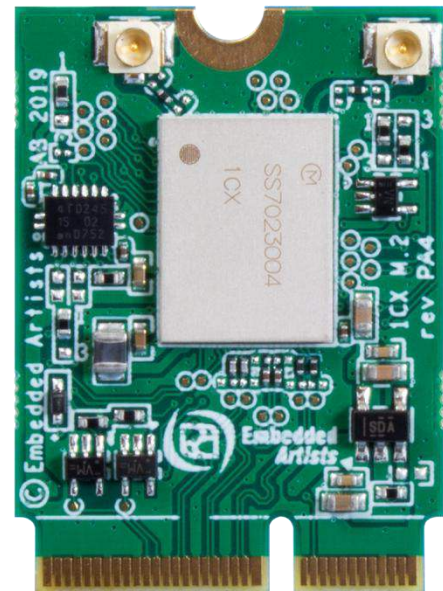


1CX M.2 Module Datasheet

- 802.11a/b/g/n/ac 2x2 MIMO and BT/BLE 5.0
- PCIe interface
- 22 x 30 mm with dual antenna connectors



*Get Up-and-Running Quickly and
Start Developing Your Application On Day 1!*

Embedded Artists AB

Jörgen Ankersgatan 12
211 45 Malmö
Sweden

<http://www.EmbeddedArtists.com>

Copyright 2019 © Embedded Artists AB. All rights reserved.

No part of this publication may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual or otherwise, without the prior written permission of Embedded Artists AB.

Disclaimer

Embedded Artists AB makes no representation or warranties with respect to the contents hereof and specifically disclaim any implied warranties or merchantability or fitness for any particular purpose. The information has been carefully checked and is believed to be accurate, however, no responsibility is assumed for inaccuracies.

Information in this publication is subject to change without notice and does not represent a commitment on the part of Embedded Artists AB.

Feedback

We appreciate any feedback you may have for improvements on this document.

Trademarks

All brand and product names mentioned herein are trademarks, services marks, registered trademarks, or registered service marks of their respective owners and should be treated as such.

Table of Contents

1	Document Revision History	4
2	Introduction	5
2.1	Benefits of Using an M.2 Module to get Wi-Fi/BT Connectivity	5
2.2	More M.2 Related Information	5
2.3	ESD Precaution and Handling	5
2.4	Product Compliance	5
3	Specification	6
3.1	Power Up Sequence	7
3.2	External Sleep Clock	7
3.3	Mechanical Dimensions	7
3.4	M.2 Pinning	8
3.5	Test Points	11
3.6	VDDIO Override Feature	11
4	Antenna	12
5	Regulatory	13
6	Disclaimers	14
6.1	Definition of Document Status	15

1 Document Revision History

<i>Revision</i>	<i>Date</i>	<i>Description</i>
PA1	2019-04-30	First version.

2 Introduction

This document is a datasheet that specifies and describes the *1CX M.2 module* mainly from a hardware point of view. Software related issues, like the Linux driver, are not addressed. There are separate documents for that.

2.1 Benefits of Using an M.2 Module to get Wi-Fi/BT Connectivity

There are several benefit to use an *M.2 module* to add connectivity to an embedded design:

- Drop-in, certified solution!
- Modular and flexible approach to evaluate different Wi-Fi/BT solutions - with different trade-offs around performance, cost, power consumption, longevity, etc.
- Access to maintained software drivers (Linux) with responsive support from Murata.
- Supported by Embedded Artists' Developer's Kits for i.MX 6/7/8 development, including advanced debugging support on carrier boards
- One component to buy, instead of 50+
- No RF expertise is required
- Developed in close collaboration with Murata and Cypress

2.2 More M.2 Related Information

For more information about the M.2 standard and Embedded Artists' adaptation, see: [M.2 Primer](#)

For more general information about the M.2 standard, see: <https://en.wikipedia.org/wiki/M.2>

The official M.2 specification (PCI Express M.2 Specification) is available from: www.pcisig.com

2.3 ESD Precaution and Handling

Please note that the M.2 module come without any case/box and all components are exposed for finger touches – and therefore extra attention must be paid to ESD (electrostatic discharge) precaution, for example use of static-free workstation and grounding strap. Only qualified personnel shall handle the product.

Make it a habit always to first touch the mounting hole (which is grounded) for a few seconds with both hands before touching any other parts of the boards. That way, you will have the same potential as the board and therefore minimize the risk for ESD.

In general touch as little as possible on the boards in order to minimize the risk of ESD damage. The only reasons to touch the board are when mounting/unmounting it on a carrier board.

Note that Embedded Artists does not replace modules that have been damaged by ESD.



2.4 Product Compliance

Visit Embedded Artists' website at http://www.embeddedartists.com/product_compliance for up to date information about product compliances such as CE, RoHS2, Conflict Minerals, REACH, etc.

3 Specification

This chapter lists some of the more important characteristics of the M.2 module, but it is not a full specification of performance and timing. The main component in the design is Murata's 1CX module (full part number: LBEH5UL1CX), which in turn is based around Cypress CYW4356 chipset.

For a full specification, see on Murata's 1CX Module (LBEH5UL1CX) see Murata's 1CX product page (<https://wireless.murata.com/eng/type-1cx.html>) and the 1CX datasheet (url TBD).

Module / Chipset	
Murata module	LBEH5UL1CX
Chipset	Cypress CYW4356

Wi-Fi	
Standards	802.11a/b/g/n/ac 2x MIMO
Network	AP and STA dual mode
Frequency	2.4GHz and 5 GHz band
Data rates	11, 54, 65, 150, 866 Mbps
Host interface	PCIe

Bluetooth	
Standards	5.0 BR/EDR/LE
Power Class	Class 1
Host interface	4-wire UART@3MBaud
Audio interface	PCM for audio

Powering			
Supply voltage to M.2 module	Min	Typ	Max
Note: Do not exceed minimum or maximum voltage. Module will be permanently damaged above this limit!	TBD minimum 3.3 RF specification	3.3V	3.6V
Receive mode current (WLAN)	170 mA typical max		
Transmit mode current (WLAN)	450 mA typical max		

Environmental Specification		
Operational Temperature	-20 to +75 degrees Celsius	Functionally ok, but specification is derated at temperature extremes
Storage Temperature	-40 to +85 degrees Celsius	
Relative Humidity (RH), operating and storage	10 - 90% non-condensing	

3.1 Power Up Sequence

The supply voltage shall not rise (10 - 90%) faster than 40 microseconds and not slower than 100 milliseconds.

Signals WL_REG_ON or BT_REG_ON must be held low for at least 700 microseconds after supply voltage has reached specification level before pulled high. 2 clock cycles of the 32.678kHz clock must also have passed before any of the signals is pulled high. These clock cycles will typically occur during the 700 microseconds but if the clock signal has a long delay during power-up, the 700 microsecond period can be extended.

3.2 External Sleep Clock

The sleep clock signals can be applied to a powered and unpowered M.2 module.

Clock Specification	
Frequency	32.768 kHz
Frequency accuracy	±200 ppm
Duty cycle	30 - 70%
Clock jitter	<10000 ppm
Voltage level	3.3V logic, according to M.2 standard

3.3 Mechanical Dimensions

The M.2 module is of type: 2230-S3-E according to the M.2 nomenclature. This means width 22 mm, length 30mm, top side component height 1.5 mm and key-E connector. The table below lists the different dimensions and weight.

M.2 Module Dimension	Value (±0.15 mm)	Unit
Width	22	mm
Height	30	mm
PCB thickness	0.8	mm
Maximum component height on top side	1.5	mm
Maximum component height on bottom side	0	mm
Ground hole diameter	3.5	mm
Plating around ground hole, diameter	5.5	mm
Module weight	1.5 ±0.5 gram	gram

The picture below gives dimensions for the grounded center (half) hole and the u.fl. antenna connectors.

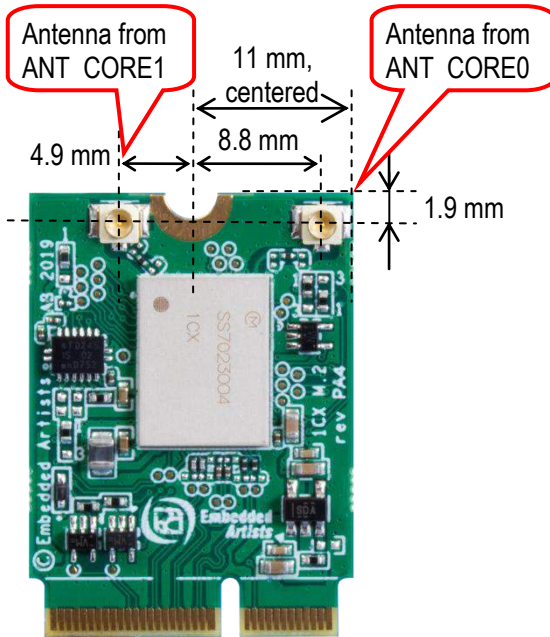


Figure 1 – M.2 Module Antenna Connector Measurements

3.4 M.2 Pinning

This section presents the pinning used for the M.2 module. It is essentially M.2 Key-E compliant with enhancements to support additional debug signals and 3.3V VDDIO override. The pin assignment for specific control and debug signals has been jointly defined by Embedded Artists, Murata and Cypress.

The picture below illustrates the edge pin numbering. It starts on the right edge and alternates between top and bottom side. The removed pads in the keying notch counts (but as obviously non-existing).

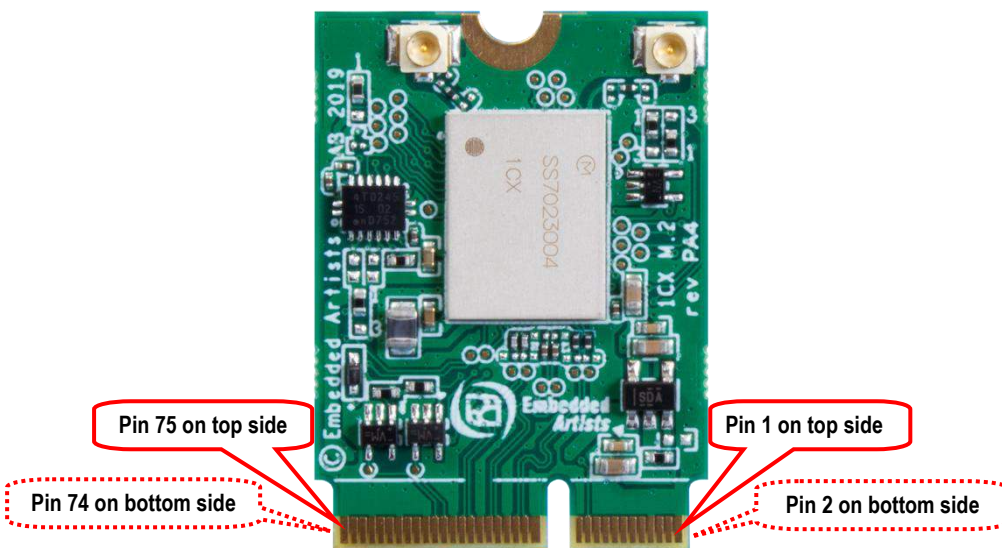


Figure 2 – M.2 Module Pin Numbering

The Wi-Fi interface uses the PCIe interface. The Bluetooth interface uses the UART interface for control and PCM interface for audio. The table below lists the pin usage for the 1CX M.2 modules. The column "When is signal needed" signals four different categories:

- Always: These signals shall always be connected.
- Wi-Fi: These signals shall always be connected then the Wi-Fi interface is used.
- Bluetooth: These signals shall always be connected then the Bluetooth interface is used.
- Optional: These signals are optional to connect.

Pin #	Side of pcb	M.2 Name	Voltage Level and Signal Direction	When is signal needed	Note
1	Top	GND	GND	Always	Connect to ground
2	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
3	Top	USB_D+			Not connected.
4	Bottom	3.3 V		Always	Power supply input. Connect to stable, low-noise 3.3V supply.
5	Top	USB_D-			Not connected.
6	Bottom	LED_1#			Not connected.
7	Top	GND	GND	Always	Connect to ground.
8	Bottom	PCM_CLK	1.8V I/O	Bluetooth audio	For Bluetooth audio interface: BT_PCM_CLK
9	Top	SDIO CLK			Not connected.
10	Bottom	PCM_SYNC	1.8V I/O	Bluetooth audio	For Bluetooth audio interface: BT_PCM_SYNC
11	Top	SDIO CMD			Not connected.
12	Bottom	PCM_OUT	1.8V output from M.2	Bluetooth audio	For Bluetooth audio interface: BT_PCM_OUT
13	Top	SDIO DATA0			Not connected.
14	Bottom	PCM_IN	1.8V input to M.2	Bluetooth audio	For Bluetooth audio interface: BT_PCM_IN
15	Top	SDIO DATA1			Not connected.
16	Bottom	LED_2#			Not connected.
17	Top	SDIO DATA2			Not connected.
18	Bottom	GND		Always	Connect to ground.
19	Top	SDIO DATA3			Not connected.
20	Bottom	UART WAKE#	3.3V OD output from M.2	Bluetooth	For Bluetooth UART interface: BT_HOST_WAKE_L Require an external 10K pullup resistor to 3.3V.
21	Top	SDIO WAKE#			Not connected.
22	Bottom	UART TXD	1.8V output from M.2	Bluetooth	For Bluetooth UART interface: BT_UART_TXD
23	Top	SDIO RESET#			Not connected.
24	Key, non existing				
25	Key, non existing				
26	Key, non existing				
27	Key, non existing				
28	Key, non existing				
29	Key, non existing				
30	Key, non existing				

31	Key, non existing				
32	Bottom	UART_RXD	1.8V input to M.2	Bluetooth	For Bluetooth UART interface: BT_UART_RXD
33	Top	GND		Always	Connect to ground.
34	Bottom	UART_RTS	1.8V output from M.2	Bluetooth	For Bluetooth UART interface: BT_UART_RTS
35	Top	PERp0	PCIe input to M.2	Wi-Fi PCIe	PCIe data input (receive, positive signal)
36	Bottom	UART_CTS	1.8V input to M.2	Bluetooth	For Bluetooth UART interface: BT_UART_CTS
37	Top	PERn0	PCIe input to M.2	Wi-Fi PCIe	PCIe data input (receive, negative signal)
38	Bottom	VENDOR DEFINED	1.8V I/O	Optional	WL_GPIO_5 / JTAG_TDO ⁽¹⁾
39	Top	GND		Always	Connect to ground.
40	Bottom	VENDOR DEFINED	1.8V I/O	Optional	WL_GPIO_4 / JTAG_TDI ⁽¹⁾
41	Top	PETp0	PCIe output to M.2	Wi-Fi PCIe	PCIe data output (transmit, positive signal)
42	Bottom	VENDOR DEFINED	1.8V input to M.2	Bluetooth	BT_DEV_WAKE_L
43	Top	PETn0	PCIe output to M.2	Wi-Fi PCIe	PCIe data output (transmit, negative signal)
44	Bottom	COEX3	1.8V I/O	Optional	WL_GPIO_6 / JTAG_TRST ⁽¹⁾
45	Top	GND		Always	Connect to ground.
46	Bottom	COEX_TXD	1.8V I/O	Optional	WL_GPIO_2 / JTAG_TCK ⁽¹⁾
47	Top	REFCLKp0	PCIe clock input to M.2	Wi-Fi PCIe	PCIe clock input (receive, positive signal)
48	Bottom	COEX_RXD	1.8V I/O	Optional	WL_GPIO_3 / JTAG_TMS ⁽¹⁾
49	Top	REFCLKn0	PCIe clock input to M.2	Wi-Fi PCIe	PCIe clock input (receive, negative signal)
50	Bottom	SUSCLK	3.3V input to M.2	Always	External sleep clock input (32.768kHz)
51	Top	GND		Always	Connect to ground.
52	Bottom	PERST0#	3.3V input to M.2	Wi-Fi PCIe	PCIe PERST# signal, used to initialize the M.2 functions once power sources stabilize.
53	Top	CLKREQ0#	3.3V OD output from M.2	Wi-Fi PCIe	PCIe clock request (low level request reference clock) Note: Requires external 10Kohm pullup
54	Bottom	W_DISABLE2#	3.3V input to M.2	Always	BT_REG_ON, High = BT enabled, Low = BT disabled
55	Top	PEWAKE0#	3.3V OD output from M.2	Wi-Fi PCIe	PCIe PERST# signal, used to implement host wakeup functionality Note: Requires external 10Kohm pullup
56	Bottom	W_DISABLE1#	3.3V input to M.2	Always	WL_REG_ON, High = Wi-Fi enabled, Low = Wi-Fi disabled
57	Top	GND		Always	Connect to ground.
58	Bottom	I2C_SDA			Not connected.
59	Top	Reserved			Not connected.
60	Bottom	I2C_CLK			Not connected.
61	Top	Reserved			Not connected.
62	Bottom	ALERT#			Not connected.
63	Top	GND		Always	Connect to ground.
64	Bottom	RESERVED		Optional	Optional supply voltage input for control and data signal voltage level. Apply a stable, low-noise, 3.3V 100mA supply to set 3.3V voltage level on all signals.
65	Top	Reserved			Not connected.
66	Bottom	UIM_SWP			Not connected.
67	Top	Reserved			Not connected.

68	Bottom	UIM_POWER_SNK		Not connected.
69	Top	GND	Always	Connect to ground.
70	Bottom	UIM_POWER_SRC/GPIO_1		Not connected.
71	Top	Reserved		Not connected.
72	Bottom	3.3 V	Always	Power supply input. Connect to stable, low-noise 3.3V supply.
73	Top	Reserved		Not connected.
74	Bottom	3.3 V	Always	Power supply input. Connect to stable, low-noise 3.3V supply.
75	Top	GND	Always	Connect to ground.

[1] Note: In order to have JTAG signal enabled, the JTAG control resistor must be in 2-3 position, see Figure 3 below for locating the resistor.

3.5 Test Points

There are some test points that can be of interest to probe for debugging purposes, as illustrated in the picture below.

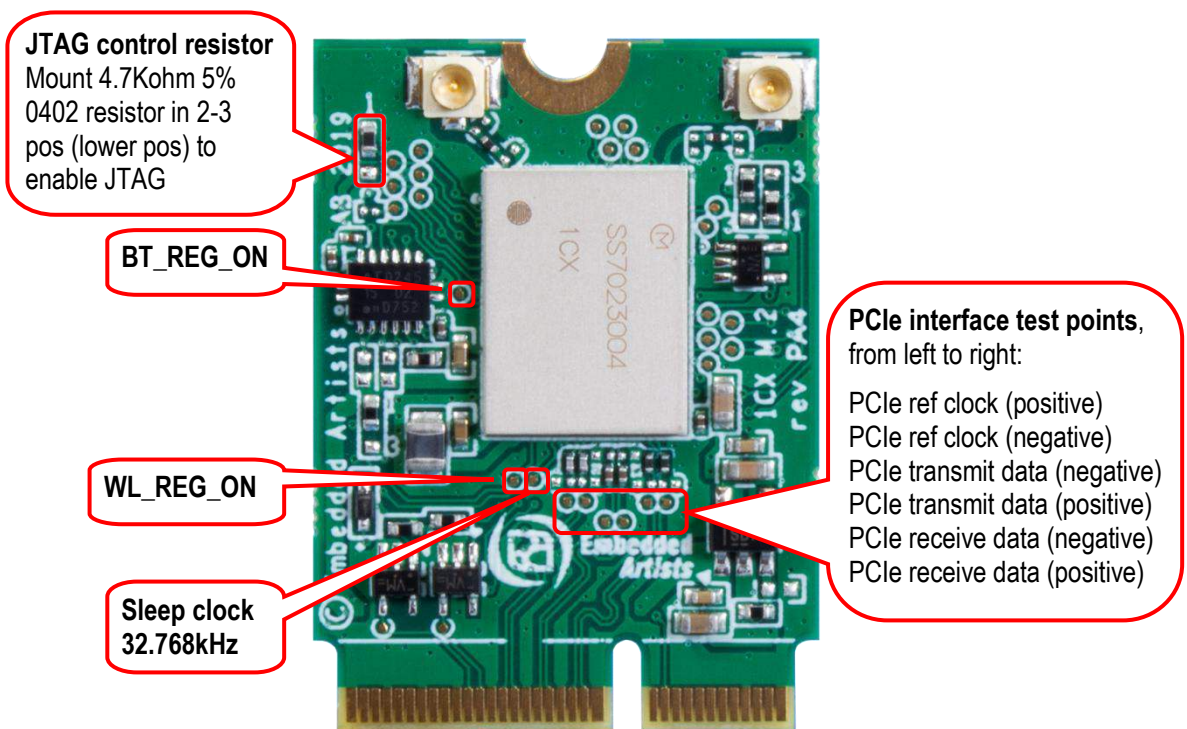


Figure 3 – 1CX M.2 Module Test Points and JTAG Control Resistor

3.6 VDDIO Override Feature

The M.2 standard specify 1.8V logic level on several of the data and control signals. It is possible to override the voltage level for the 1.8V signals via pin 64. Apply a 3.3V / 100 mA supply to pin 64 in order to get 3.3V voltage level on all data and control signals.

4 Antenna

The module does not have any on-board antenna because the module is too small to get spatial separation of the two antennas. Two external antennas must be connected (to support MIMO).

5 Regulatory

The Murata 1CX module is not reference certified.

6 Disclaimers

Embedded Artists reserves the right to make changes to information published in this document, including, without limitation, specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Customer is responsible for the design and operation of their applications and products using Embedded Artists' products, and Embedded Artists accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Embedded Artists' product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products. Customer is required to have expertise in electrical engineering and computer engineering for the installation and use of Embedded Artists' products.

Embedded Artists does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Embedded Artists' products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Embedded Artists does not accept any liability in this respect.

Embedded Artists does not accept any liability for errata on individual components. Customer is responsible to make sure all errata published by the manufacturer of each component are taken note of. The manufacturer's advice should be followed.

Embedded Artists does not accept any liability and no warranty is given for any unexpected software behavior due to deficient components.

Customer is required to take note of manufacturer's specification of used components. Such specifications, if applicable, contains additional information that must be taken note of for the safe and reliable operation.

All Embedded Artists' products are sold pursuant to Embedded Artists' terms and conditions of sale: http://www.embeddedartists.com/sites/default/files/docs/General_Terms_and_Conditions.pdf

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by Embedded Artists for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN EMBEDDED ARTISTS' TERMS AND CONDITIONS OF SALE EMBEDDED ARTISTS DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF EMBEDDED ARTISTS PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY THE CEO OF EMBEDDED ARTISTS, PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, NUCLEAR, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE.

Resale of Embedded Artists' products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by Embedded Artists

for the Embedded Artists' product or service described herein and shall not create or extend in any manner whatsoever, any liability of Embedded Artists.

This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

6.1 Definition of Document Status

Preliminary – The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Embedded Artists does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information. The document is in this state until the product has passed Embedded Artists product qualification tests.

Approved – The information and data provided define the specification of the product as agreed between Embedded Artists and its customer, unless Embedded Artists and customer have explicitly agreed otherwise in writing.