

VTAP

Application Note - External NFC antennas with VTAP50

VTAP Core Firmware from v2.2.5.0

VTAP50

Revised January 2025 v1.12

If you need help to set up or use your VTAP reader, beyond what is contained in this Application Note, then please contact our support team.

Email: vtap-support@dotorigin.com

Download the latest documentation and firmware from <https://vtapnfc.com>

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If you have any feedback on setting up or using your VTAP reader or this documentation, then please contact our support team. The product is constantly being reviewed and improved and we value feedback about your experience.

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1 External NFC antennas with VTAP50

The VTAP50-OEM has an option to snap off the on-board antenna and connect an external antenna, with a suitable matching circuit, to the VTAP50.

Dot Origin can provide support for integrating external off-the-shelf or custom NFC antennas with VTAP50 readers. This Application Note includes matching circuit examples for a number of off-the-shelf NFC antennas (section [4.1](#)).

Scenarios where an external antenna may be required include:

- A VTAP reader will be embedded inside other equipment, beyond standard antenna range, for instance within a turnstile;
- Design preference for a custom antenna, for example an antenna that loops around a kiosk or vending machine touchscreen.

Note: The VTAP50-OEM reader board has been EMC tested with its integrated loop antenna, printed on the PCB. The VTAP50-OEM reader board is designed so that you can carefully break the integrated antenna from the board and connect an external antenna, or buy the VTAP50-OEM without its antenna, sold as VTAP50-MOD.

Annex If any external antenna is attached to the VTAP50 module, that new arrangement will require corresponding tuning circuits and EMC approvals. Contact vtap-support@dotorigin.com for details about tuning circuit and EMC approvals for the tested external antennas.

2 External antenna choices

There are two ways in which an external antenna can be used in place of the VTAP50 on-board antenna. Your decision will be affected by the type of enclosure you are designing to house the VTAP50-OEM reader board and its external antenna, and by the way that you plan to approach radio testing and certification of your end product.

- A. Integrate a suitable tuning circuit into your own antenna assembly, which will then substitute for the VTAP50-OEM on-board antenna;
- B. Design a separate tuning circuit that can be mounted in between the VTAP50-OEM reader module and an off-the-shelf external antenna.

You will need assistance from VTAP support engineers to design a suitable tuning circuit, as detailed knowledge of the VTAP hardware design will be required.

The VTAP50-OEM reader board already has modular certification, and our VTAP support engineers have experience of obtaining approval for use of the product with an alternate antenna. This involves seeking relevant regional radio compliance approvals, such as an FCC/ISED permissive change filing, which may be an approach you would like to follow.

Please consult **VTAP support** at an early stage, to discuss your plans and requirements.

3 Connect an external antenna

1. Snap off the VTAP50 on-board antenna. We recommend that you break the snap off points by applying pressure with a screwdriver, when the PCB is lying on a flat surface.

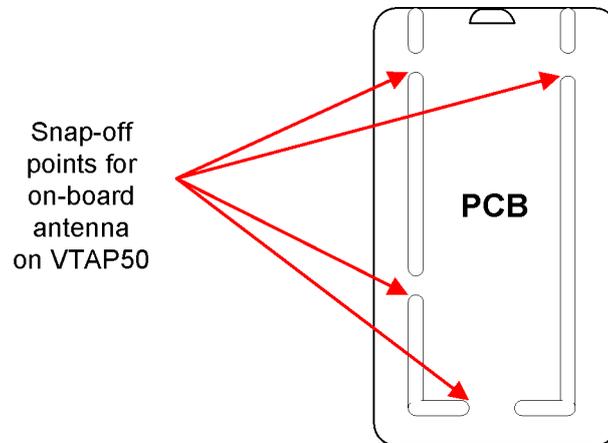


Figure 3-1 Points on VTAP50 to snap off the on-board antenna.

2. Then connect the external antenna to the VTAP reader using the 10/12 pin expansion header via a matching or tuning circuit (see examples in section [4](#). The pins 1 and 2 on the expansion header are used for external antenna connection.

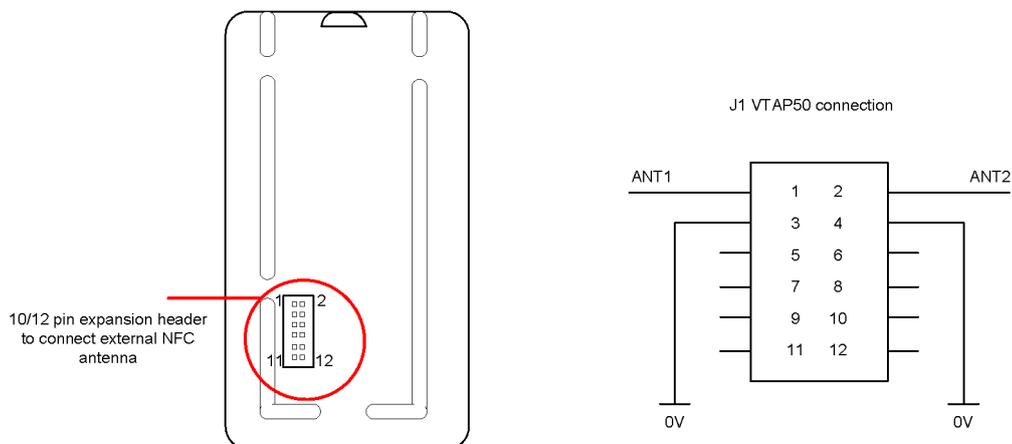


Figure 3-2 Expansion header to connect external antenna

CAUTION: Always ensure sufficient clearance between the VTAP antenna and other RF transmitters to avoid electromagnetic interference between equipment. The clearance required varies from antenna to antenna, depending on antenna size, power and sensitivity.

4 Antenna matching or tuning

A matching or tuning circuit ensures that there is maximum power transmitted between the antenna and the RF transmitter device, with the antenna working only in the desired frequency band (13.56MHz), and minimum signal loss between the transmitter and antenna (Return Loss/VSWR). Tuning is essential to NFC transmission, since imperfect antenna matching or tuning can cause high power loss and poor antenna performance, and in some cases lead to circuit failure.

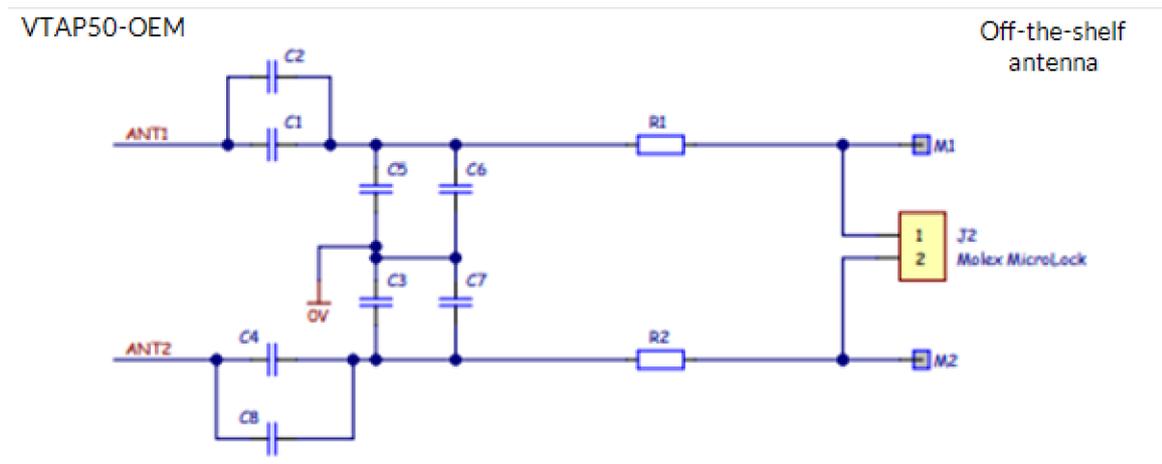


Figure 4-1 Example board schematic for antenna matching or tuning

We have designed the matching circuits with for various off-the-shelf NFC antennas, which could be readily used with the VTAP50. (These tuning circuits are not off-the-shelf accessories, only examples of the type of design required. You will need to make design decisions about where best to accommodate the tuning circuit, refer to section [2 External antenna choices](#).) The example antennas are:

- **Pulse Antennas W7002- NFC Wire Loop Antenna**
- **Pulse Antennas W7013- Small Planar NFC Antenna with Ferrite**
- **Molex Antennas 146236-2131 NFC Coil 45x55mm**
- **Molex Antennas 146236-2122 NFC Coil 34x46mm**
- **Molex Antennas 146236-2102 NFC Coil 15x25mm**
- **Molex Antennas 146236-2151 NFC Coil 15x15mm**

Component values provided in the following tables to integrate the example antennas, all relate to the tuning circuit diagram [Figure 4-1](#) above.

Note: If you need matching circuit calculations for another NFC antenna, or other support in custom NFC antenna design, please contact vtap-support@dotorigin.com with your requirement to explore how we can support you.

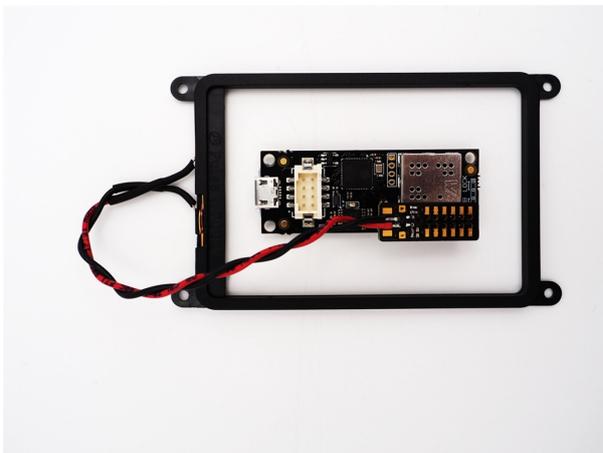
CAUTION: These values are calculated using the standard out-of-the-box cable arrangements (100mm cables where mentioned) and matching header PCB as shown in the photographs. Your matching board needs to be designed and mounted on the expansion header in similar fashion. Changes in component values, matching board style or cable length will change the characteristic and result in a mismatch.

4.1 Matching circuit examples for off-the-shelf antennas

Pulse Antennas W7002- NFC Wire Loop Antenna

There are two sets of matching circuit components for this antenna model:

- antenna without a cable (standard out-of-the-box arrangement); and
- antenna with a pair of 24AWG, 100mm long cable.



a. Without cable (Out-of-the-box arrangement):

Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	-	-
C2	56pF	Cseries
C3	68pF	Cshunt
C4	-	-
C5	10pF	Cshunt
C6	68pF	Cshunt
C7	10pF	Cshunt
C8	56pF	Cseries
R1	3.3Ω	Rseries
R2	3.3Ω	Rseries

This arrangement provides an NFC pass read distance of up to 90mm.

b. With 100mm, 24AWG cable pair:

Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	33pF	Cseries
C2	10pF	Cseries
C3	75pF	Cshunt
C4	33pF	Cseries
C5	-	-
C6	75pF	Cshunt
C7	-	-
C8	10pF	Cseries
R1	2.7Ω	Rseries
R2	2.7Ω	Rseries

This arrangement provides an NFC pass read distance of up to 95mm.

Pulse Antennas W7013- Small Planar NFC Antenna with Ferrite

This antenna comes without a connecting cable. We have calculated the matching circuit for this NFC antenna with a pair of 24AWG, 102mm long cable.



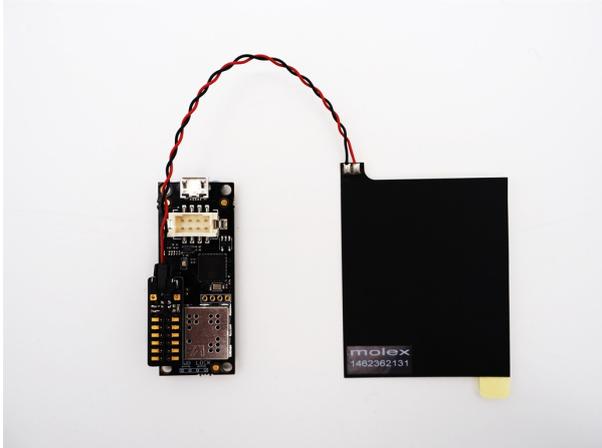
Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	68pF	Cseries
C2	-	-
C3	150pF	Cshunt
C4	68pF	Cseries
C5	-	-
C6	150pF	Cshunt
C7	-	-
C8	-	-
R1	1.0Ω	Rseries
R2	1.0Ω	Rseries

This arrangement provides an NFC pass read distance of up to 50mm.

Molex Antennas 146236-2131 NFC Coil 45x55mm

This 45x55mm antenna comes with a 102mm long, 28AWG cable and a Micro-Lock Plus connector. It has a ferrite sheet on one side and adhesive mounting on the other side.



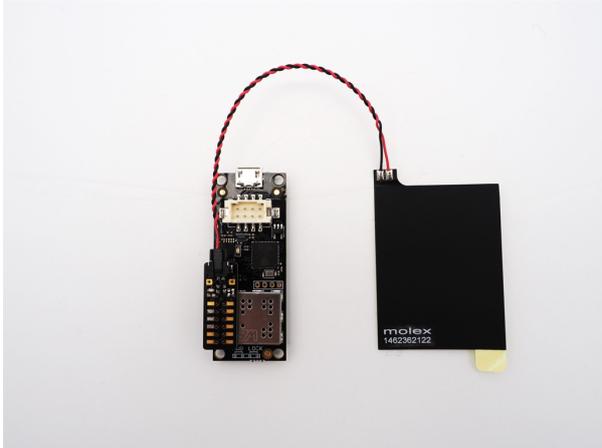
Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	33pF	Cseries
C2	-	-
C3	33pF	Cshunt
C4	33pF	Cseries
C5	4.7pF	Cshunt
C6	33pF	Cshunt
C7	4.7pF	Cshunt
C8	-	-
R1	1.5Ω	Rseries
R2	1.5Ω	Rseries

This arrangement provides an NFC pass read distance of up to 75mm.

Molex Antennas 146236-2122 NFC Coil 34x46mm

This 34x46mm antenna comes with a 102mm long, 28AWG cable and a Micro-Lock Plus connector. It has a ferrite sheet on one side and adhesive mounting on the other side.



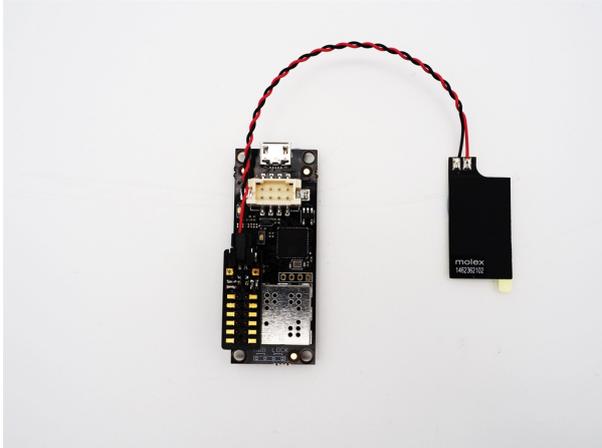
Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	33pF	Cseries
C2	-	-
C3	27pF	Cshunt
C4	33pF	Cseries
C5	-	-
C6	27pF	Cshunt
C7	-	-
C8	-	-
R1	1.5Ω	Rseries
R2	1.5Ω	Rseries

This arrangement provides an NFC pass read distance of up to 70mm.

Molex Antennas 146236-2102 NFC Coil 15x25mm

This 15x25mm antenna comes with a 102mm long, 28AWG cable and a Micro-Lock Plus connector. It has a ferrite sheet on one side and adhesive mounting on the other side.



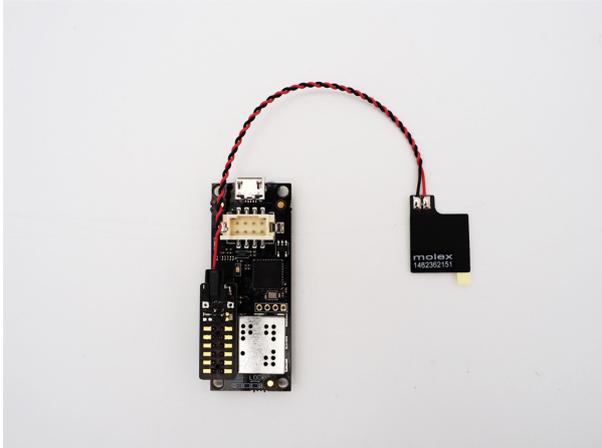
Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	33pF	Cseries
C2	10pF	Cseries
C3	33pF	Cshunt
C4	33pF	Cseries
C5	4.7pF	Cshunt
C6	33pF	Cshunt
C7	4.7pF	Cshunt
C8	10pF	Cseries
R1	1.5Ω	Rseries
R2	1.5Ω	Rseries

This arrangement provides an NFC pass read distance of up to 35mm.

Molex Antennas 146236-2151 NFC Coil 15x15mm

This 15x15mm antenna comes with a 102mm long, 28AWG cable and a Micro-Lock Plus connector. It has a ferrite sheet on one side and adhesive mounting on the other side.



Matching circuit component values for **Figure 4-1**.

Component	Value	Remarks
C1	47pF	Cseries
C2	-	-
C3	68pF	Cshunt
C4	47pF	Cseries
C5	-	-
C6	68pF	Cshunt
C7	-	-
C8	-	-
R1	1.5Ω	Rseries
R2	1.5Ω	Rseries

This arrangement provides an NFC pass read distance of up to 30mm.

5 About Application Notes

Application Notes address topics of interest to small groups of customers, or topics around the use of a VTAP reader with third-party systems.

The main documents available to support your use of the VTAP50 are the Installation Guide for your VTAP reader model and the VTAP Configuration Guide. You will find the latest versions of these, and other useful information at <https://vtapnfc.com>.

If you need further help do contact us by email to vtap-support@dotorigin.com, or by phone +44 (0) 1428 685861 from Europe and Asia, or +1 (562) 262-9642 from Northern and Latin America.