

# PAN1781

Bluetooth® Low Energy Module  
Module Integration Guide

Rev. 1.0



## Overview

The PAN1781 is a Bluetooth 5 Low Energy (LE) module based on the Nordic nRF52820 single chip controller.

## Features

- Surface mount type dimensions: 15.6 mm × 8.7 mm × 2 mm
- Drop-in replacement for PAN1026A and PAN1762
- Nordic nRF52820 featuring ARM Cortex®-M4 with 64 MHz
- Bluetooth 5 LE including LE 2M and LE Coded PHY
- Embedded 256 kB flash memory and 32 kB internal RAM
- 128-bit AES/ECB/CCM/AAR co-processor
- Up to 16 General Purpose I/O's (GPIO), which are shared with up to 2× SPI, 2× I<sup>2</sup>C, UART, COMP, QDEC, nRESET
- USB 2.0 full-speed device interface
- Built-in temperature sensor

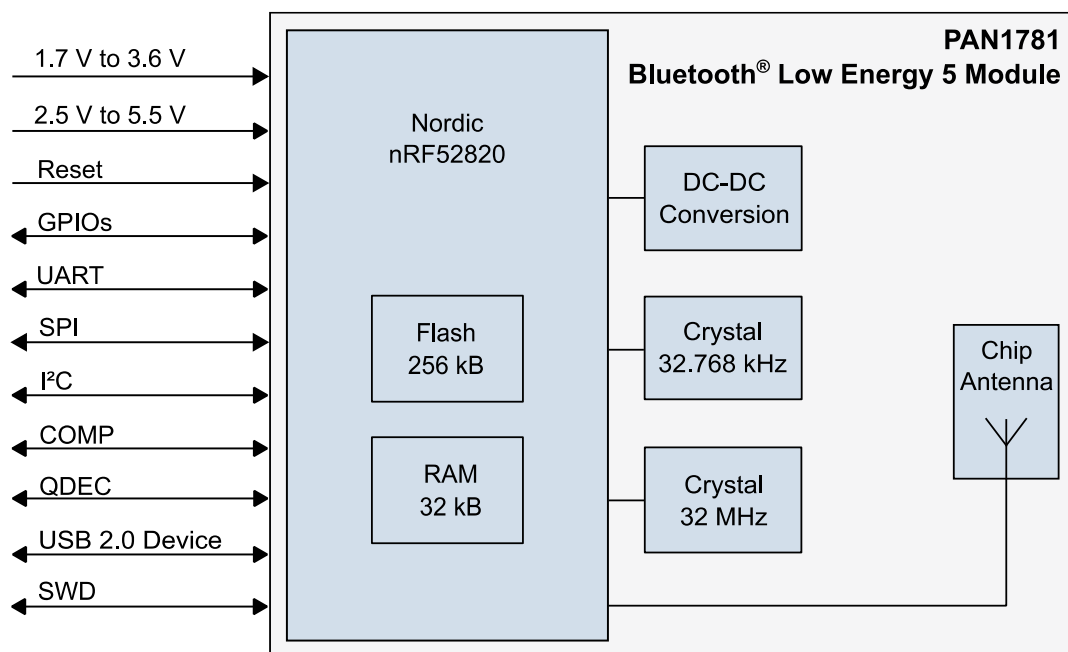
## Bluetooth

- LE 2 Mbps high speed PHY, LE long range coded PHY
- LE advertising extensions (advertising on 40 channels total)
- Channel selection algorithm #2
- LE secure connections
- Angle of arrival (AoA) and angle of departure (AoD) direction finding

## Characteristics

- Typical sensitivity: -95 dBm at 1 Mb/s and -103 dBm at 125 kb/s
- Typical max. output power: 8 dBm, configurable from -20 dBm in 4 dB steps and -40 dBm in whisper mode
- Typical current consumption: 4.9 mA in Tx (at 0 dBm) and 4.7 mA in Rx mode
- Typical current consumption: 0.3 µA in System OFF mode, 1.2 µA with RTC wake up
- On-module DC/DC and LDO regulators with automated low current modes
- Voltage range: 1.7 V to 5.5 V
- Temperature range: -40 °C to 85 °C

## Block Diagram



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# 1 About This Document

## 1.1 Purpose and Audience

This Module Integration Guide is intended to support the easy integration of the PAN1781 into a product and to ensure the compliance with regulatory requirements. It gives an overview about the hardware design requirements

It is intended for hardware design, application, and Original Equipment Manufacturers (OEM) engineers.




Please read this guide carefully to assure the compliance of your product to regulatory.

The product is referred to as “the PAN1781” or “the module” within this document.

## 1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	2021-04-22	First version

## 1.3 Use of Symbols

Symbol	Description
	<b>Note</b> Indicates important information for the proper use of the product. Non-observance can lead to errors.
	<b>Attention</b> Indicates important notes that, if not observed, can put the product’s functionality at risk.
	<b>Tip</b> Indicates useful information designed to facilitate working with the module and software.
⇒ [chapter number] [chapter title]	<b>Cross Reference</b> Indicates cross references within the document. <b>Example:</b> Description of the symbols used in this document ⇒ 1.3 Use of Symbols.
✓	<b>Requirement</b> Indicates a requirement that must be met before the corresponding tasks can be completed.
→	<b>Result</b> Indicates the result of a task or the result of a series of tasks.
<b>This font</b>	<b>GUI Text</b> Indicates fixed terms and text of the graphical user interface. <b>Example:</b> Click <b>Save</b> .

Symbol	Description
<b>Menu &gt; Menu item</b>	<p><b>Path</b></p> <p>Indicates a path, e.g. to access a dialog.</p> <p><b>Example:</b></p> <p>In the menu, select <b>File &gt; Setup page</b>.</p>
This font	<p><b>File Names, Messages, User Input</b></p> <p>Indicates file names or messages and information displayed on the screen or to be selected or entered by the user.</p> <p><b>Examples:</b></p> <p>pan1760.c contains the actual module initialization.</p> <p>The message Failed to save your data is displayed.</p> <p>Enter the value Product 123.</p>
<b>Key</b>	<p><b>Key</b></p> <p>Indicates a key on the keyboard, e.g. <b>F10</b>.</p>

## 1.4 Related Documents

For related documents please refer to the Panasonic website ⇒ [6.2 Product Information](#).

## 2 Overview

The PAN1781 is a Bluetooth 5 Low Energy (LE) module based on the Nordic nRF52820 single chip controller.

The Bluetooth 5 features additionally a higher symbol rate of 2 Mbps using the high speed LE 2M PHY or a significantly longer range using the LE coded PHY at 500 kb/s or 125 kb/s. The new channel selection algorithm (CSA#2) improves the performance in high interference environments. Furthermore, the new LE advertising extensions allow for much larger amounts of data to be broadcasted in connectionless scenarios.

An output power of up to 8 dBm and the high sensitivity of the nRF52820 in combination with the LE coded PHY make the module very attractive in applications, where a long range is required.

In addition the ultra-low current consumption of the PAN1781 makes the module an ideal choice for battery powered devices.

With the Cortex-M4 processor, 32 kB RAM, and the built-in 256 kB flash memory, the PAN1781 can easily be used in standalone mode, thereby eliminating the need for an external processor, saving complexity, space, and cost.

The PAN1781 also supports angle of arrival (AoA) and angle of departure (AoD) direction finding using Bluetooth.

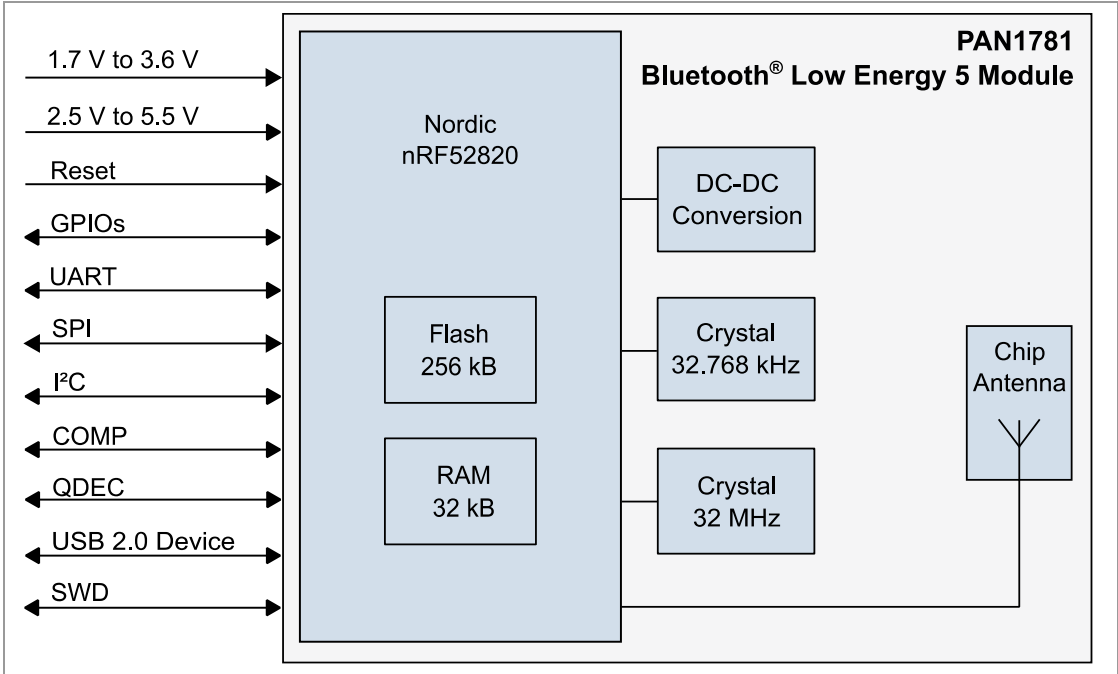
A 128-bit AES/ECB/CCM/AAR co-processor may be used for on-the-fly packet encryption.

For related documents please refer to [⇒ 6.2 Product Information](#).




### 3 PAN1781 Module

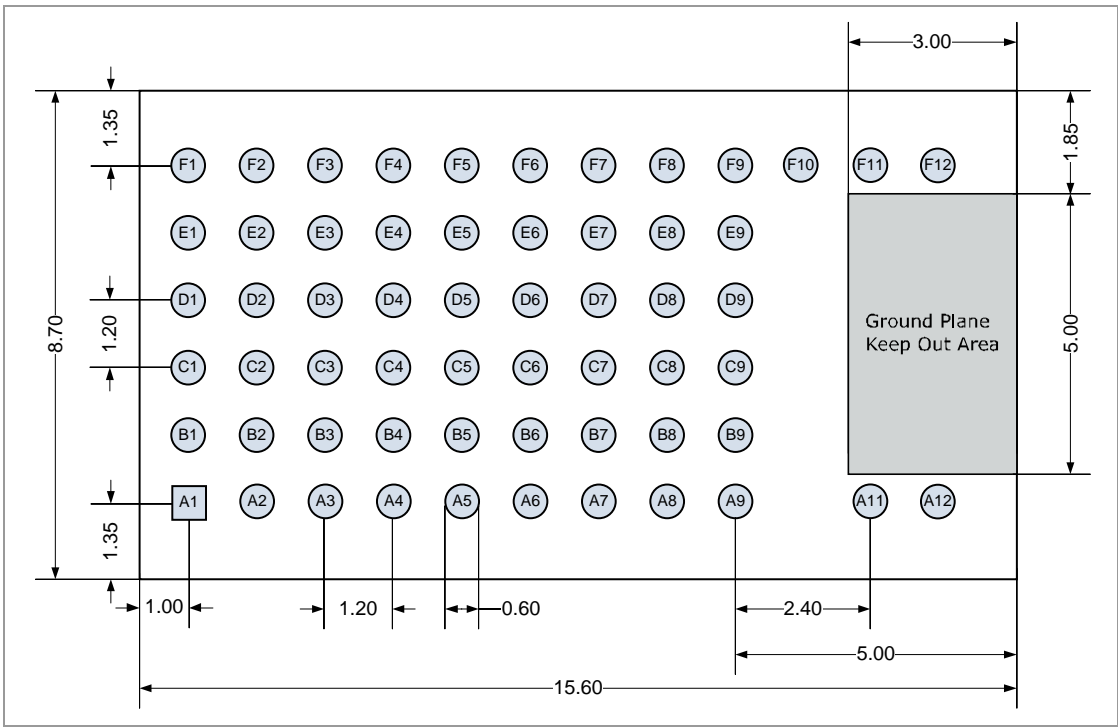
#### 3.1 Block Diagram



### 3.2 Footprint

 The dimensions are in millimeters.  
The outer dimensions have a tolerance of  $\pm 0.3$  mm.

Top View



### 3.3 Placement



#### Antenna “Keep out Area”

Do not place any ground plane under the marked restricted antenna area in any layer! This would be affecting the performance of the chip antenna in a critical manner.



#### Impact of Placement on the Antenna Radiation Pattern

The placement of the module, surrounding material, and customer components has an impact on the radiation pattern of the antenna.




The recommendation for the ground plane is based on a FR4 4-Layer PCB.

The following requirements must be met:

- ✓ The supply voltage must be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47  $\mu$ F directly at the module).
- ✓ This module should not be mechanically stressed when installed.
- ✓ Keep this module away from heat. Heat is the major cause of decreasing the life time of these modules.
- ✓ Avoid assembly and use of the target equipment in conditions where the module temperature may exceed the maximum tolerance.
- ✓ Keep this module away from other high frequency circuits.
- ✓ Refer to the recommended pattern when designing a board.

The antenna requires a cutout area of 5 mm  $\times$  3 mm under the PAN1781 module. This “Keep out Area” shall be located in every layer under the module antenna.

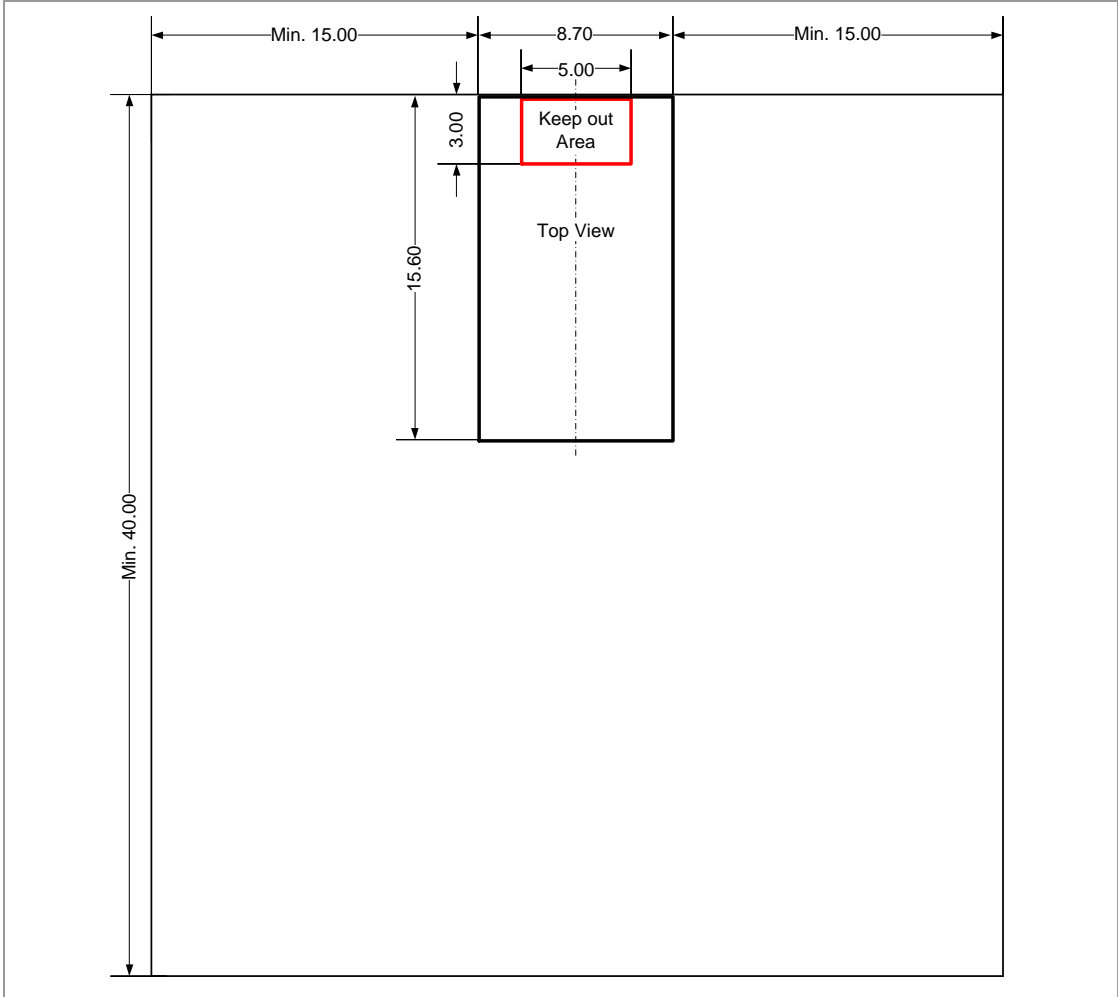
It is recommended to verify the perfect position of the module in the target application before fixing the design.

 All dimensions are in millimeters.

 Use a ground plane in the area surrounding the module wherever possible.

- It is recommended to place the module:
- In the center (horizontal) of mother PCB.
  - At the edge (horizontal) of mother PCB.

### Antenna Placement Recommendation



## 4 Regulatory and Certification Information

### 4.1 General Certification Information



Regulatory certifications are valid for the following radio relevant software:

- Nordic SoftDevices S112, S113, or S140
- Bluetooth Specification 5



For further certification requests for other radio software please contact Panasonic ⇒ [6 Contact Details](#).

### 4.2 Federal Communications Commission (FCC) for US

#### 4.2.1 FCC Statement

**The following FCC statement has to be printed in the OEM end product user information:**

The device meets the requirements for modular transmitter approval as detailed in FCC public Notice DA00-1407. The transmitter operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

#### 4.2.2 Caution

**The following FCC caution has to be printed in the OEM end product user information:**



The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Panasonic Industrial Devices Europe GmbH may void the user's authority to operate the equipment.



This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception (which can be determined by turning the equipment off and on) the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna,
- Increase the separation between the equipment and receiver,
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected,
- Consult the dealer or an experienced radio/TV technician for help.

### 4.2.3 Label Requirements

**The following labelling requirements have to be implemented on the OEM end product:**



The OEM must ensure that FCC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Panasonic FCC identifier for this product as well as the FCC notice above.

The FCC identifier is **FCC ID: T7V1781**.

This FCC identifier is valid for the PAN1781.

The end product must in any case be labelled on the exterior with:

"Contains FCC ID: T7V1781"

Due to the PAN1781 model size, the FCC identifier is displayed in the installation instruction only and it cannot be displayed readable on the module's label due to the limited size.

### 4.2.4 Antenna Warning

**The following antenna has to be followed by the OEM:**


This antenna warning refers to the device with the model number PAN1781.

The device is tested with a integrated antenna listed below. When integrated into the OEM's product, these fixed antennas require installation preventing end users from replacing them with non-approved antennas. Any antenna not in the following table must be tested to comply with FCC Section 15.203 for unique antenna connectors and with Section 15.247 for emissions.

**4.2.5 Approved Antenna List**

Item	Part Number	Manufacturer	Frequency Band	Type	Max. Gain (dBi)
1	ANT016008LCS2442MA1	TDK	2.4 GHz	Chip Antenna	-1.0

**4.2.6 RF Exposure**

 To comply with FCC RF Exposure requirements, the OEM must ensure that only antennas from the Approved Antenna List are installed ⇒ [4.2.5 Approved Antenna List](#).

The preceding statement must be included as a “CAUTION” statement in manuals for products operating with the approved antennas to alert users on FCC RF Exposure compliance.

Any notification to the end user of installation or removal instructions about the integrated radio module is not allowed.

The radiated output power of the PAN1781 with a mounted ceramic antenna (**FCC ID: T7V1781**) is below the FCC radio frequency exposure limits. Nevertheless, the PAN1781 shall be used in such a manner that the potential for human contact during normal operation is minimized.

End users may not be provided with the module installation instructions. OEM integrators and end users must be provided with transmitter operating conditions for satisfying RF exposure compliance.

### 4.3 Innovation, Science, and Economic Development (ISED) for Canada

The following IC rules have to be followed by end product OEM's:

#### English

The PAN1781 is licensed to meet the regulatory requirements of ISED.

License ID: **IC: 216Q-1781**

HVIN: **ENW89857A1KF, ENW89857A2KF**

Manufacturers of mobile, fixed or portable devices incorporating this module are advised to clarify any regulatory questions and ensure compliance for SAR and/or RF exposure limits. Users can obtain Canadian information on RF exposure and compliance from [www.ic.gc.ca](http://www.ic.gc.ca).

This device has been designed to operate with the antennas listed in Approved Antenna List, having a maximum gain of -1.0 dBi. Antennas not included in this list or having a gain greater than -1.0 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. The antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter without the need of re-assessment of conformity by ISED.

Due to the model size, the IC identifier is displayed in the installation instruction and on the package label only. It cannot be displayed readable on the module's label due to the limited size.



The end customer has to assure that the device has a distance of more than 10 mm from the human body under all circumstances.

If the end customer application intends to use the PAN1781 in a distance smaller 10 mm from the human body, SAR evaluation has to be repeated by the OEM.

The end customer equipment must meet the actual Safety/Health requirements according to ISED.



**French**

PAN1781 est garanti conforme aux dispositions réglementaires d'Industry Canada (ISED).

License: **IC: 216Q-1781**

HVIN: **ENW89857A1KF, ENW89857A2KF**

Il est recommandé aux fabricants d'appareils fixes, mobiles ou portables de consulter la réglementation en vigueur et de vérifier la conformité de leurs produits relativement aux limites d'exposition aux rayonnements radiofréquence ainsi qu'au débit d'absorption spécifique maximum autorisé.

Des informations pour les utilisateurs sur la réglementation Canadienne concernant l'exposition aux rayonnements RF sont disponibles sur le site [www.ic.gc.ca](http://www.ic.gc.ca).

Ce produit a été développé pour fonctionner spécifiquement avec les antennes listées dans le tableau Approved Antenna List, présentant un gain maximum de -1.0 dBi. Des antennes autres que celles listées ici, ou présentant un gain supérieur à -1.0 dBi ne doivent en aucune circonstance être utilisées en combinaison avec ce produit. L'impédance des antennes compatibles est 50 Ohm. L'antenne utilisée avec ce produit ne doit ni être située à proximité d'une autre antenne ou d'un autre émetteur, ni être utilisée conjointement avec une autre antenne ou un autre émetteur.

En raison de la taille du produit, l'identifiant IC est fourni dans le manuel d'installation.



Le client final doit s'assurer que l'appareil se trouve en toutes circonstances à une distance de plus de 10 mm du corps humain.

Si le client final envisage une application nécessitant d'utiliser le PAN1781 à une distance inférieure à 10 mm du corps humain, alors le FEO doit répéter l'évaluation DAS.

L'équipement du client final doit répondre aux exigences actuelles de sécurité et de santé selon l'ISED.

### 4.3.1 IC Notice

The following IC notice has to be printed in English and French in the OEM end product user information:

#### English



The device PAN1781, including the integrated antenna mentioned in ⇒ [4.2.5 Approved Antenna List](#), complies with Canada RSS-GEN Rules. The device meets the requirements for modular transmitter approval as detailed in RSS-Gen.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

#### French



Le présent appareil PAN1781, les antennes y compris ⇒ [4.2.5 Approved Antenna List](#) est conforme aux CNR-Gen d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage, et
2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### 4.3.2 Labeling Requirements

The following IC labelling requirements have to be followed by end product OEM's:

#### English



#### Labeling Requirements

The OEM must ensure that IC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Panasonic IC identifier for this product as well as the IC Notice above.

The IC identifier is: **IC: 216Q-1781**

This IC identifier is valid for the PAN1781 module. In any case, the end product must be labelled on the exterior with:

"Contains IC: 216Q-1781"

#### French



#### Obligations d'étiquetage

Les fabricants d'équipements d'origine (FEO) – en anglais Original Equipment Manufacturer (OEM) – doivent s'assurer que les obligations d'étiquetage IC du produit final sont remplies. Ces obligations incluent une étiquette clairement visible à l'extérieur de l'emballage externe, comportant l'identifiant IC du module Panasonic inclus, ainsi que la notification ci-dessus.

L' identifiant IC est: **IC: 216Q-1781**

Cet identifiant est valide pour module PAN1781. Dans tous les cas les produits finaux doivent indiquer sur leur emballage externe la mention suivante:

"Contient IC: 216Q-1781"

## 4.4 European Conformity According to RED (2014/53/EU)



All modules described in this Module Integration Guide comply with the standards according to the following LVD (2014/35/EU), EMC-D (2014/30/EU) together with RED (2014/53/EU) articles.

### Standards

- Due to the model size, the CE marking is displayed in the installation instruction and on the package label only. It cannot be displayed according to regulation (EU) No. 765/2008 in 5 mm height on the module's label due to the limited space.
- The end product OEM has to re-assess the conformity of the end product to EU regulations, but can use the PAN1781 RED pre-assessment to shorten this procedure.
- The RED EU Type Examination Certificate No. **T818833N-01-TEC** issued by the Notified Body 0682 can be used for the OEM end product conformance assessment. If a Notified Body has been contracted for the end product conformity assessment, it should be noted that this EU Type Examination Certificate should be used for conformance assessment.

As a result of the OEM end product conformity assessment procedure described in 2014/53/EU Directive and other applicable EU directives, the end customer equipment should be labelled as follows:



The requirements for CE marking are described in regulation (EU) No. 765/2008 Annex II.



The end customer has to assure that the device has a distance of more than 5 mm from the human body under all circumstances.

If the end customer application intends to use the PAN1781 in a distance smaller 5 mm from the human body, SAR evaluation has to be repeated by the OEM.

The end customer equipment must meet the actual Safety/Health requirements according to RED.

PAN1781 and its model versions in the specified reference design can be used in all countries of the European Economic Area (Member States of the EU, European Free Trade Association States [Iceland, Liechtenstein, Norway]), Monaco, San Marino, Andorra, and Turkey.

## 4.5 Bluetooth

For Bluetooth end products which integrate the PAN1781 the OEM needs to apply for an own end product listing (EPL) at the Bluetooth SIG. If the PAN1781 is used on more than one OEM product, costs can be saved by applying for a family EPL.

For the end product EPL the following IDs can be used in order to avoid re-testing:

Bluetooth 5	Declaration ID	QDID
Component (Tested) Link Layer	D043345	136204
Component (Tested) Host Layer	D043346	136227
Component (Tested) RF PHY	D043344	137461
End Product (PAN1781 Bluetooth LE LR Module)	D054152	164160

### Bluetooth Marks

According to the Bluetooth SIG, the PAN1781 fulfills the criteria to label your product as a Bluetooth device:



For further information please refer to the Bluetooth website [www.bluetooth.com](http://www.bluetooth.com)

## **5 Restricted Use**

### **5.1 Life Support Policy**

This Panasonic Industrial Devices Europe GmbH product is not designed for use in life support appliances, devices, or systems where malfunction can reasonably be expected to result in a significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

Panasonic customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Panasonic Industrial Devices Europe GmbH for any damages resulting.

### **5.2 Restricted End Use**

This Panasonic Industrial Devices Europe GmbH product is not designed for any restricted activity that supports the development, production, handling usage, maintenance, storage, inventory or proliferation of any weapons or military use.

Transfer, export, re-export, usage or reselling of this product to any destination, end-user or any end-use prohibited by the European Union, United States or any other applicable law is strictly prohibited.

## 6 Contact Details

### 6.1 Contact Us

Please contact your local Panasonic Sales office for details on additional product options and services:

For Panasonic Sales assistance in the **EU**, visit

<https://eu.industrial.panasonic.com/about-us/contact-us>

Email: [wireless@eu.panasonic.com](mailto:wireless@eu.panasonic.com)

For Panasonic Sales assistance in **North America**, visit the Panasonic website “Sales & Support” to find assistance near you at

<https://na.industrial.panasonic.com/distributors>

Please visit the **Panasonic Wireless Technical Forum** to submit a question at

<https://forum.na.industrial.panasonic.com>

### 6.2 Product Information

Please refer to the Panasonic Wireless Connectivity website for further information on our products and related documents:

For complete Panasonic product details in the **EU**, visit

<http://pideu.panasonic.de/products/wireless-modules.html>

For complete Panasonic product details in **North America**, visit

<http://www.panasonic.com/rfmodules>