The local device is labeled "adapter" to signal that it is connected locally to the computer. The device name and *Bluetooth* device address are shown at the top. The attribute table of the device is shown below them.

To expand a menu that shows actions and configurations available for the local device, click the **Device** options icon **\$**.



4 Establishing *Bluetooth* low energy connections

The nRF Connect *Bluetooth* low energy app can establish and maintain up to eight simultaneous *Bluetooth* low energy connections.

To connect to devices, complete the following steps:

1. To scan for nearby *Bluetooth* devices, click the Start scan button in the Discovered devices view.

The advertising devices start to appear in a list in the Discovered devices view. Each entry in the list shows the name, address, and RSSI of the received advertising packet. For information on how to set up advertising for a device, see Setting up advertising on page 16.

To view the advertising type and data fields of a packet, select the packet entry in the list.

To sort the list according to signal strength and thus according to which device is closest, click **Options** and select **Sort by signal strength**.

2. To establish a *Bluetooth* connection with a peer device, click the **Connect** button associated with the device.



Figure 3: Discovered services

When the connection has been established, a new device appears in the main view to the right of the local device. The nRF Connect *Bluetooth* low energy app automatically performs an initial service discovery. The discovered services are listed below the connected device. Attributes that are known to the application are shown by their name. Attributes that are unknown to the application are shown by their UUID only. For information on how to add UUID definitions, see Adding UUID definitions on page 20.



A line connects the local and remote device signaling that they are connected over *Bluetooth*. To open a connection info dialog displaying the parameters of the connection, encryption, and bond state, hover the mouse pointer over the padlock icon.

nRF Connect v2.0.0 - Bluete	ooth low energy	– o ×
■ 00068065390	05 - ●	NORDIC
D7-25-46:00.04:1	Connection Interval 400 ms Slave latency 0 ms Timeout 4000 ms Si Not bonded	Discovered devices Start scan Clear Options Soft by signal strength
Generic Attribute	Unencrypted link Part Bate Measurement notsy 04 E8 Body Sensor Location read o3 Battery Service Device Information v	Filter: HRM Nordic_HRM F3.E1:88:11:10:72 Connect C Totals Address type: RandomStalic Services: Heart Rate Battery Service Device Information 0: 41-03
Log 11.04.17.2470 Attr 11.04.18.2490 Attr 11:04:19.2510 Attr 11:04:19.4970 Cor 11:04:20.3040 Attr 11:04:21.4990 Attr 11:04:21.5140 Attr	Incure value changed, handle: 0x10, value (0x): 00-00 incure value changed, handle: 0x10, value (0x): 14-02-1D-01-1E-01-1F-01-20-01-21-01-22-01-23-01-24-01 incure value changed, handle: 0x10, value (0x): 14-0C-33-01-34-01-35-01-36-01-37-01-38-01-39-01-3A-01 innection parameters updated for device F3:E1:B8:11:1D:72: Interval 400ms, timeout 4000ms, latency: 0 incure value changed, handle: 0x10, value (0x): 04-E6 incure value changed, handle: 0x11, value (0x): 00-00 incure value written, handle: 0x11, value (0x): 00-00	*

Figure 4: Hovering over the padlock icon



5 Viewing service details

The nRF Connect *Bluetooth* low energy app can discover and display services, characteristics, and descriptors of a connected peer device's attribute table.

Ξ C6E0ED67BA51 - □ Cor	nection Map 😑 Server Setup	NORDIC
RF5x Adapter OSEDED:67:8A:51 Generic Access Generic Attribute	ImRF5x Pergebensi D9:E7:E0:EF:D5:86 Ceneric Access • Generic Access Ceneric Actitioute • Generic Attribute Ceneric Attribute • Heart Rate Ceneric Attribute • Heart Rate Measurement Ceneric • Ceneric Characteristic Configuration Co co	Discovered devices Start scan Clear Cotions Soft by signal strength Filter: HRM Nordic_HRM DR:E7:E0:EF:D5:86 Consect @ Details
Log 09:28:22:5260 Scan stopped 09:28:25:560 Scan stopped 09:28:25:3580 Scan stopped 09:28:45:9270 Scan started 09:28:56:3990 Connecting to device 09:28:56:4310 Connected to device D9 09:28:56:6780 Attribute value read, har	E7:E0:EF:D5:86 idle: 0x03, value (0x): 6E-52-46-35-78	

Figure 5: Service details

• To view the handle and UUID of an attribute, move the mouse pointer over the attribute name.

A hover text is displayed.

• To view the characteristics of a service, click the Expand/collapse icon .

The characteristics have different buttons available depending on the associated properties. Read, write, and notify actions are available if the corresponding properties are available for the characteristic.

- To view descriptors, expand the characteristics.
- To configure the peer device to start sending notifications, click the Toggle notifications icon **D**.

When a device receives a notification, the corresponding attribute is highlighted and its value is updated.

If a service or characteristic does not have any child attributes, the list is empty when you click the **Expand/collapse** icon *****.



6 Updating connection parameters

In a connection, you can request new connection parameters and respond to an incoming connection parameter update request.

To define connection parameters, complete the following steps:

- 1. To view device options for the connected device, click the **Device options** icon 🌣.
- 2. To open the Connection update dialog, click Update connection....

= c	20M3 -	Events and actions	Server Sehin		
D nRF5x	10:84.1E	Connection update F3/E1/86/11:10/72	Connection parameters u F3:E1:B8:11:1	update for device ID:72	Start scan Clear Options
Generic Acces			Connection Interval (ms) Slave latency	20	Sort by signal strength ar. HRM rdic_HRM
Generic Attribu	•		Connection supervision timeout (ms)	4000 Update Cancel	158-11:10.72 Connect of etails Idress type: RandomStatic reices: Heart Rate Battery Service vice Information
		Device Informat	non	Close	
Log					
Log	Autour	nue changeu, hanue. 0811, Value	: (ux) uu-uu		
Log 11.04.21.4350 11:04.21.5140	Autobale va Attribute va	sue changeu, nanue, 0X11, value slue written, handle: 0X11, value (i	r (ux)uu-uu 0x): 00-00		
Log 11.04.21.4550 11.04.21.5140 11.06:14.7020	Attribute vi Attribute vi Disconnect	ave changed, narrole. 0x11, value alue written, handle: 0x11, value (ted from device F3.E1.88-11.1D:7	r (ux). 00-00 0x): 00-00 2. reason: BLE_HCI_LOCAL_HOST_TERMI	NATED_CONNECTIC	
Log 11.04.21.4590 11.04.21.5140 11.06:14.7020 11.06:17.1180	Attribute vi Attribute vi Disconnecting	aue changeu, nanue: oxi i , varue alue written, handle: 0x11, value (led from device F3:E1:86:11:10:7 g to device	: (ux). 00-00 0x): 00-00 2, reason: BLE_HCI_LOCAL_HOST_TERMI		
Log 11.04.21.4590 11.04.21.5140 11.06.14.7020 11.06.17.1180 11.06.17.7900	Attribute vi Attribute vi Disconnecting Connected	aue changeu, nanue. ox m, value alue written, handle: 0x11, value (i ted from device F3.E1:86:11:1D.7 j to device 1 to device F3.E1:88:11:1D.72	: (UX)UU-UU OX): 00-00 2, reason: BLE_HCI_LOCAL_HOST_TERMI	NATED_CONNECTIC	
Log 11.04.21.4550 11.04.21.5140 11.06.14.7020 11.06.17.180 11.06.17.8210	Attribute vi Attribute vi Disconnecting Connected ATT MTU (alue Changeu, hanole: ux F, value alue written, handle: 0x11, value (r ted from device F3: E1:88:11:10:7 1 to device 1 to device 53: E1:88:11:10:72 changed, new value is 158	: (UX): 00-00 0X): 00-00 2, reason: BLE_HCI_LOCAL_HOST_TERMI	NATED_CONNECTIC	

- **3.** Set the desired parameters in the dialog, then click **Update**.
- 4. To close the Connection update dialog, click Close.

There are two main options for responding to update requests: Letting the nRF Connect *Bluetooth* low energy app accept the request automatically (default) or responding to the request manually.

To select the responding option, complete the following steps:

- 1. Click the local **Device options** icon 🌣.
- 2. Select or deselect Auto accept update requests.



7 Pairing devices

Pairing is the process of exchanging security keys and establishing an encrypted link. The level of security is configurable, and it ranges from an unencrypted link with no security to an encrypted link with authentication and protection against man-in-the-middle attacks.

To pair with a connected device, complete the following steps:

- 1. To view device options for the connected device, click the **Device options** icon 🌣.
- 2. To open the Pairing dialog, click Pair....

nRF Connect v2.0.0	0 - Bluetooth low e	nergy			- 0 ×
= c	COM3 -	Events and actions	Server Setun		
nRF5x	00.84.1E	Pairing F3.E1.88.11.10.72	U	ser initiated pairing	Scovered devices Startscan Clear
			IO capabilities	Keyboard and display -	Options Sort by signal strength
Generic Access Generic Attribut	s Ae		Authentication	Enable LE Secure Connection pairing	rr HRM rdic_HRM al
				Enable MITM protection	tais
				Enable OOB data	idress type: RandomStatic
			Keypress notifications	Enable keypress notifications	rvices: Heart Rate Battery Service vice Information 45-03
			Bonding	Perform bonding	
				Pair Cancel	_
Log	_			Close	
11.04.21.4390					
11:04:21.5140	Attribute va	lue written, handle: 0x11, value (0x	: 00-00		
11:06:14.7020	Disconnect	ed from device F3:E1:B8:11:1D:72,	reason: BLE_HCI_LOCAL	_HOST_TERMINATED_CONNECTIC	
11:06:17.1180	Connecting	to device			
11:06:17.7900	Connected	to device F3.E1:88:11:1D:72			
11:06:17.8210	ATT MTU c	hanged, new value is 158			
11:06:18.1680	Attribute va	lue read, handle: 0x03, value (0x):	4E-6F-72-64-69-63-5F-48	-52-4D 👻	
4					

3. Set the desired parameters in the dialog, then click Pair.

Depending on the chosen security parameters, an additional dialog may be shown for passkey, out-ofband data, or numerical comparison input.

4. To close the Pairing dialog, click Close.

When the pairing procedure has been completed, the following changes are displayed:

- A log entry shows the new security level of the connection.
- The connection info padlock changes to locked if the connection is encrypted.
- The event view text turns green to indicate success.

Bonding can also be established, which means you can create and exchange long-term keys that are used for reestablishing an encrypted link without having to go through the pairing process.

The nRF Connect *Bluetooth* low energy app can reply automatically to an incoming pairing request by default, or it can be handled by the user.

To select the reply option for pairing requests, complete the following steps:

- 1. Click the local **Device options** icon 🌣.
- 2. Select or deselect Auto reply security requests.



When Auto reply security requests is selected, the nRF Connect *Bluetooth* low energy app uses the settings specified in Security parameters when automatically replying to the request.

To edit security parameters, complete the following steps:

- 1. Click the local **Device options** icon 🌣.
- 2. To open the Security parameters dialog, click Security parameters.
- **3.** Click **Apply** when done.

Important:

- Bonding is supported, but the keys are not retained across application restarts.
- Address resolving is currently not supported. Therefore, using keys from a bond after the device has changed address will most likely fail.



8 Configuring server setup

The nRF Connect *Bluetooth* low energy app supports the configuration of the local device's GATT (Generic Attribute profile) attribute table, also known as server setup. Adding attributes to the server setup allows the local device to exchange data with a connected peer device.

The default server setup consists of two mandatory services: GATT and GAP (Generic Access Profile). These services can be modified, but they cannot be removed, and you cannot extend them with more characteristics or descriptors.

To add new attributes to the server setup, complete the following steps:

1. In the navigation bar, click the Server setup button.

Initially, the default server setup that is displayed contains only GAP and GATT services.

- 2. Click New service.
- **3.** Select the service you just added.
 - A form is displayed.
- 4. Define the attribute values, then click Save.
- 5. To add a new characteristic, expand the added New Service, then click New characteristic.
- 6. Select the characteristic you just added.

A form is displayed.

7. Define the attribute values, then click Save.

Important: When adding a notify or indicate property on a characteristic, you need to add a Client Characteristic Configuration Descriptor (CCCD) for that characteristic.

- 8. To add a new descriptor, expand the added New Characteristic, then click New descriptor.
- **9.** Select the descriptor you just added.

A form is displayed.

- 10. Define the attribute values, then click Save.
- **11.** When you have completed the server setup, click **Apply to device** to upload the setup to the local device.



nRF5x Adapter D725.4600.84.1E	Descriptor UUID	2902	٧Q	Start scan Clear Cotions
Generic Access	Descriptor name Initial value	Client Characteristic Configuration		
Generic Attribute	Read	No security required		
Heart Rate Measurement	permission Write	No security required	•	
Client Characteristic Configuration O New descriptor	permission Max length	Fixed length		
New characteristic New service	[20		
Clear Apply to device		X Delete Save		
3 12:36.5500 Server setup was applied	1		0 • 1	l

Figure 6: Server setup

To save a server setup to file for later use, complete the following steps:

- 1. Click the local **Device options** icon 🌣.
- 2. Click Save setup....
- 3. Choose a directory and type a file name, then click Save.

To load a previously saved server setup from file, complete the following steps:

- 1. Click the local **Device options** icon 🌣.
- 2. Click Load setup....
- 3. Navigate to the right directory and select the file, then click **Open**.

Important: If you remove or overwrite a setup from the device, you need to reset and reopen it. When prompted, confirm the reset.

After the setup has been applied to the device, you can view the resulting setup by clicking the **Connection map** button in the navigation bar. The new setup is reflected in the local device.



9 Setting up advertising

The nRF Connect *Bluetooth* low energy app enables the local device to operate as a peripheral that can send connectable advertising packets. The contents of the advertising packets can be configured in the advertising setup.

To start sending advertising packets, complete the following steps:

- 1. Click the local **Device options** icon 🌣.
- 2. To start advertising the device, click Start advertising.
- 3. Specify the contents of the advertising packets:

nRF Connect v2.0.0	- Bluetooth low energy	- 0 X
	044 - En Connection Man II - Server Setun I Advertising setup	NORDIC
Generic Acc	AD type Value UUID 16 bit complete list	tes Tear
Generic Attr	Advertising data Scan response data AD type Value UUID 16 bit complete list 180D, 180F O Delete Complete local name	
	Appy	Close
Log		
11:12:36.5500	Server setup was applied *	
11:13:51.5800	UART port COM3 closed.	
11:13:53.9560	Connectivity firmware version 1.1.0 detected	
11:13:53.9610	Opening adapter connected to COM3	
11:13:53.9660	Successfully opened COM3. Baud rate: 1000000. Flow control: none. Parity: none.	
11:13:53.9680	Reset performed on adapter COM3	
11.12.51.50.00		

- a) Click the local **Device options** icon 🌣.
- b) To display the Advertising setup dialog, click Advertising setup.
- c) From the AD type drop-down menu, select an AD type.
- d) In the Value field, add a data value.
- e) Select Add to advertising data or Add to scan response.
- f) Repeat until all wanted fields are present.
- g) Click Apply, then click Close.



10 Updating firmware over the air

If the connected device has Nordic Device Firmware Update (DFU) Service, you can update the firmware on the device.

For more information on the DFU process, see Device Firmware Update process. For DFU bootloader examples, see DFU bootloader examples.

For a device that has DFU Service, Secure DFU appears in the device's list of discovered services and the Start Secure DFU button appears in the list header.

0 nRF Connect v2.0.0	- Bluetooth low energy	-	- D X
■ 00068	0853905 - 🗧 🔲 Connection Map 📲 Server Setup	(NORDIC
nRF5x 07:25:46:0 Generic Access Generic Attribus	DB4.1E Dfu Targ Personeral E E E E E E E E E E E E E E E E E E E	Discovered devic Start scan C Options Soft by signal strengt Filter: Dfu DfuTarg F3:E1:80:11:10:73 Details	ces itear h Connect 2
Log	0 0	1	
11:16:44.7010	Scan started	^ ^	
11:16:45.2430	Scan stopped	-	
11:16:51.2570	Connecting to device	-	
11:16:51.2820	Connected to device P3/E1/86/11/10/73	-	
11:16:51.4400	Connection parameters updated for device F3:E1:B8:11:1D:73: interval 15ms, timeout 4000ms, latency: 0	-	
11:16:51.7190	Attribute value read, handle: 0x03, value (0x): 44-66-75-54-61-72-67	-	
		w	

Figure 7: Secure DFU in the list of discovered services

To update the firmware, complete the following steps:

- **1.** To open the DFU dialog, click the **Start Secure DFU** button ().
- 2. Browse and select a DFU zip package file on your computer.

Important: To create the DFU zip package file, use the nrfutil tool. See the nrfutil documentation for more information.

Information on the content of the DFU zip package is displayed in the Package info field.



nRF Connect v2.0.0) - Bluetooth low energy				-		×
	Device Firmware Upgrade ((DFU) for device F3:E1:B8:11:1D:73			100	NO	RDIC
D nRF5	Zip file	C:\Users\befr\Desktop\dfu_test_app_hrm_s132.zip		Choose	lear		
Generic Acc	Package info	application: bin_file: nrf52832_xxaa.bin dat_file: nrf52832_xxaa.dat			•]
Generic Attri				Start DFU		Conne	20
				Close			
Log			0 0 1				
11:16:44.7010	Scan started		-				
11:16:45.2430	Scan stopped						
11:16:51.2570	Connecting to device						
11:16:51.2820	Connected to device F3:E1:B8	11:10:73					
11:16:51.4400	Connection parameters update	ed for device F3.E1:B8:11:1D:73: interval 15ms, timeout 4000ms,	latency: 0				
11:16:51.7190	Attribute value read, handle: 0	x03, value (0x): 44-66-75-54-61-72-67					
			÷				

3. To start the transfer of the DFU package to the connected peer device, click **Start DFU**.





4. When the progress bar has reached 100%, click Close.



0 nRF Connect v2.0.0	0 - Bluetooth low energy				-		×
	OM3 - OM3 - Connect	ion Man 🖃 Server Setun					RDIC
	Device Firmware Upgrade	(DFU) for device F3:E1:B8:11:1D:73			es		
nRF5	Zip file	C:\Users\befr\Desktop\dfu_test_app_hrm_s1	132.zip	Choose	100		
Generic Acc	Package info	application: bin_file: nrf52832_xxaa.bin dat_file: nrf52832_xxaa.dat			n		1
Generic Attri	Progress	Completed				Conne	a 0
	-		100%				
					J		
				Close			
Log							
11:18:52.6630	Attribute value changed, hand	e: 0x12, value (0x): 01-02-04-02-00-00	*				
11:18:52.6640	Attribute value changed, hand	e: 0x12, value (0x): 60-01-01					
11:18:53.0440	Attribute value changed, hand	e: 0x12, value (0x): 03					
11:18:53.0450	Attribute value changed, hand	e: 0x12, value (0x): 60-03-01-04-92-00-00-7D-	-30-82-C4				
11.18:53.1060	Attribute value changed, hand	e: 0x12, value (0x): 04					
11.18.53.3480	Attribute value changed, hand	e: 0x12, value (0x): 60-04-01					
11.18.57.4240	DFU completed successfully.		×				

To stop the transfer, click **Stop DFU**. The transfer continues from where it was stopped when you click **Start DFU** again.

If you click **Close** before the DFU transfer has completed, a confirmation dialog appears. If you click **OK** in the confirmation dialog, the transfer is canceled.



11 Adding UUID definitions

The nRF Connect *Bluetooth* low energy app comes with a list of predefined names and UUIDs for some well-known profiles. You can extend this list with custom definitions.

To extend the list of known UUIDs, complete the following steps:

- 1. To expand the device options for the local device, click the **Device options** icon 🌣.
- 2. Click Open UUID definitions file.
 - The definitions file is opened in your default application for .json files.
- **3.** Following the examples in the file, add your UUIDs, then save the file.
- 4. To load the changes, reconnect to the adapter or reload the application (CTRL + r).



12 Troubleshooting

For troubleshooting, the nRF Connect *Bluetooth* low energy app has a more detailed log file than the one shown in the log view. To open the detailed log file, click the **Open log file** button in the log view.

Firmware programming

If you receive the error **Could not connect to debug probe**, verify that J-Link software is properly installed on the system.

If the device has been programmed with memory protection, the nRF Connect *Bluetooth* low energy app cannot program the firmware. To erase the device, download nRF Command Line Tools from Nordic Semiconductor and issue the following command from the command line:

nrfjprog -e -f <nrf51 or nrf52>

In Windows: If you receive the error **Could not load nrfjprog DLL**, verify that nRF Command Line Tools are installed.

OS X J-Link issue

In OS X: An issue with the SEGGER J-Link OB firmware leads to the corruption of long packets over UART. See www.nordicsemi.com/nRFConnectOSXfix for more information.

Serial port access permissions on Ubuntu Linux

If you receive errors when trying to open the serial port in the nRF Connect *Bluetooth* low energy app on Ubuntu Linux, you may need to grant serial port access permissions to your user. To do this, run the following command:

sudo usermod -a -G dialout <username>

nRF52840 USB problems

If you receive errors related to the nRF52840 Dongle USB connection on Windows, see GitHub.



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The SVHC (Substances of Very High Concern) candidate list is continually being updated. Complete hazardous substance reports, material composition reports and latest version of Nordic's REACH statement can be found on our website www.nordicsemi.com.

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