

Quick Start Guide

for

VTX-352

Product Variants

Model	Description
VTX-352	V2X Module, 0C1

Reviewers

Department	Name	Acceptance Date	Note
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Modification History

Revision	Date	Originator	Comment
0.1	2025/05/08	Nidor Huang	Creating document
0.2	2025/08/26	Nidor Huang	Adding supported MCS table
0.3	2025/09/03	Nidor Huang	Updating product description
0.4	2025/11/25	Nidor Huang	Updating FCC statement
0.5	2025/12/22	Nidor Huang	Updating FCC statement
0.6	2026/01/22	Nidor Huang	Removing watermark

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1. Objective

The purpose of this document is to provide you with information necessary to install, set and customize settings, including troubleshooting of the VTX-352 start-up. To ensure safe installation and operation of the equipment, read the safety guidelines at the beginning of this manual and follow the procedures outlined in the following chapters before connecting power to the motherboard or to the I/O cable of VTX-352. Keep this operating manual handy and distribute to all users, technicians, and maintenance personnel for reference.

2. Reference

- Unex VTX-352 information sheet
- I-PEX MHF Micro RF coax connector product series catalog
- I-PEX MHF I Connector Instruction Manual ([HIM-10002-06EN](#))
- 3GPP TS36.521-1 f50 (Release 15.5.0)
- SAE J3161 (2024-07)
- SAE J3161/2 (2024-03)
- ETSI [EN 302 571 V2.1.1](#)
- ETSI [EN 302 636-4-1 V1.4.1](#)
- ETSI [EN 302 663 V1.3.1](#)
- FCC [KDB 511808 D01 C-V2X v02](#)

3. Limited Warranty Policy

Unex Technology Corporation selling the product warrants that commencing from the date of shipment to customer and continuing for a period of twelve (12) months. This limited warranty extends only to the original customer of the product. Customer's sole and exclusive remedy and the entire liability of Unex under this limited warranty will be, at Unex's option, return for repair to Unex's repair center with freight and insurance prepaid or shipment of a replacement within the warranty period or a refund of the purchase price if the hardware is returned to Unex. Unex's obligations hereunder are conditioned upon the return of affected hardware in accordance with Unex's service center's then-current Return Material Authorization (RMA) procedures.

This warranty does not cover:

- Products found to be defective after the warranty period has expired.
- Products subjected to misuse or abuse, whether by accident or other causes. Such product conditions will be determined by Unex at its sole and unfettered discretion.
- Products damaged due to a natural disaster, including but not limited to lightning, flooding, earthquake, or fire.
- Software products.
- Products dismantled or opened by unauthorized persons. Please contact a representative of Unex if you need advanced technical support.
- Products with an altered and/or damaged serial number.
- Loss of data or software.
- Products that have been updated, reworked, or improperly tested by the Customer, or by a third party at the request of the Customer.
- Customized and original design manufacturer (ODM) products. The warranty terms for customized and ODM products should be defined in the contract that governs the project.

4. Safety Guidelines

- Keep working area clean and dry while assembling/installing.
- When operating under extreme temperature conditions, environmental control measures (e.g., heating, cooling) should be considered.
- Make sure every accessory has been fastened, including the V2X antenna cables, board-to-board connector, and the mounting screw.
- Follow the Attention instructions.

Attention 	Follow the operation instructions to make sure the product functioning properly and to avoid product damages during handling / installation / operation.
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- Follow the Caution instructions.

Caution 	Follow the safety instructions to keep users / operators from health hazards.
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5. FCC Compliance and Advisory Statement

FEDERAL COMMUNICATIONS COMMISSION INTERFERENCE STATEMENT

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.

CAUTION:

Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. 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.

RF Exposure warning

This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

Information for OEMs and host integrators

The OEM or integrator is obligated to adhere to these requirements and restrictions as a condition for using the module's certification.

The OEM or integrator is responsible to perform the required additional host regulatory testing and/or obtaining the required host approvals for compliance.

Per KDB 996369 D03 v01r01 OEM Manual section 2.2 to 2.12, this module is intended for OEM integrators under the following conditions:

2.2 List of applicable FCC rules

This module has been tested for compliance to FCC Part 95 Subpart L and Part 90 Subpart M.

2.3 Summarize the specific operational use conditions

The module is tested for standalone mobile RF exposure use condition. Any other usage conditions such as co-location with other transmitter(s) will need a separate reassessment through a class II permissive change application or new certification.

2.4 Limited module procedures

Not applicable, this device is a single modular approval.

2.5 Trace antenna designs

Not applicable. This module has its own antenna, and does not need a host's printed board micro strip trace antenna, etc.

2.6 RF exposure considerations

This equipment complies with FCC mobile radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator & your body. A separate SAR/Power Density evaluation is required to confirm compliance with relevant FCC portable RF exposure rules.

2.7 Antennas

The following antennas have been certified for use with this module; antennas of the same type with equal or lower gain may also be used with this module, except as described below. The antenna must be installed such that 20 cm can be maintained between the antenna and users.

No.	Manufacturer	Model No.	Antenna Type	Peak Gain (dBi)	Freq. Range (GHz)	Connector Type
1	Unex	EX-53	Omni	7.6	5795-5925 MHz	Type N plug
2	Unex	EX-55	Omni	5	5150-5950 MHz	FAKRA Z Jack
3	TOP-LINK	ZG-OI-596005-NM	Omni	4	5800-6000 MHz	N-Male

IMPORTANT: The final host product must have an integral antenna which is not removable by the end-user.

2.8 Label and compliance information

Label of the end product:

The final end product must be labeled in a visible area with the following: **"Contains FCC ID: NUK-VTX352C"**. The grantee's FCC ID can be used only when all FCC compliance requirements are met. The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end product user manual shall include all required regulatory information/warning as shown in this manual.

2.9 Information on test modes and additional testing requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) class II permissive change re-evaluation or new certification.

2.10 Additional testing, Part 15 Subpart B disclaimer

This transmitter module is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement applicable to the final host. The final host will still need to be reassessed for

compliance to this portion of rule requirements if applicable. OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment.

As long as all conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

2.11 Note EMI Considerations

Note that a host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional noncompliant limits due to module placement to host components or properties. For standalone mode, reference the guidance in D04 Module Integration Guide and for simultaneous mode; see D02 Module Q&A Question 12, which permits the host manufacturer to confirm compliance.

2.12 How to make changes

Only Grantees are permitted to make permissive changes, if the module will be used differently than granted conditions, please contact us to ensure modifications will not affect compliance.

IMPORTANT NOTE: In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The host integrator must follow the integration instructions provided in this document and ensure that the composite-system end product complies with the requirements by a technical assessment or evaluation to the rules and to KDB Publication 996369.

The host integrator installing this module into their product must ensure that the final composite product complies with the requirements by a technical assessment or evaluation to the rules, including the transmitter operation and should refer to guidance in KDB 996369.

OEM/Host manufacturer responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment.

6. Product Appearance

The photos in this document may differ from actual product; the Model and Part No. on label may differ for each model. However, the differences do not affect actual functionalities.

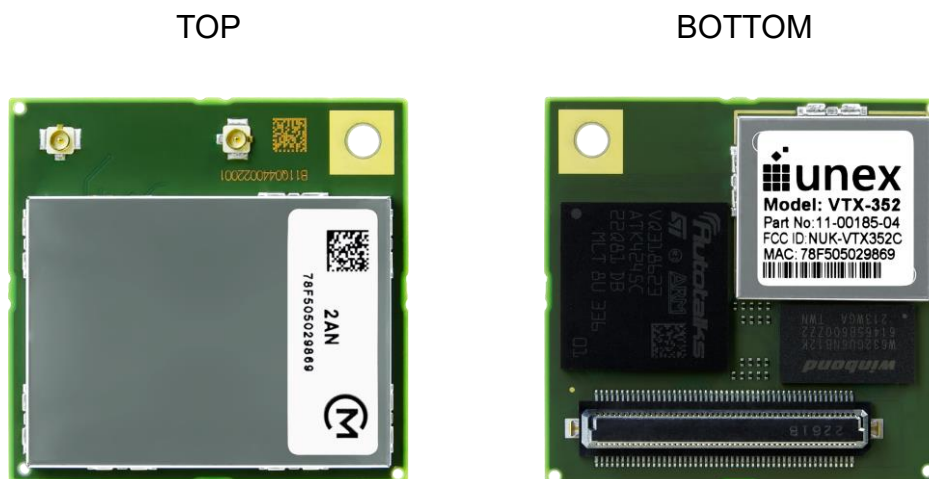


Figure 1. VTX-352 appearance

7. Functional Block Diagram

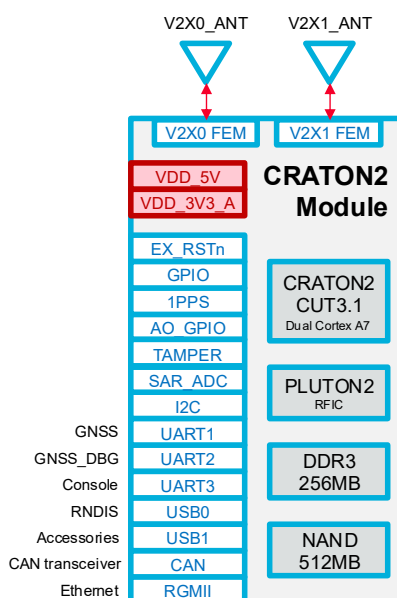


Figure 2: Functional block diagram

8. Electrical Characteristics

8.1. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted).

Table 1. Absolute maximum ratings

Parameters	Conditions	Min.	Max.	Unit
Storage Temperature	-	-40	105	°C
Supply Voltage	VDD_5V	-0.3	5.25	V
	VDD_3V3_A	-0.3	3.9	V
V2X maximum input level	-	-	10	dBm
Note: (1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime. (2) All voltages are with respect to network GND.				

8.2. Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted).

Table 2. Recommended operating conditions

Parameters	Conditions	Min.	Typ.	Max.	Unit
Ta (Ambient operating temperature)	Free-air temp.	-40	25	85	°C
Supply voltage	VDD_5V	4.8	5.0	5.2	V
	VDD_3V3_A	3.0	3.3	3.6	V
RPU (Equivalent pull-up)	VDD_3.3V *1	30	50	70	kΩ
RPD (Equivalent pull-down)	VDD_3V3_A	30	50	70	kΩ
Input resistance		1			MΩ
VIL (Input low level voltage)	VDD_3V3_A VDD_3.3V *2	-0.3	-	0.8	V
VIH (Input high level voltage)	VDD_3.3V *3	2.0	-	3.6	V
	VDD_3V3_A	2.0	-	VDD_3V3_A + 0.3	V
VOL (Output low level voltage)	VDD_3.3V IOL = 4/8mA *4	-	-	0.4	V
	VDD_3V3_A IOH = 2mA	-	-	0.4	V
VOH (Output high level voltage)	VDD_3.3V IOH = -4/-8mA *5	2.9	-	-	V

Parameters	Conditions	Min.	Typ.	Max.	Unit
	VDD_3V3_A IOH= -2mA	VDD_3V3_A -0.4	-	-	V
GNSS_PPS (P25) tolerance	Accuracy/Bias	-100	-	100	ns
	Precision/Jitter	-30	-	30	ns
	Pulse width	15	-	-	ns
C-V2X sensitivity *6	RB allocation=96 PER ≤ 10%	-	-	-86.1	dBm
C-V2X maximum output power *7	Target Power=23dBm, RB allocation=96 Power Class3	19.7	23	26.3	dBm
C-V2x minimum output power *8	Target Power=-30dBm, RB allocation=96	-	-	-28.5	dBm
C-V2X output power tolerance *9	Test Point1 Power=-18dBm	-5	-	5	dB
	Test Point2 Power=15dBm	-5	-	5	dB
C-V2X adjacent channel leakage power ratio *10	Target Power=23dBm, RB allocation=18, Start RB #: 82, EUTRA1	29.2	-	-	dB
	Target Power=23dBm, RB allocation=18, Start RB #: 0, EUTRA1	29.2	-	-	dB
	Target Power=23dBm, RB allocation=96, Start RB #: 0, EUTRA1	29.2	-	-	dB
Carrier frequency accuracy	DSRC mode	-20	-	20	ppm
DSRC sensitivity *11	PER ≤ 10%	-	-	-86	dBm
	PER ≤ 10%, -40 - +85 °C	-	-	-82	dBm
DSRC maximum input level	PER ≤ 10%	-30	-	-	dBm
DSRC adjacent channel rejection	-	13	-	-	dB
DSRC non-adjacent channel rejection	-	29	-	-	dB
DSRC output power	Spectrum mask Class C	0	-	20	dBm
V2X duty cycle *12	Transmission	-	-	20	%
Antenna connector durability	Mating cycle limit	-	-	30	cycles

Parameters	Conditions	Min.	Typ.	Max.	Unit
Note: *1: Except USB0_DN/USB0_DP/USB1_DN/USB1_DP *2: Except USB0_DN/USB0_DP/USB1_DN/USB1_DP in USB 2.0 high speed mode. See ERROR! REFERENCE SOURCE NOT FOUND. for drive strength of each pin. *3: Except USB0_DN/USB0_DP/USB1_DN/USB1_DP in USB 2.0 high speed mode. See ERROR! REFERENCE SOURCE NOT FOUND. for drive strength of each pin. *4: IOL = Low level output current *5: IOH = High level output current *6: 3GPP TS36.521-1 f50 (Release 15.5.0) §7.3G.1/Reference sensitivity level for V2X Communication Bandwidth: 20MHz, Modulation: QPSK, Frequency: 5890MHz, Start RB #: 0, RB allocation=96. *7: 3GPP TS36.521-1 f50 (Release 15.5.0) §6.2.2G.1/UE maximum output power for V2X Communication *8: 3GPP TS36.521-1 f50 (Release 15.5.0) §6.3.2G.1/UE minimum output power for V2X Communication *9: 3GPP TS36.521-1 f50 (Release 15.5.0) §6.3.5G/Power Control Absolute power tolerance for V2X Communication *10: 3GPP TS36.521-1 f50 (Release 15.5.0) §6.6.2.3G.1/Adjacent channel leakage power ratio for V2X communication *11: Bandwidth: 10MHz, Modulation: QPSK 1/2, Frequency: 5890MHz, Target Power: 20dBm. *12: Duty cycle is calculated in 100ms period.					

8.3. Power Consumption

VTX-352 must be powered with dual voltage (VDD_5V/VDD_3V3) power rails. The data listed in [TABLE 3. DUAL VOLTAGE POWER CONSUMPTION](#) serve only as a reference for system integrators. The actual conditions will vary depending on firmware version and user applications.

Table 3. Dual voltage power consumption

Condition			Power Consumption (A)		
Temp.	Power Source	Voltage (V)	Low *1	Typical *2	High *3
25°C	VDD_5V *4	5.0	0.34	0.40	2.0
	VDD_3V3_A *5	3.3	0.01	0.01	0.05
85°C	VDD_5V *4	5.0	0.38	0.44	2.0
	VDD_3V3_A *5	3.3	0.01	0.01	0.05
Note: *1: CPU idle and V2X stack loaded. *2: CPU 50% and V2X transmitting 400 bytes at 20dBm every 100ms. *3: Hardware upper limit. *4: From VDD_5V (pin 1, 2, 3, 4, 5) *5: From VDD_3V3_A (pin 64)					

8.4. Operation Frequency

8.4.1. C-V2X (PC5)

VTX-352 can transmit/receive C-V2X signals (PC5, mode 4 sidelink) in U-NII-4 band (Band 47, 5895-5925 MHz). Supported C-V2X channels and output limits are listed in [TABLE 4](#); modulation and coding scheme (MCS) can be found in [TABLE 5](#):

Attention 	1	Geofencing is not supported according to KDB 511808 D01 C-V2X v02 §2.1.A
	2	An OBU/RSU product integrating VTX-352 module(s) can operate without geofencing with the following sentence shown on its label: Contains FCC ID: NUK-VTX-352C
	3	If an OBU/RSU product integrating VTX-352 module(s) needs to activate geofencing function and increase EIRP limits, the manufacturer of the OBU/RSU must apply a new FCC ID.

Table 4: Supported C-V2X channels

Channel	Frequency (MHz)	Bandwidth (MHz)	Output power limit (dBm) *1	OBUEIRP limit (dBm) *2	RSUEIRP limit (dBm) *3
180	5895-5905	10	23	23	33
182	5905-5915	10	23	33 *4	33
184	5915-5925	10	23	33 *4	33
181	5895-5915	20	23	23	33
183	5905-5925	20	23	33 *4	33

Note:

*1: Following SAE J3161 maxTxPower-r12/maxTxPower-r14 (2024-07)

*2: Following FCC [KDB 511808 D01 C-V2X v02, §3.2.1, TABLE 1](#)

*3: Following FCC [KDB 511808 D01 C-V2X v02, §3.2.2, TABLE 2](#). The radiation center of an RSU antenna shall not exceed 8 meters above the roadway surface bed.

*4: Reduced to 27dBm within ± 5 degrees of horizontal

Table 5. Supported C-V2X MCS table

C-V2X Modulation and Coding Scheme				
MCS	Modulation	Coding Rate	Bandwidth	
			20MHz	10MHz
5	QPSK	0.40	Yes	Yes
6	QPSK	0.50	Yes	Yes
7	QPSK	0.58	Yes	Yes
11	16QAM	0.41	Yes	Yes

Note:

Following TS 36.213 v15.15.0, Table 7.1.7.2.1-1: Transport block size table

8.4.2. DSRC (ITS-G5)

VTX-352 can transmit/receive DSRC signals (ETSI ITS-G5) in U-NII-4 band (5855-5925 MHz). Supported DSRC channels and output limits are listed in [TABLE 6](#); modulation and coding scheme (MCS) can be found in [TABLE 7](#):

Table 6: Supported DSRC channels

Channel	Frequency (MHz)	Bandwidth (MHz) *1	Output power limit (dBm) *2	EIRP limit (dBm) *3
172	5855-5865	10	20	33
174	5865-5875	10	20	33
176	5875-5885	10	20	33
178	5885-5895	10	20	33
180	5895-5905	10	20	33
182	5905-5915	10	20	33
184	5915-5925	10	20	33
Note: *1: Following EN 302 571 V2.1.1 (2017-02) §4.2.1 *2: Following EN 302 571 V2.1.1 (2017-02) §4.2.5.2 *3: Following EN 302 571 V2.1.1 (2017-02) §4.2.2.2				

Table 7. Supported DSRC MCS table

DSRC Modulation and Coding Scheme				
Data Rate	Modulation	Coding Rate	Bandwidth	
			20MHz	10MHz
3	BPSK	1/2	-	Yes
4.5	BPSK	3/4	-	Yes
6	QPSK	1/2	-	Yes
9	QPSK	3/4	-	Yes
12	16QAM	1/2	-	Yes
18	16QAM	3/4	-	Yes
24	64QAM	2/3	-	Yes
27	64QAM	3/4	-	Yes
Note: Following EN 302 663 V1.3.1 , Table 1: Static receiver sensitivity				

9. I/O Interfaces

9.1. V2X Interfaces

9.1.1. RF Connector

The VTX-352 provides two 50 Ω RF connectors. Receptacle connectors are *I-PEX MHF I 20279-001E-03*. For more information about mating plug connectors, visit the website <https://www.i-pex.com/product/mhf-i> for details.

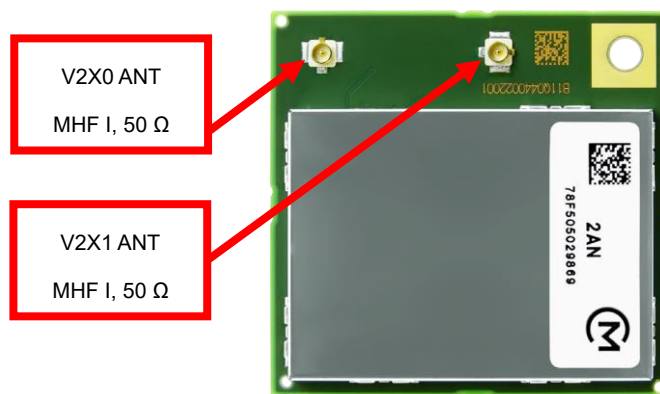


Figure 3: Antenna connectors

The antenna connection is one of the most important aspects in the full product design as it strongly affects the RF performance. Connecting cables between the module and the antenna must have 50 Ω impedance. If the impedance of the module is mismatched, RF performance will be reduced significantly.

Please be careful when extracting the antenna cables from a VTX-352 module. Extracting the connector by pulling the cable may cause damage on the antenna plug assembly. It is recommended to extract the cable using a proper extraction tool suggested by the cable plug manufacturer. For I-PEX plugs please use *I-PEX 90192-001 or 90224-001*.

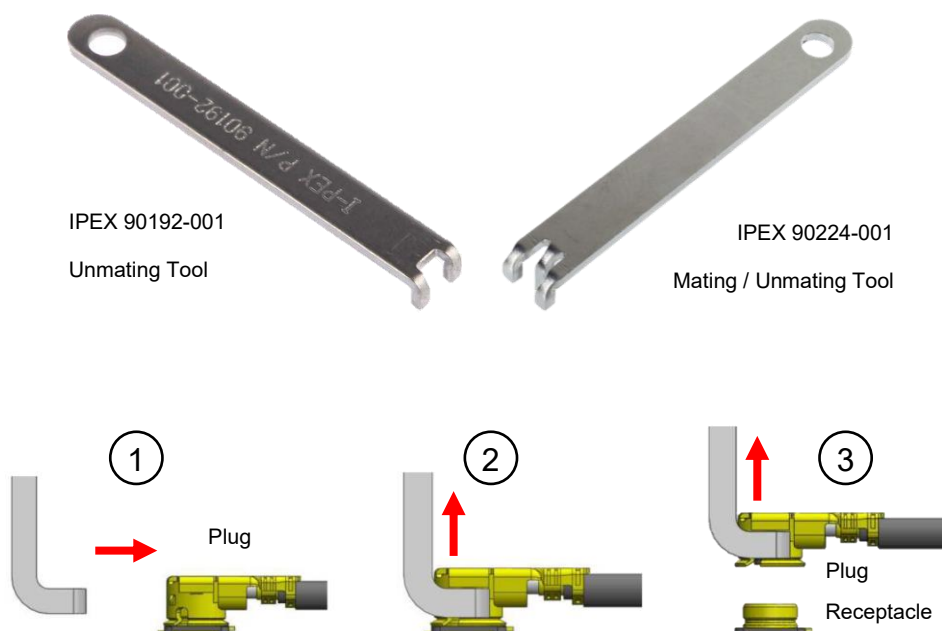


Figure 4: Antenna cable extraction tool

Attention 	1 The durability of MHF I connector lasts up to 30 mating cycles. If V2X signal strength becomes too low, either for TX or RX, please check the mating cycles. 2 If repetitive mating / unmating actions have been performed, once the mating cycle exceeds 30 times, please replace the plug connector cable.
Attention 	1 Always use only the extraction tool recommended by the plug manufacturer of your choice. It is possible to cause severe damage on the receptacle if a third-party extraction tool is used. For example, using an I-PEX tool on a HIROSE plug has been known to lead to connector damages. 2 It is very important to keep the extraction tool at a vertical position at all time, and apply only vertical pulling force on the tool. Applying a non-vertical force or using the tool in a crowbar style will damage not only the antenna connector but also other components in proximity. 3 Please follow HIM-10002-06EN for more detailed instructions.

9.1.2. Antenna Detection

The V2X antenna ports has a built-in antenna detection function (see [TABLE 8](#)). This detection mechanism only works with Unex V2X antennas [EX-55](#) or [EX-53](#).

Attention 	1 Do not start TX activity without V2X antennas connected. 2 Always check antenna status before any V2X TX activity. 3 TX activity without V2X antennas connected will cause permanent damages to RF components. 4 TX activity under OPEN/SHORT conditions may also cause permanent damages to RF components. 5 ETSI FW VPS-352EC/VPS-352ED will automatically start beacon TX after powered up. This is the default behavior defined in ETSI EN 302 636-4-1 V1.4.1 §10.2.3. Always connect V2X antennas before powering up VX-352 with above FW models.
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Table 8: V2X antenna status

Antenna Status	Value	Command
OPEN	616-1023	V2X0: cat /sys/bus/iio/devices/iio:device0/in_voltage4_raw V2X1: cat /sys/bus/iio/devices/iio:device0/in_voltage5_raw
NORMAL	410-615	
SHORT	0-409	

Please note that the EX-55/EX-53 antennas are not included in VTX-352 product package and can be purchased separately.

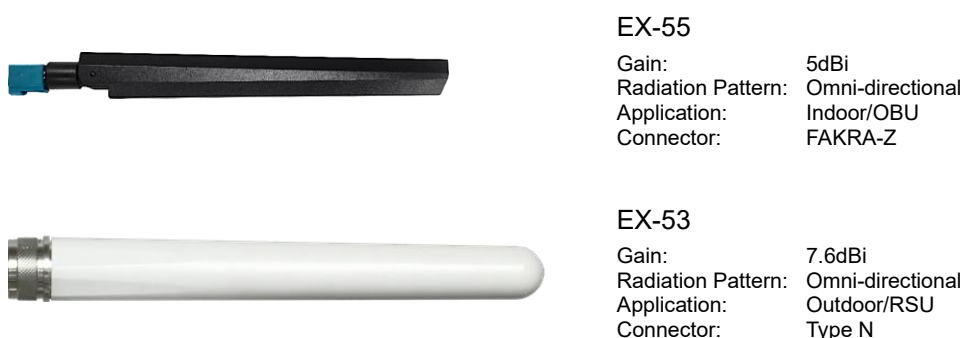


Figure 5: V2X antennas EX-55/EX-53

10. Dimensions and Weight

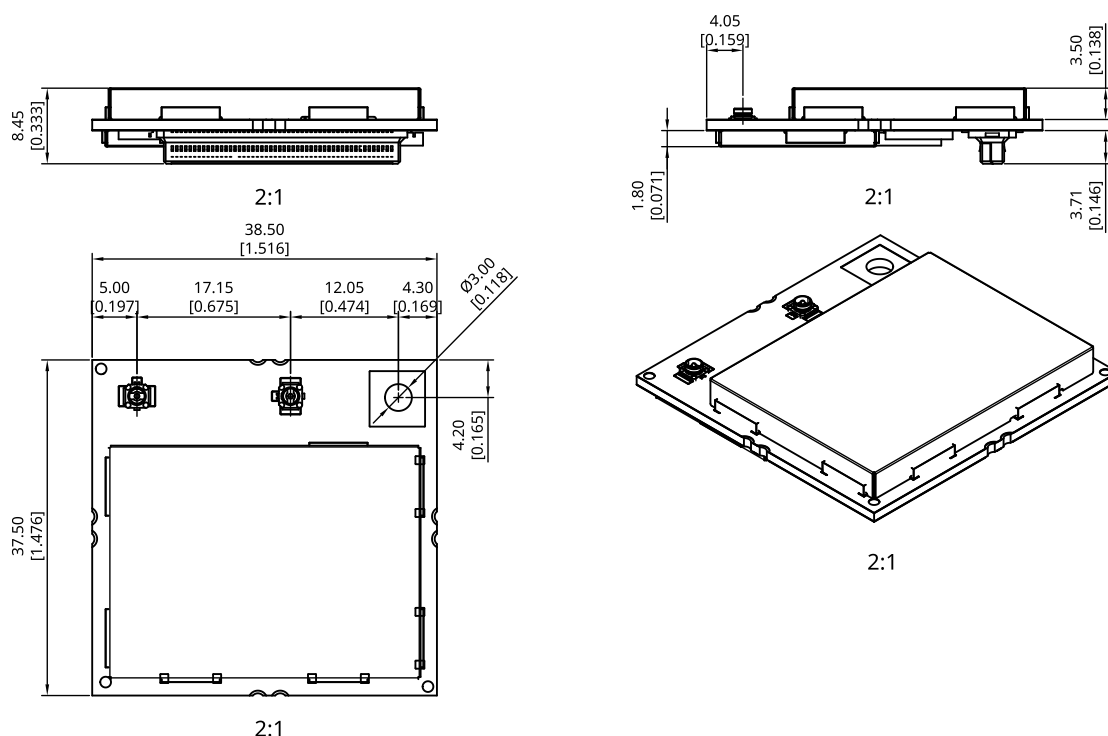


Figure 6: VX-352 dimensions

Table 9: Dimensions and weight

Model	Length (mm)	Width (mm)	Height (mm)	Weight (g)
VTX-352	37.5±0.3	38.5±0.3	8.45±0.3	10.2±0.5

10.1. Component Keep Out Area

In order to avoid interference with VTX-352, the system board side component height underneath the VTX-352 should not exceed 3.0mm.

11. Thermal Management

Applying a soft silicone thermally conductive pad to fill the air gap between VTX-352 and its system board could help disperse heat generated by the VTX-352 to the system board. It is recommended to keep continuous large copper pour area on the system PCB underneath the VTX-352, better with exposed bare copper especially directly under the

CPU.

The distance between system board and CPU top surface is 3.7mm. Recommended size of thermally conductive pad: 16x16x4mm.



Figure 7: Recommended Thermally Conductive Pad Area