

phyWAVE[®] -CC26xx

Hardware Manual

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List of Figures	ii
List of Tables	ii
Conventions, Abbreviations and Acronyms	iii
Preface	v
1 Introduction	1
1.1 Features of the phyWAVE-CC26xx	2
1.2 Block Diagram	3
1.3 phyWAVE-CC26xx Component Placement	4
2 Pin Description	5
3 Jumpers	7
4 Technical Specification	9
4.1 Physical Dimensions	9
4.2 Electrical Characteristics	10
4.3 RF Characteristics	11
4.3.1 On-board PCB Antenna	12
4.3.2 External Antenna	14
5 Integrating and Handling of the Module	15
5.1 Footprint Recommendation for a Custom PCB	15
5.2 Module Placement into Custom Application PCB	16
5.3 Soldering Recommendations	17
5.4 Application Schematic	17
5.5 Integration and Support	18
5.6 Modifications on the phyWAVE Module	18
6 Firmware	19
6.1 SimpleLink SensorTag Software with a Bluetooth Low Energy stack	19
6.2 Other TI Solutions	19
6.2.1 Z-Stack	19
6.2.2 RF4CE	19
6.2.3 IEEE 802.15.4 MAC software stack	19
6.2.4 Contiki-OS	19
7 Revision History	20
Index	21

List of Figures

Figure 1:	Block Diagram of the phyWAVE-CC26xx	3
Figure 2:	phyWAVE-CC26xx Component Placement (top view)	4
Figure 3:	Jumper Locations (top view)	7
Figure 4:	Dimensions of the phyWAVE-CC26xx Wireless Module (top view)	9
Figure 5:	Measured PCB Antenna Gain with a phyWAVE-CC26xx mounted on a phyNODE Board	12
Figure 6:	Orientation of the phyWAVE-CC26xx during RF Antenna Gain Measurements.....	13
Figure 7:	Footprint of the phyWAVE-CC26xx.....	15
Figure 8:	Recommended integration of the phyWAVE-CC26xx.....	16
Figure 9:	Minimal Application Schematic	17

List of Tables

Table 1:	Signal Types used in this Manual	iv
Table 2:	Abbreviations and Acronyms used in this Manual.....	iv
Table 3:	Pinout of the phyWAVE DSC Connector DSC1	6
Table 4:	Jumper Settings	8
Table 5:	General Electrical Specifications of the phyWAVE-CC26xx	10
Table 6:	Current Consumption of the MCU and Transceiver inside the TI CC26xx SoC.....	10
Table 7:	IEEE 802.15.4 Characteristics of the phyWAVE-CC26xx Module.....	11
Table 8:	Bluetooth Low Energy Characteristics of the phyWAVE-CC26xx Module	11
Table 9:	Internal PCB Antenna Characteristics of the phyWAVE-CC26xx Module.....	12
Table 10:	Characteristics of the Pulse W1010 external Rod Antenna (measured in Combination with the phyWAVE-CC26xx).....	14

Conventions, Abbreviations and Acronyms

This hardware manual describes the phyWAVE-CC26xx wireless module. The manual specifies the phyWAVE-CC26xx's design and function. Precise specifications for the Texas Instruments CC26xx microcontrollers can be found in the microcontroller data sheet/reference manual.

Note: We refrain from providing detailed part specific information within this manual, which can be subject to continuous changes, due to part maintenance for our products. Please read the paragraph "**Product Change Management and information in this manual on parts populated on the SOM**" within the [Preface](#).

Conventions

The conventions used in this manual are as follows:

- Signals that are preceded by an "n", "/", or "#" character (e.g.: nRD, /RD, or #RD), or that have a dash on top of the signal name (e.g.: $\overline{\text{RD}}$) are designated as active low signals. That is, their active state is when they are driven low, or are driving low.
- A "0" indicates a logic zero or low-level signal, while a "1" represents a logic one or high-level signal.
- Tables which describe jumper settings show the default position in **bold, blue text**.
- Text in *blue italic* indicates a hyperlink within, or external to the document. Click these links to quickly jump to the applicable URL, part, chapter, table, or figure.

Types of Signals

Different types of signals are brought out at the phyWAVE DSC-Connector. The following table lists the abbreviations used to specify the type of a signal.

Signal Type	Description	Abbr.
Power	Supply voltage input	PWR_I
Ref-Voltage	Reference voltage output	REF_0
Input	Digital input	I
Output	Digital output	O
Input / Output	Bidirectional input/output	I/O
5V Input PD	5 V tolerant input with pull down	5V_PD
USB IO	Differential line pairs 90 Ohm USB level bidirectional input/output	USB_I/O

Table 1: *Signal Types used in this Manual*

Abbreviations and Acronyms

Many acronyms and abbreviations are used throughout this manual. Use the table below to navigate unfamiliar terms used in this document.

Abbreviation	Definition
DSC	Direct Solder Connection; a phyWAVE wireless module can be populated on any base board via DSC without the need of dedicated expensive connectors.
EMI	Electromagnetic Interference.
GPI	General purpose input.
GPIO	General purpose input and output.
GPO	General purpose output.
J	Solder jumper; these types of jumpers require solder equipment to remove and place.
JP	Solderless jumper; these types of jumpers can be removed and placed by hand with no special tools.
PCB	Printed circuit board.
PEB	PHYTEC Extension Board
POR	Power-on reset
RTC	Real-time clock.
SOC	System on Chip
Sx	User button Sx (e.g. S1, S2, etc.) used in reference to the available user buttons, or DIP-Switches on the carrier board.

Table 2: *Abbreviations and Acronyms used in this Manual*

Preface

As a member of PHYTEC's phyWAVE[®] product family the phyWAVE-CC26xx is one of a series of PHYTEC wireless modules that can be populated with different controllers and, hence, offer different functions and configurations. PHYTEC supports multiple wireless modules using different protocols like IEEE 802.15.4, Bluetooth Smart and IEEE 802.11:

- (1) as the basis for Rapid Development Kits which serve as a reference and evaluation platform.
- (2) as insert-ready, fully functional phyWAVE[®] OEM modules, which can be embedded directly into the user's peripheral hardware design.

Implementation of an OEM-able module subassembly as the "core" of your embedded design allows you to focus on hardware peripherals and firmware without expending resources to "re-invent" microcontroller circuitry and RF design. Furthermore, much of the value of the phyWAVE[®] module lies in its layout and test.

Production-ready firmware implementations and Design Services for our hardware will further reduce your development time and risk and allow you to focus on your product expertise. Take advantage of PHYTEC products to shorten time-to-market, reduce development costs, and avoid substantial design issues and risks. With this new innovative full system solution you will be able to bring your new ideas to market in the most timely and cost-efficient manner.

For more information go to:

<http://www.phytec.de/de/leistungen/entwicklungsunterstuetzung.html> or
<http://www.phytec.eu/europe/oem-integration/evaluation-start-up.html>

Ordering Information¹

The part numbering of the phyWAVE-CC26xx has the following structure:

PWA-A-001-xxxx.Ay

Product number

Assembly options:

Controller

- 0 – CC2620 (RF4CE)
- 1 – CC2630 (IEEE 802.15.4)
- 2 – CC2640 (BLE)
- 3 – CC2650 (Multi Standard, IEEE 802.15.4, BLE, RF4CE)

Antenna

- 0 – int. PCB Antenna
- 1 – ext. Antenna via U.FL

Shielding

- 0 – Shield not mounted
- 1 – Shield mounted (essential if product is targeted for US market)

Reserved

Version number

Product Specific Information and Technical Support

In order to receive product specific information on changes and updates in the best way also in the future, we recommend to register at

<http://www.phytec.de/de/support/registrierung.html> or
<http://www.phytec.eu/europe/support/registration.html>

For technical support and additional information concerning your product, please visit the support section of our web site which provides product specific information, such as errata sheets, application notes, FAQs, etc.

<http://www.phytec.de/support/knowledge-database/internet-of-things/iot/> or
<http://www.phytec.eu/europe/support/faq/faq.html#IOT>

¹: The structure shows the ordering options available as of the printing of this manual. Additional ordering options may have been added. Please contact our sales team to get an update on the ordering options available.

Declaration of Electro Magnetic Conformity of the PHYTEC phyWAVE-CC26xx

PHYTEC wireless modules (henceforth products) are designed for installation in electrical appliances or as dedicated Evaluation Boards (i.e.: for use as a test and prototype platform for hardware/software development) in laboratory environments.

Caution!

PHYTEC products lacking protective enclosures are subject to damage by ESD and, hence, may only be unpacked, handled or operated in environments in which sufficient precautionary measures have been taken in respect to ESD-dangers. It is also necessary that only appropriately trained personnel (such as electricians, technicians and engineers) handle and/or operate these products. Moreover, PHYTEC products should not be operated without protection circuitry if connections to the product's pin header rows are longer than 3 m.

PHYTEC products fulfill the norms of the European Union's Directive for Electro Magnetic Conformity only in accordance to the descriptions and rules of usage indicated in this hardware manual (particularly in respect to the DSC connector, power supply, climate conditions and serial interface to a host-PC). The measurements that lead to the verified declaration of conformity have been executed by an external laboratory according to the normative regulation stated in:

- EN 300 328 – Radio spectrum conformity of radio equipment in the 2.4 GHz ISM band
- EN 301 489 – Electro Magnetic Conformity for radio equipment
- EN 60950-1 – Information technology equipment, Safety

Implementation of PHYTEC products into target devices, as well as user modifications and extensions of PHYTEC products, is subject to renewed establishment of conformity to, and certification of, Electro Magnetic Directives. Users should ensure conformance following any modifications to the products as well as implementation of the products into target systems.

Product Change Management and information in this manual on parts populated on the wireless module

When buying a PHYTEC wireless module, you will, in addition to our HW and SW offerings, receive a free obsolescence maintenance service for the HW we provide.

Our PCM (Product Change Management) Team of developers, is continuously processing, all incoming PCN's (Product Change Notifications) from vendors and distributors concerning parts which are being used in our products.

Possible impacts to the functionality of our products, due to changes of functionality or obsolescence of a certain part, are being evaluated in order to take the right measures in purchasing or within our HW/SW design.

Our general philosophy here is: **We never discontinue a product as long as there is demand for it.**

Therefore we have established a set of methods to fulfill our philosophy:

Avoiding strategies

- Avoid changes by evaluating long-livety of parts during design in phase.
- Ensure availability of equivalent second source parts.
- Stay in close contact with part vendors to be aware of roadmap strategies.

Change management in rare event of an obsolete and non replaceable part

- Ensure long term availability by stocking parts through last time buy management according to product forecasts.
- Offer long term frame contract to customers.

Change management in case of functional changes

- Avoid impacts on product functionality by choosing equivalent replacement parts.
- Avoid impacts on product functionality by compensating changes through HW redesign or backward compatible SW maintenance.
- Provide early change notifications concerning functional relevant changes of our products.

Therefore we refrain from providing detailed part specific information within this manual, which can be subject to continuous changes, due to part maintenance for our products.

In order to receive reliable, up to date and detailed information concerning parts used for our product, please contact our support team through the contact information given within this manual.

1 Introduction

The phyWAVE-CC26xx is a subminiature (19 mm x 29 mm) insert-ready wireless module populated with the Texas Instruments CC26xx microcontroller. The low power architecture and an integrated multistandard wireless transceiver enable its insertion in a wide range of wireless applications. Depending on the populated variant, the CC26xx microcontroller can be used with the IEEE 802.15.4, Bluetooth Low Energy, or TI's RF4CE wireless protocol.

The phyWAVE-CC26xx belongs to Phytex's wireless module family. The phyWAVE boards integrate all core elements of a wireless microcontroller system on a subminiature board and are designed in a manner that ensures their easy expansion and embedding in peripheral hardware developments.

A typical application of the phyWAVE-CC26xx is the usage in battery powered wireless sensor nodes, which perceive environmental data. In this scenario, no other components beside sensors, battery or accumulator and optionally energy harvesting components need to be used. The integrated ARM Cortex M3 microprocessor will be used as application processor which runs the network stack and the user application to interface the sensors.

The phyWAVE-CC26xx wireless module can also be used as network interface in higher performance hardware, such as a gateway. A gateway may consist of a *Linux* driven Phytex SOM in combination with a phyWAVE-CC26xx. The SOM offers computation power while the phyWAVE module provides wireless connectivity to the system. Please contact our sales team for further information.

phyWAVE modules achieve their small size through modern SMD technology and multi-layer design. In accordance with the complexity of the module, 0402-packaged SMD components and laser-drilled microvias are used on the boards, providing phyWAVE users with access to this cutting edge miniaturization technology for integration into their own design. At the same time phyWAVE modules can be integrated to a carrier board by using an easy-to-solder DSC connector.

1.1 Features of the phyWAVE-CC26xx

The phyWAVE-CC26xx offers the following features:

- Insert-ready, sub-miniature (19 mm x 29 mm) wireless module subassembly in low EMI design, achieved through advanced SMD technology
- Populated with the TI CC26xx microcontroller (VQFN48 packaging)
- ARM Cortex M3 application processor providing
 - 128 kB Flash
 - 128 kB ROM (contains pre-compiled libraries)
 - 28 kB SRAM
 - Integrated RF-Section
 - 2.5 GHz ISM band, IEEE 802.15.4, BLE, RF4CE²
- PCB antenna and a U.FL connector to connect an external antenna
- Controller signals and ports extend to the modules' Direct Solder Connection (DSC), enabling the phyWAVE-CC26xx to be soldered to the target application like a "big chip"
- Universal Asynchronous Serial Interface (UART-TTL)
- I²C, I²S interface
- Two SPI interfaces
- PWM output
- 12 bit ADC and Analog Comparator
- Hardware encryption support
- cJTAG and JTAG interface
- RTC with populated 32 kHz quartz crystal
- Nearly all GPIOs³ available at the DSC connector
- Wide supply voltage range of 1.8 V - 3.8 V
- Industrial temperature grade of -40°C to +85°C ([section 4.2](#))

²: Depends on the version of the CC26xx SoC populated on the module, refer to the ordering information in the [Preface](#).

³: Almost every controller port which connects directly to the DSC connector may be used as GPIO by using the TI CC26xx pin muxing options.

1.2 Block Diagram

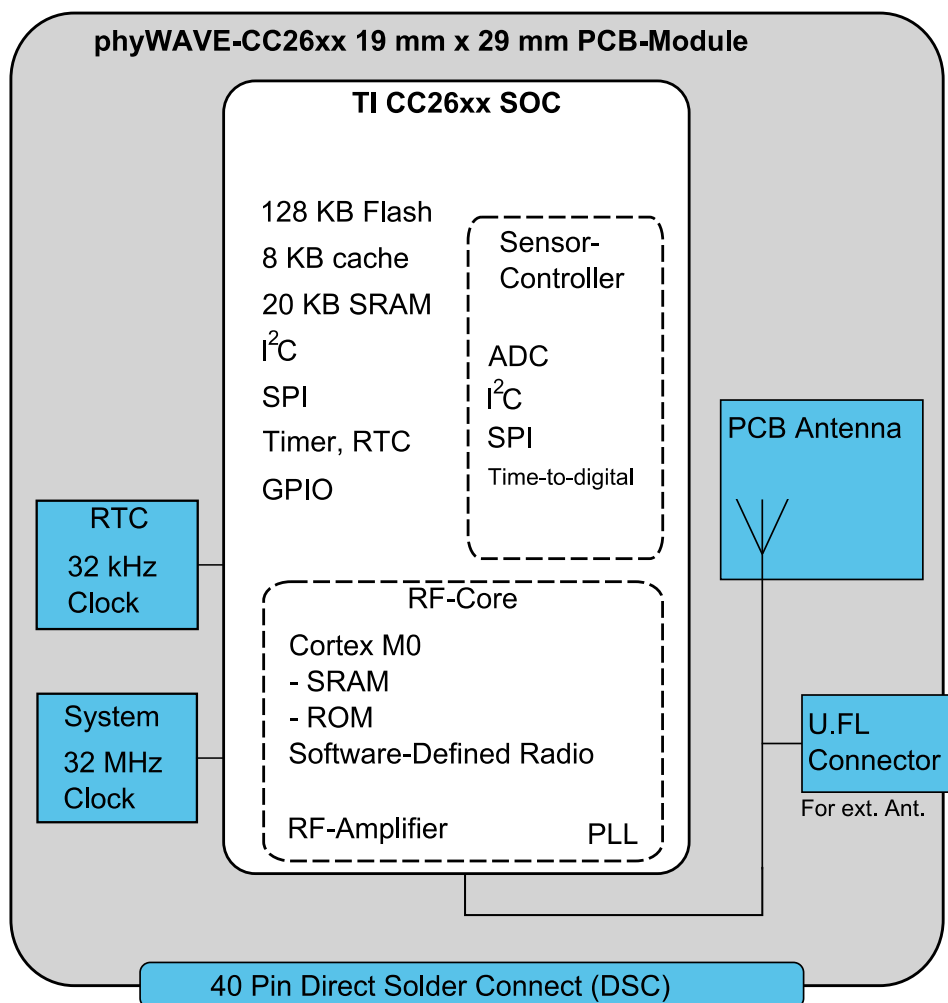


Figure 1: Block Diagram of the phyWAVE-CC26xx

1.3 phyWAVE-CC26xx Component Placement

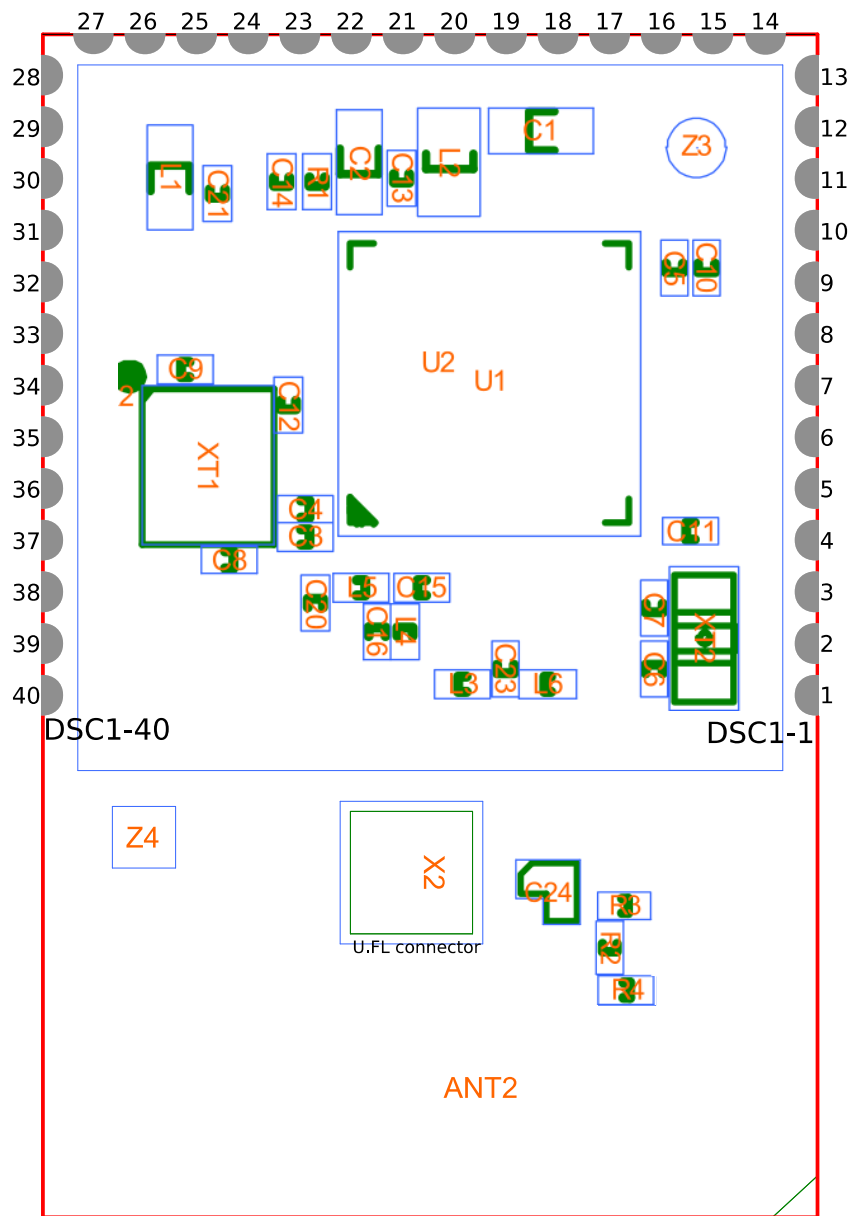


Figure 2: phyWAVE-CC26xx Component Placement (top view)

2 Pin Description

Please note that all module connections are not to exceed their expressed maximum voltage or current. Maximum signal input values are indicated in the corresponding controller manuals/data sheets. As damage from improper connections varies according to use and application, it is the user's responsibility to take appropriate safety measures to ensure that the module connections are protected from overloading through connected peripherals.

All controller signals selected extend to the 40 pin DSC connector . This allows the phyWAVE-CC26xx to be soldered to any target application like a "big chip".

[Table 3](#) provides an overview of the pinout of the DSC connector DSC1 with signal names and descriptions specific to the phyWAVE-CC26xx. It also provides the appropriate voltage domain, signal type (ST) and a functional grouping of the signals. The signal type includes also information about the signal direction. A description of the signal types can be found in [Table 1](#).

Caution!

- The Texas Instruments CC26xx is a 1.8 V to 3.8 V operated microcontroller and as such special attention should be paid to the interface voltage levels to avoid unintentional damage to the microcontroller. Please refer to the *TI CC26xx SimpleLink Wireless MCU Technical Reference Manual* for details on the functions and features of controller signals and port pins.

Note:

- Most of the controller pins have multiple multiplexed functions. [Table 3](#) describes only the pin type, e.g. GPIO, nRESET., not their configurable special function. The pin multiplexing needs to be configured in the firmware of the phyWAVE module. [Section 6](#) gives an overview of available firmware solutions. Please also refer to the *TI CC26xx SimpleLink Wireless MCU Technical Reference Manual* to get to know about alternative pin functions.
- The following tables describe the full set of signals available at the phyWAVE DSC connector according to the phyWAVE-CC26xx specification.

Pin #	Signal	ST	SL	Description
1	GND1	PWR_0	GND	Ground 0 V
2	DIO_0	I/O	3.3 V	GPIO
3	DIO_1	I/O	3.3 V	GPIO
4	DIO_2	I/O	3.3 V	GPIO
5	DIO_3	I/O	3.3 V	GPIO
6	DIO_4	I/O	3.3 V	GPIO
7	DIO_5	I/O	3.3 V	GPIO
8	DIO_6	I/O	3.3 V	GPIO
9	DIO_7	I/O	3.3 V	GPIO
10	DIO_8	I/O	3.3 V	GPIO
11	DIO_9	I/O	3.3 V	GPIO
12	DIO_10	I/O	3.3 V	GPIO
13	DIO_11	I/O	3.3 V	GPIO
14	GND2	PWR_0	GND	Ground 0 V
15	DIO_12	I/O	3.3 V	GPIO
16	DIO_13	I/O	3.3 V	GPIO
17	DIO_14	I/O	3.3 V	GPIO
18	DIO_15	I/O	3.3 V	GPIO
19	JTAG_TMSC	I/O	3.3 V	JTAG_TMS
20	JTAG_TCKC	I/O	3.3 V	JTAG_TCLK
21	DIO_16	I/O	3.3 V	GPIO, JTAG_TDO
22	DIO_17	I/O	3.3 V	GPIO, JTAG_TDI
23	DIO_18	I/O	3.3 V	GPIO
24	DIO_19	I/O	3.3 V	GPIO
25	DIO_20	I/O	3.3 V	GPIO
26	DIO_21	I/O	3.3 V	GPIO
27	GND3	PWR_0	GND	Ground 0 V
28	DIO_22	I/O	3.3 V	GPIO
29	GND4	PWR_0	GND	Ground 0 V
30	VDD_IN	PWR_0	3.3 V	VCC 3.3 V
31	nRESET	I	3.3 V	Reset input (low active)
32	DIO_23	I/O	3.3 V	GPIO
33	DIO_24	I/O	3.3 V	GPIO
34	DIO_25	I/O	3.3 V	GPIO
35	DIO_26	I/O	3.3 V	GPIO
36	DIO_27	I/O	3.3 V	GPIO
37	DIO_28	I/O	3.3 V	GPIO
38	DIO_29	I/O	3.3 V	GPIO
39	DIO_30	I/O	3.3 V	GPIO
40	GND5	PWR_0	GND	Ground 0 V

Table 3: Pinout of the phyWAVE DSC Connector DSC1

3 Jumpers

For configuration purposes, the phyWAVE-CC26xx has one solder jumper, that is configured prior to delivery. [Table 4](#) below provides a functional summary of the solder jumper which can be changed to select the internal PCB antenna, or an external antenna via U.FL connector. It shows its default position, and possible alternative positions and functions.

If manual jumper modification is required please ensure that the board as well as surrounding components and sockets remain undamaged while de-soldering. Overheating the board can cause the solder pads to loosen, rendering the module inoperable. Carefully heat neighboring connections in pairs. After a few alternations, components can be removed with the solder-iron tip. Alternatively, a hot air gun can be used to heat and loosen the bonds.

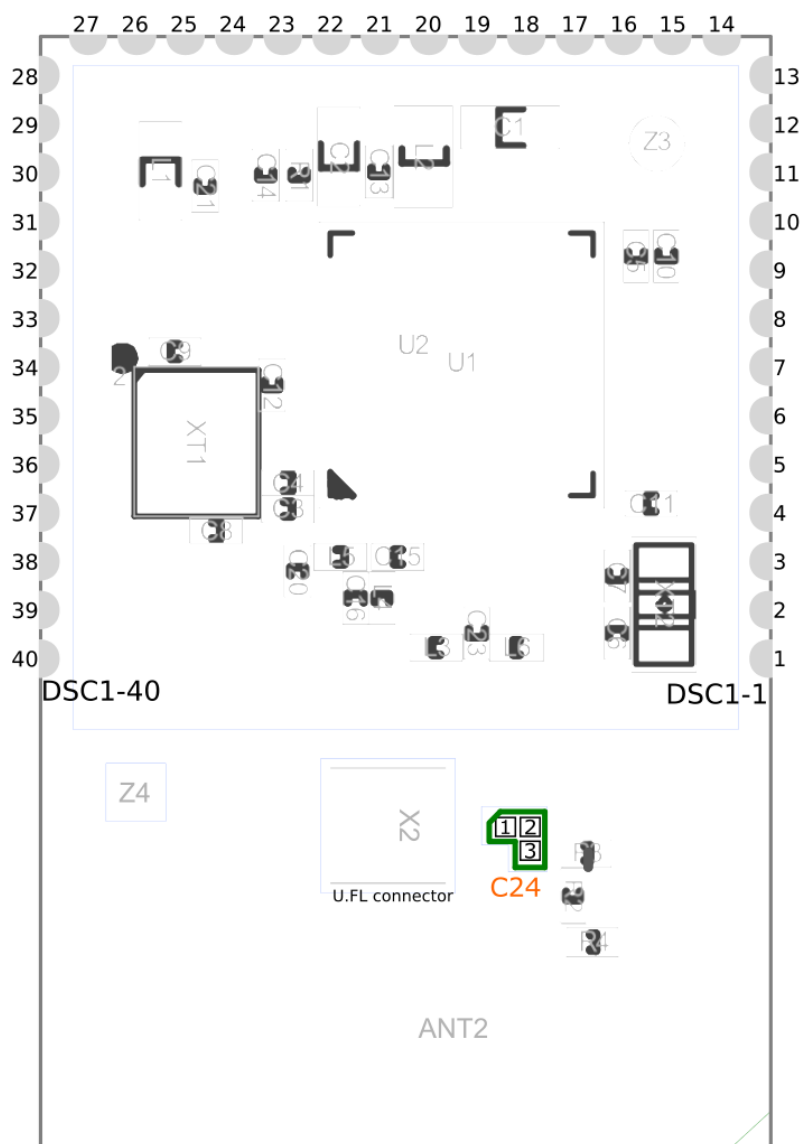


Figure 3: Jumper Locations (top view)

Please pay special attention to the "TYPE" column to ensure you are using the correct type of jumper (0 Ohms, 10k Ohms, etc...).

The jumper (J = solder jumper) has the following function:

Jumper	Description	Type	Chapter
C24	C24 defines which antenna is used. You can specify the default setting in your order, see Ordering Information in Preface .	12 pF (0402)	4.3
1+2	phyWAVE-CC26xx configured for external antenna, connected via U.FL. connector X2		
2+3	phyWAVE-CC26xx configured for internal PCB antenna		

Table 4: Jumper Settings

4 Technical Specification

The phyWAVE-CC26xx operates off of a single power supply voltage.

The following sections of this chapter discuss mechanical electrical, and RF specifications of the phyWAVE- CC26xx wireless module.

4.1 Physical Dimensions

The physical dimensions of the phyWAVE- CC26xx are represented in *Figure 4*. The module's profile is max. 4.8 mm thick (2.6 without shielding). The board itself is 1 mm thick.

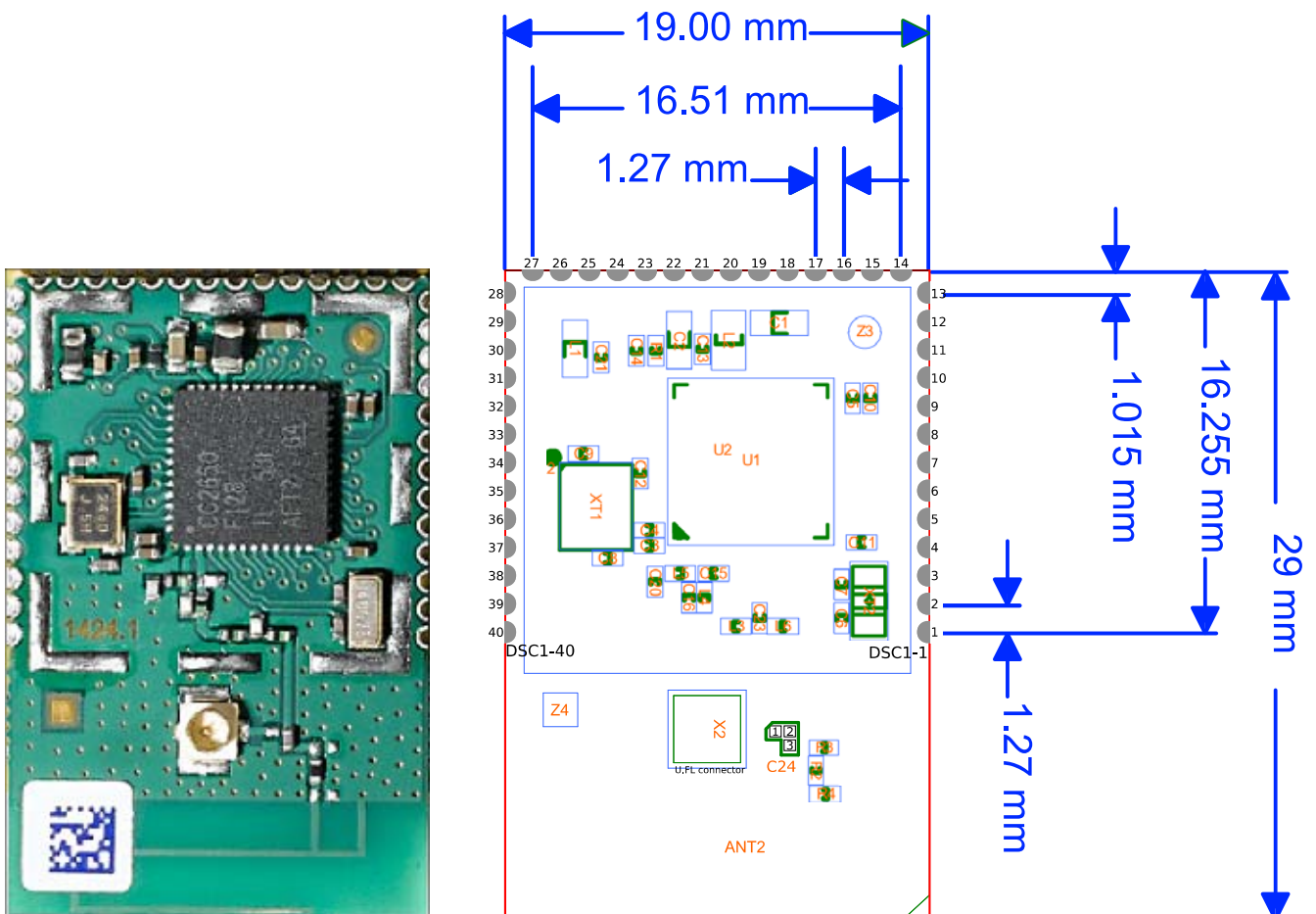


Figure 4: Dimensions of the phyWAVE-CC26xx Wireless Module (top view)

4.2 Electrical Characteristics

Table 5 provides general specifications of the module. *Table 6* gives an overview of the most important power modes of MCU and transceiver inside the CC26xx SOC and their corresponding current flow.

Parameter	Value
Storage temperature:	-40 °C - +150 °C
Operating temperature:	-40 °C - +85 °C
Frequency stability of 32 MHz clock source (25 °C)	10 ppm
Frequency stability: of 32 MHz clock source (-40 - +85 °C)	15 ppm
Max. MCU frequency:	48 MHz
Operating voltage:	1.8 V – 3.8 V
Humidity:	95 % r.F. not condensed

Table 5: General Electrical Specifications of the phyWAVE-CC26xx

Electrical load	Current consumption (typical current at 2.7 V, T = 25 °C)
MCU at 48 MHz, without peripherals	3 mA
MCU+Modem in low power mode	1 µA, with RTC
Modem RX, CCA, ED	5.9 mA
Modem TX at 0dBm	6.1 mA

Table 6: Current Consumption of the MCU and Transceiver inside the TI CC26xx SoC

4.3 RF Characteristics

Table 7 and *Table 8* list the key facts for the internal multiprotocol RF transceiver in IEEE 802.15.4 mode and Bluetooth Low Energy mode.

Parameter	Value
Frequency band	2.4 GHz ISM band (2.4 GHz - 2.48 GHz)
Wireless standard	IEEE 802.15.4 PHY, upper layer e.g. 6LoWPAN, ZigBee
IEEE 802.15.4 channels	11-26
Bandwidth/channel	5 MHz
Modulation	DSSS, O-QPSK, 250 kbps
TX output power	-21 dBm - +5 dBm (programmable)
RX sensitivity	-100 dBm
Antenna	PCB or external via U.FL connector
RF Operating range indoor ⁴	~20 m
RF Operating range outdoor ⁴	~150 m

Table 7: IEEE 802.15.4 Characteristics of the phyWAVE-CC26xx Module

Parameter	Value
Frequency band	2.4 GHz ISM band (2.4 - 2.48 GHz)
Wireless standard	Bluetooth Smart 4.2 (stack and HW certified)
BLE channels	40ch(37 data+3 advertising)
Bandwidth/channel	2 MHz
Modulation	1-mbps GFSK
TX output power	-21 dBm - +5 dBm (programmable)
RX sensitivity	-97 dBm
Antenna	PCB or external via U.FL connector
RF Operating range indoor ⁴	~15 m
RF Operating range outdoor ⁴	~100 m

Table 8: Bluetooth Low Energy Characteristics of the phyWAVE-CC26xx Module

⁴: The maximum operating range depends on environmental conditions such as channel occupation, barriers and TX-power. The stated range should only be understood as a rough guideline.

4.3.1 On-board PCB Antenna

The on-board PCB antenna has been exclusively designed for the phyWAVE-CC26xx wireless module. The key parameters of the RF measurement that has been executed during the CE certification process in a certified lab are listed in [Table 9](#). The on-board PCB antenna has a slight directivity. The directivity pattern has been measured and is visualized in [Figure 5](#). The orientation of the phyWAVE during measurements is depicted in [Figure 6](#). [Figure 6](#) shows the phyWAVE module on the phyNODE evaluation board in the same direction as in [Figure 5 A](#).

Parameter	Value
Type	PCB, unsymmetrical
Impedance	50 Ohm
Bandwidth	2.4 GHz – 2.483 GHz
Antenna gain, channel 11 ⁵	0.7 dBi
Antenna gain, channel 18 ⁵	1.5 dBi
Antenna gain, channel 26 ⁵	2.1 dBi

Table 9: Internal PCB Antenna Characteristics of the phyWAVE-CC26xx Module

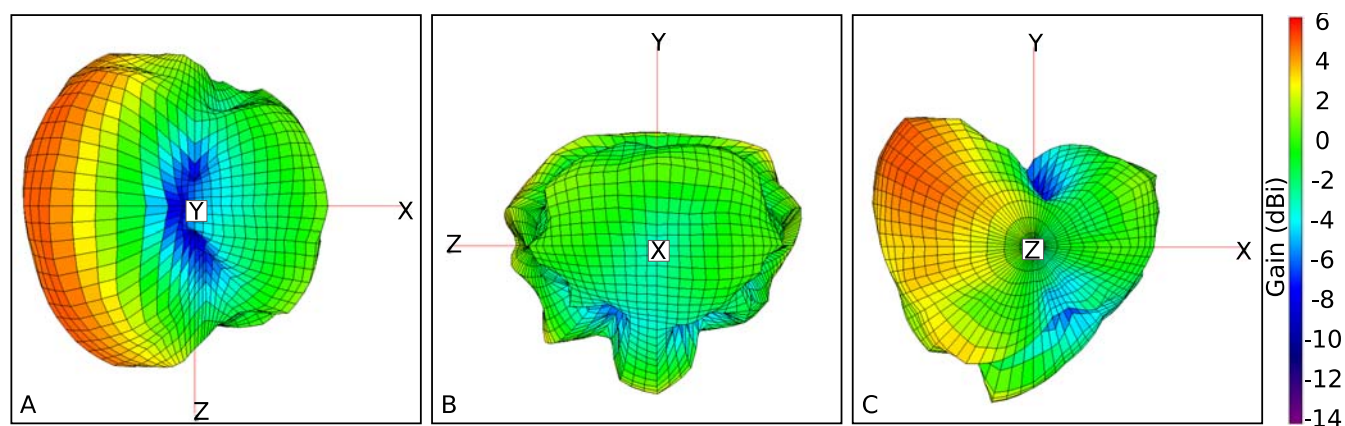


Figure 5: Measured PCB Antenna Gain with a phyWAVE-CC26xx mounted on a phyNODE Board

⁵: The antenna gain has been measured on a phyWAVE-CC26xx populated on a phyNODE board. Measurement has been executed in a shielded fully anechoic chamber to avoid interference and reflection.

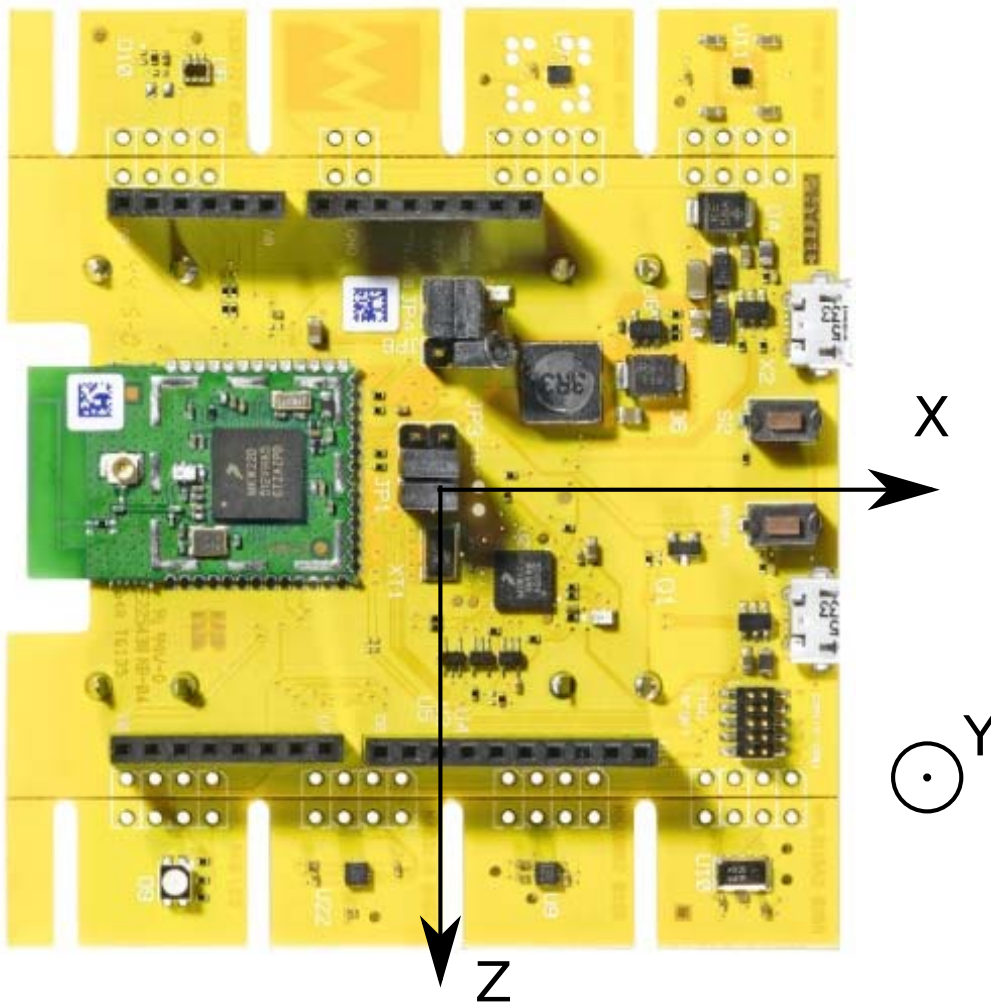


Figure 6: Orientation of the phyWAVE-CC26xx during RF Antenna Gain Measurements

Please find more information about the phyNODE in [chapter 5](#) or at <http://www.phytec.de/produkte/internet-of-things/phynode>.

Note: The directivity pattern in [Figure 5](#) is only valid for a phyNODE with a populated phyWAVE in the measurement setup depicted in [Figure 6](#). If you use the phyWAVE-CC26xx module standalone or mounted on your own hardware, antenna characteristics and directivity might change. [Chapter 5](#) gives guidelines how you can achieve similar results when integrating the module to your application.

4.3.2 External Antenna

In general, all external antennas in the 2.4 GHz frequency band with an impedance of 50 Ohm can be used with the phyWAVE-CC26xx. However, the module may exceed regulated maximum output power when using antennas with a strong directivity. Therefore, we selected a one-quarter wave rod antenna that can be used with the module. The proposed external antenna as well as the internal PCB antenna has been measured for CE compliance. You can safely use it in your application⁶. [Table 10](#) shows the measured characteristics of the Pulse W1010 rod antenna. The antenna gain in the datasheet of the antenna - available at the *Pulse* website - is reported to be 2 dBm. The measured antenna characteristics in [Table 10](#) show a slightly higher gain, which is regulatory compliant. The Pulse datasheet also provides a 360° radiation pattern. The radiation pattern of the external rod antenna is donut-shaped.

Parameter	Value
Manufacturer	Pulse
Manufacturer Part Number	W1010
Type	unsymmetrical
Impedance	50 Ohm
Bandwidth	2.4 GHz – 2.483 GHz
Antenna gain, channel 11	2.6 dBi
Antenna gain, channel 18	2.8 dBi
Antenna gain, channel 26	2.1 dBi

Table 10: Characteristics of the Pulse W1010 external Rod Antenna (measured in Combination with the phyWAVE-CC26xx)

Phytec item number of the verified external antenna:

- External rod antenna: *xx19*
- Adapter cable that converts from U.FL to SMA connector: *WK130*

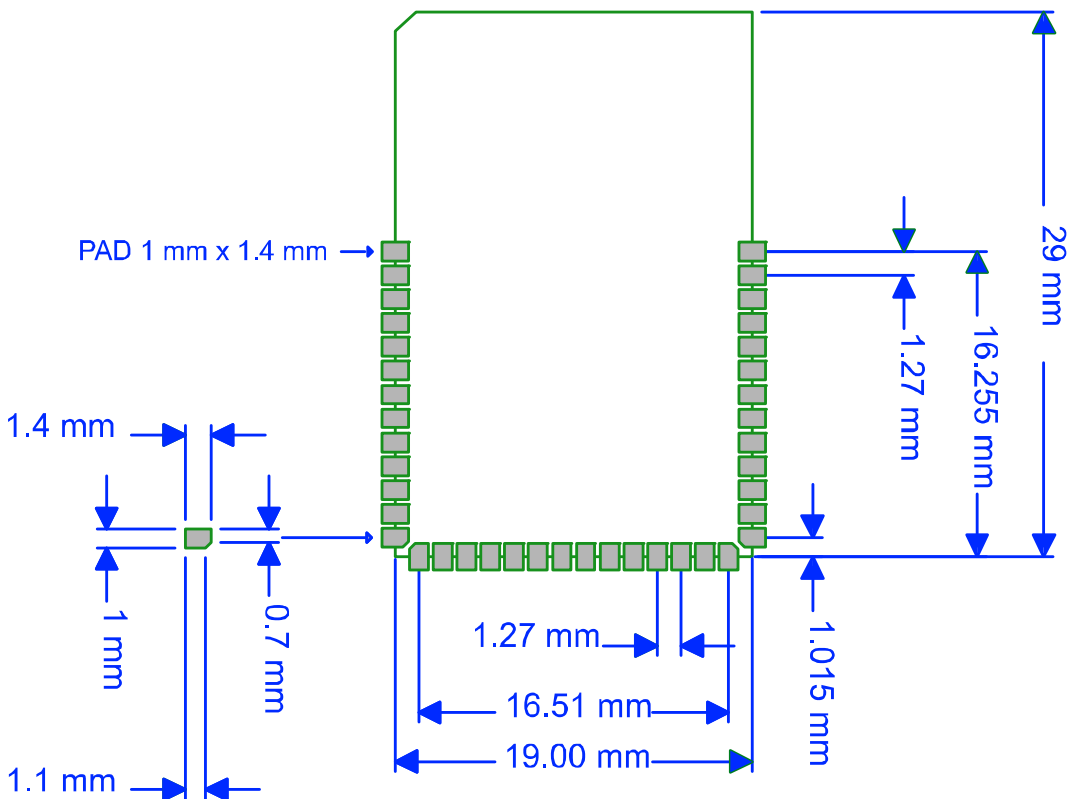
Fitting solutions with other external antennas are also available in case you need to place the phyWAVE module along with an antenna in a custom housing. Please contact our sales team for more information.

⁶: Nevertheless, the final end product must be validated for being CE conformant.

5 Integrating and Handling of the Module

5.1 Footprint Recommendation for a Custom PCB

Figure 7 shows the recommended footprint for the host PCB.



A tolerance of ± 0.1 mm applies to all indicated measures, except for the measures of the outer edges which have a tolerance of ± 0.2 mm.

Figure 7: Footprint of the phyWAVE-CC26xx

The footprint, as shown in *Figure 7*, is available in *.dxf* file format at <ftp://ftp.phytec.de/pub/Products/phyWAVE-CC2650/Layout/Dimension>. Use of this data allows integrating the phyWAVE-CC26xx wireless module as a single component into your design.

5.2 Module Placement into Custom Application PCB

Successful integration in user target circuitry greatly depends on the adherence to the layout design rules for the GND connections of the phyWAVE module. For maximum EMI and RF performance we recommend as a general design rule to connect all GND pins to a solid ground plane. *Figure 8* shows the recommended placement of the phyWAVE within your application's PCB, all GND pins are marked black. For optimal RF performance the GND area below the phyWAVE should be at least 27 mm wide. It is not critical which layer is being used for the solid GND plane. However, please make sure to connect the GND pins as short as possible, e.g. with a VIA next to each pin. Furthermore, we recommend placing the module on the edge of your custom PCB. It is very important that there is no copper material (e.g. GND plane, or any other tracks) directly below the PCB antenna. As shown in *Figure 8* the uppermost 5.3 mm of the module must be clear of any material. This ensures that the characteristics of the PCB antenna are as specified in *section 4.3.1*.

If phyWAVE wireless modules shall be placed inside a housing with very limited space and where the above stated conditions can not be met you should consider using an external antenna. For more information regarding the antenna configuration and characteristics refer *section 4.3*.

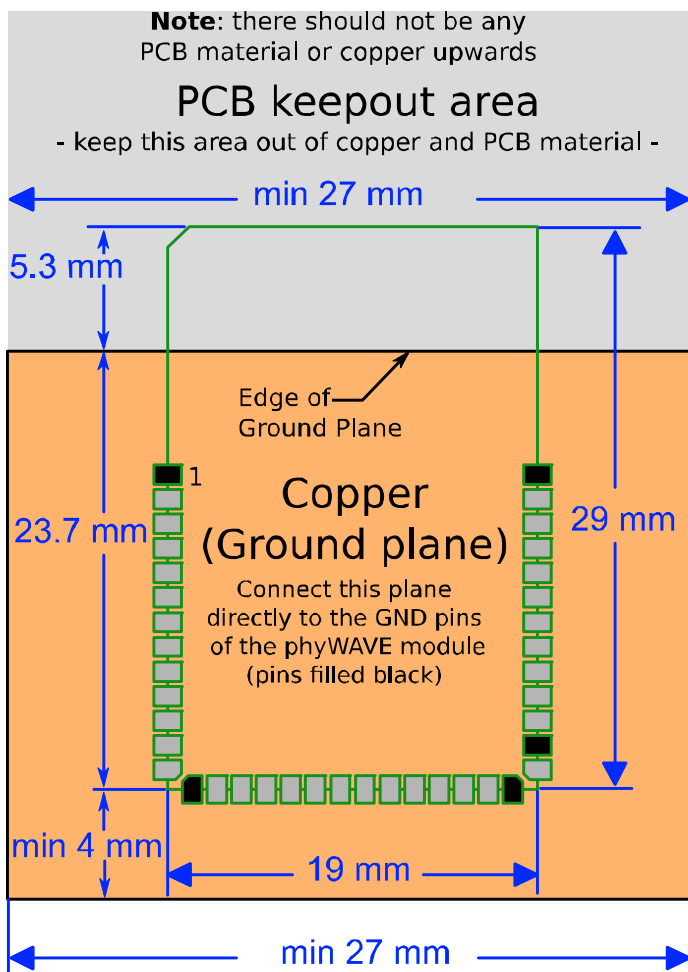


Figure 8: Recommended integration of the phyWAVE-CC26xx

5.3 Soldering Recommendations

To avoid damaging the module, the following recommendations should be met:

1. Use no-clean flux solder paste.
2. Use adhesive when placing the module to the host PCB to avoid a displacement of the module during the soldering process.
3. Do not wash the PCB after soldering the module; moisture could be trapped between module and host PCB.
4. Use only one soldering phase. If the host PCB requires multiple flows, apply the module on the final flow.

5.4 Application Schematic

Figure 9 shows a typical application schematic that includes functionality such as JTAG debug interface, reset button, power-on LED, two user LEDs, power and optionally device USB connectivity.

For debugging purposes UART0 can be used via TP1 and TP2.

With the phyNODE board, a more advanced application schematic is available on request. The phyNODE board is equipped with different sensors to perceive environmental data such as temperature and humidity. Furthermore it integrates a CMSIS-dap debugger which allows programming and debugging of the populated phyWAVE wireless module. The phyNODE board serves as platform for different wireless communication modules.

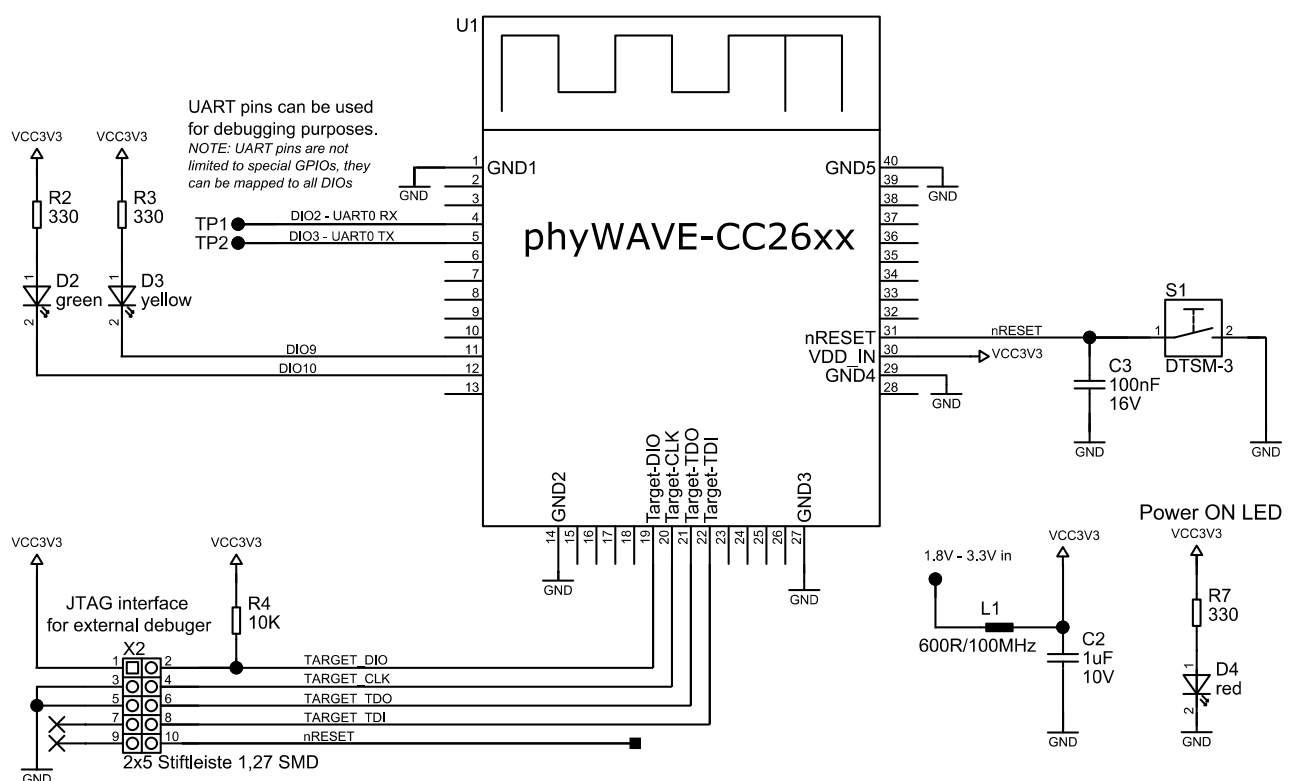


Figure 9: Minimal Application Schematic

5.5 Integration and Support

Beside this hardware manual, more information is available to facilitate the integration of the phyWAVE-CC26xx into customer applications.

- The design of the phyNODE can be used as a reference for any customer application. More information on the phyNODE can be found at <http://www.phytec.de/produkte/internet-of-things/phyndoe>.
- Different support packages are available to support you in all stages of your embedded development. Please visit <http://www.phytec.de/de/support/support-pakete.html>, or <http://www.phytec.eu/europe/support/support-packages.html>, or contact our sales team for more details.

5.6 Modifications on the phyWAVE Module

Removal of various components, such as the microcontroller and the standard quartz, is not advisable given the compact nature of the module. Should this nonetheless be necessary, please ensure that the board as well as surrounding components and sockets remain undamaged while de-soldering. Overheating the board can cause the solder pads to loosen, rendering the module inoperable. Carefully heat neighboring connections in pairs. After a few alternations, components can be removed with the solder-iron tip. Alternatively, a hot air gun can be used to heat and loosen the bonds.

Caution!

If any modifications to the module are performed, regardless of their nature, the manufacturer guarantee is voided.

6 Firmware

There are different firmware solutions that can be used on the phyWAVE-CC26xx. For some of these solutions we provide application guides and typical use cases. Others are available through the hardware manufacturer TI. The following sections provide a short overview.

6.1 SimpleLink SensorTag Software with a Bluetooth Low Energy stack

The SimpleLink Software includes a certified Bluetooth Low Energy Stack and many application examples. An application manual that explains the first steps with the phyWAVE-CC26xx in combination with a phyNODE and an adapted version of the SimpleLink Software is available at:

<http://www.phytec.de/produkt/internet-of-things/iot-enablement-kit-2-download>.

6.2 Other TI Solutions

TI itself provides some additional software stacks for the CC26xx SOC. All those stacks and examples can be used with the phyWAVE-CC26xx. However, please note that we can only give limited support for these examples. For these TI solutions, there is no Phytex application guide available. The following solutions are accessible via TI homepage:

<http://www.ti.com/product/CC2650/toolssoftware>

6.2.1 Z-Stack

ZigBee implementations for application standards according to the ZigBee specifications. The *ZigBee Home Automation* application standard is supported on the CC2630 or CC2650 SOC.

6.2.2 RF4CE

The RF4CE implementation from TI is compatible with the ZigBee Remote Control profile. The *RF4CE stack* is supported on the CC2620 or CC2650 SOC.

6.2.3 IEEE 802.15.4 MAC software stack

With the TIMAC, TI provides an IEEE 802.15.4-2006 compatible MAC layer implementation that includes the energy efficient beacon mode and non-beacon mode. TIMAC provides only layer 1 and 2 in the ISO-OSI communication model, upper layer up to the application layer are not provided therein. TIMAC is supported on the CC2630 or CC2650 SOC.

6.2.4 Contiki-OS

Contiki is a community based open source project under BSD licensing. The CC26xx platform support within *Contiki* is maintained by TI. *Contiki-OS* is hosted on *GitHub* at: <https://github.com/contiki-os/contiki>.

7 Revision History

Date	Version numbers	Changes in this manual
30.08.2016	Manual L-824e_1	First edition. Describes the phyWAVE-CC26xx PCB-Version 1424.1

Index**A**

Antenna Characteristics 12

B

Block Diagram..... 3

C

C24 8

Current consumption..... 10

D

DSC Connector 5

E**EMC**vii**F**

Features 2

Frequency stability 10

G

General electrical specification..... 10

GND Connection 16

H

Humidity..... 10

M

Max. MCU frequency 10

O

Operating Temperature 10

Operating voltage..... 10

P

Physical Dimensions..... 9

Pin Description..... 5

Pinout

DSC1 6

R

RF Characteristics (BLE) 11

RF Characteristics (IEEE 802.15.4) 11

S

Storage Temperature 10

Supply Voltage 9

T

Technical Specifications 9

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Document number: L-824e_1, August 2016

How would you improve this manual?

Did you find any mistakes in this manual? **page**

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