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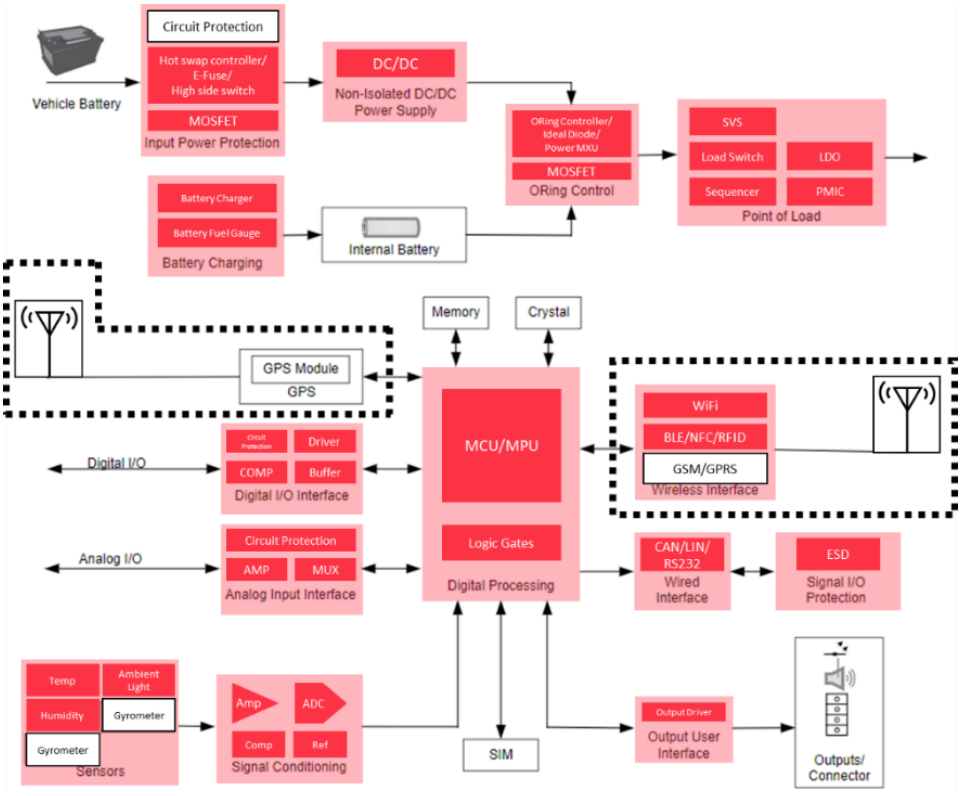
GNSS antenna for asset trackers: GPS, GALILEO, GLONASS, BeiDou in 7x3x2 mm

APPLICATION NOTE
DUO mXTEND™ (NN03-320)

ASSET TRACKING – Asset Tracker

Some of the most important challenges that manufacturers face when designing and prototyping an asset tracker, are performance, battery life, accuracy and so on.
Any asset tracking device's data transmission has to be completely reliable, therefore, the antenna is a critical component in such device.
First, chip antenna technology has been proven to deliver top GNSS (GPS, GLONASS, GALILEO, BeiDou…) performance in a variety of tracking devices and fleet management applications. Usually, a ceramic patch antenna is the option of choice for its traditional connection with satellite systems applications in terms of a good reception if the receiver is reasonably stable with respect to the GNSS satellite constellation and if the application has no relevant space and cost constrains. Nowadays, the range of different types of tracking devices is very large, and all of them have different sizes and requirements. These have to consider one important fact: they are located everywhere and not always stable and facing to the satellite reception. As modern smartphones proved that an omnidirectional, linearly polarized antenna can deliver an optimal GNSS performance for the vast majority of applications, such antenna to integrate into your tracking device will ensure the best GNSS signal regardless of the satellite location and/or the distance from the data receiver. At this point, with the endless diversity of new devices requiring versatile GNSS connection, Virtual Antenna™ components, being omnidirectional antennas, become the perfect choice where also, size, weight, portability, and cost are a priority.
Second, Virtual Antenna® technology allows for a single antenna to use multiple RF protocols with a single antenna component, letting your tracking device to broadcast a location via GPS while using Bluetooth or Cellular to receive or transmit data with an external device for configuration or managing purposes apart from location. This antenna versatility can be determining when deciding which is the best fit for your device, as you might have multiple solutions within only just one antenna component.
Furthermore, thanks to the use of the PCB for radiating, Virtual Antenna® technology allows for de-tuning to be easily solved by minor adjustments of the matching network, to adapt with the device's environment, such as close proximity to biological tissue, metal casings, concrete and so on. Also, the optimal use of the PCB to radiate the RF signal, ensures a top performance as the full size of the device is used as part of the antenna system. This will have an impact on how accurate and reliable a tracking device is.



Block Diagram: Asset Tracking – Asset Tracker

In the Block Diagram above, we see an example of an Asset Tracker Application. Some of the main components within a device like this, are:

Microcontroller unit (MCU):
An MCU or MPU is an intelligent semiconductor and the main component in any device. It is what allows for the whole system to function, by translating the data programmed in it to commands that all the other components will understand an execute to deliver results. It is essentially the brains of the module.
Choosing the best performing antenna will allow for a faster data transmission, which will lead the MPU to perform at its full capacity.

Battery system:
Whether if it's a rechargeable battery or a regular one, it's the main power unit for any Asset Tracker. All this system, engineered to manage the power transmission, is essential for the proper function of the device. For a sensor tag, the battery will be the factor that defines the life of the device (until recharging or changing the battery).
Chip antenna technology ensures a lower consumption than other types of antennas, such as an external one, bringing the overall device consumption to its lowest, which translates into longer battery life. Also, if the device doesn't have the right antenna, the transceiver will have to consume more power, reducing the battery life.

Antenna/s (wireless interface and GPS):
Any tracking device needs to have a reliable transmission of data to both satellites and gateways or other devices in other to do its function properly. That is why the antenna is one of the most important components within any tracking device. For an optimal antenna efficiency (and clearance area), the component's placement is crucial, therefore, its implementation within the device's design has to be in an early stage.
Furthermore, when tracking assets globally or through different types of networks and frequency bands, Virtual Antenna® technology will enable for a single antenna to be used, making the overall tracking device smaller, slimmer, and simpler.

In summary, when designing an Asset Tracking Device, you should consider, at an early stage, the best performance and size antenna needed for your device. This will ensure its optimal clearance area as well as placement within the PCB, along with the avoidance of any potential future connectivity, efficiency, de-tuning and/or interferences issues. By choosing Virtual Antenna® technology as your antenna solution, thanks to its high RF efficiency and adaptability, you will ensure best performance in your Asset Tracking device.

Moreover, Virtual Antenna™ components, by being off-the-shelf, tunable, and versatile antennas, will allow for faster development times, predictability of design from minute one and a fast and flexible adaptation to different tracking forms.
In this application note, we will review the performance and different metrics of the DUO mXTEND™, our dual port antenna. In asset tracking, the fact that this antenna doesn't need any clearance area beyond its footprint, gives devices the possibility to have a smaller PCB.

DUO mXTEND™: TINY CHIP ANTENNA FOR SMART TRACKING DEVICES

- **Antenna component:** DUO mXTEND™ NN03-320
- **Dimensions:** 7.0 mm x 3.0 mm x 2.0 mm
- **Frequency regions:** 1561 MHz, 1575 MHz, and 1598 MHz to 1606 MHz

This is DUO mXTEND™ for GNSS: the tiny antenna booster enabling full geolocation with GNSS connectivity (GPS, GALILEO, GLONASS, BeiDou) while minimizing the real estate use on your circuit board (no clearance beyond the component's footprint).

We understand your tracking device needs to be small while you still need to provide an optimum GNSS connectivity to locate it. Therefore, DUO mXTENDTM (NN03-320) antenna booster for GNSS delivers full GNSS performance while fitting into about every tracking device owing to its tiny form factor: **only 7.0 mm x 3.0 mm x 2.0 mm**. In addition, since DUO mXTENDTM does not need any clearance on the PCB ground beyond its antenna footprint, you can use the proximity area nearby the component to arrange other elements in the PCB, reducing the size of the overall tracking device. Featuring an omnidirectional radiation pattern, your device will be tracked, no matter its attitude and orientation with respect to the satellite constellation, making of DUO mXTENDTM your ideal component for portable, handheld and wearable tracking devices.

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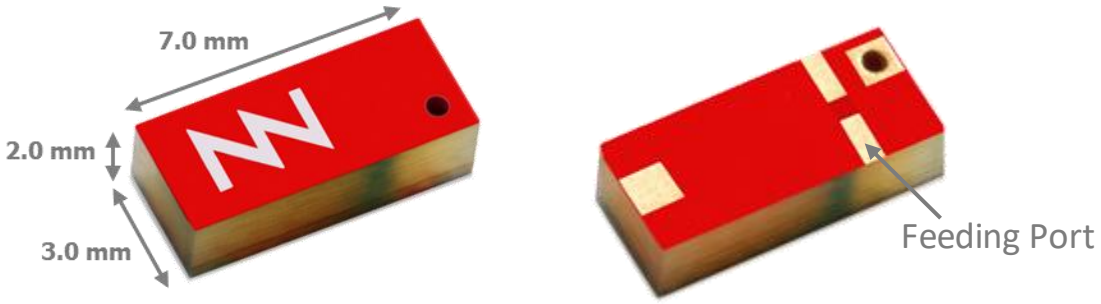
1. PRODUCT DESCRIPTION NN03-320

The DUO mXTEND™ antenna booster has been specifically designed for providing worldwide Global Navigation Satellite Systems (GNSS) performance in wireless devices with small space requirements. It is a miniature antenna capable of being adapted, with a high level of flexibility, to the antenna designer needs. It presents high antenna efficiency values and its size is much smaller than traditional patch antenna solutions and its pattern is not directive, so satellite signals are tracked regardless of the relative position, attitude and orientation of the tracking device. The DUO mXTEND™ antenna booster does not require further clearance area beyond its reduced footprint, making it an ideal alternative to larger custom antennas in for small and portable tracking devices.

TOP **BOTTOM**



Material: The DUO mXTEND™ antenna booster is built on glass epoxy substrate.

APPLICATIONS

- GPS/GALILEO/GLONASS/BeiDou modules
- Smart tracking devices
- Sport navigators
- Handsets and smartphones
- Tablets
- Digital cameras
- Smartwatches and wearables

BENEFITS

- High efficiency
- Small size
- Cost-effective
- Easy-to-use (pick and place)
- Off-the-Shelf standard product (no customization is required)
- No clearance beyond footprint.

The DUO mXTEND™ antenna booster belongs to a new generation of antenna solutions based on Virtual Antenna® technology owned by Ignion. This technology enables replacing conventional and custom antenna solutions by a new class of so-called antenna boosters, delivered in the form of a new range of miniature and off-the-shelf chip antenna components.

2. EVALUATION BOARD GPS/GALILEO/GLONASS/BeiDou

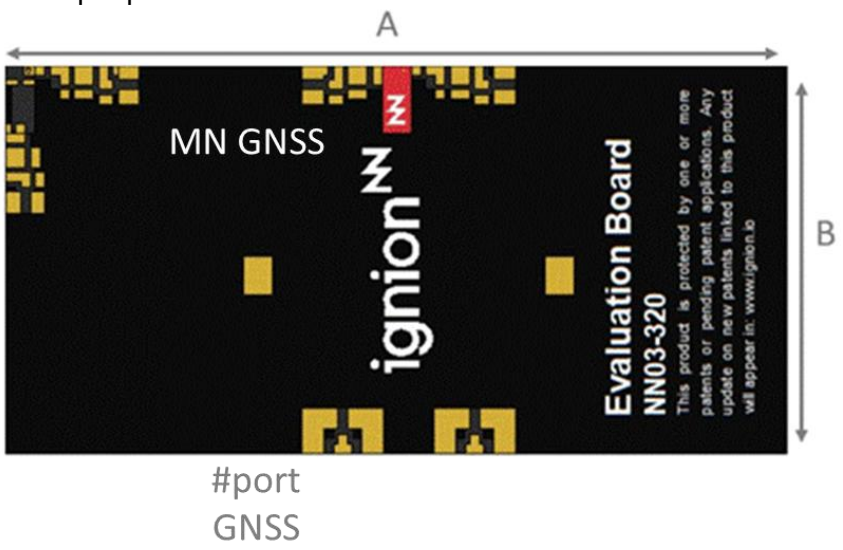
2.1. QUICK REFERENCE GUIDE

Technical features	1561 MHz	1575 MHz	1598 – 1606 MHz
Average Efficiency	> 60 %	> 70 %	> 60 %
Peak Gain	1.6 dBi	1.8 dBi	1.1 dBi
VSWR	< 2.5:1		
Radiation Pattern	Omnidirectional		
Polarization	Linear		
Weight (approx.)	0.11 g.		
Temperature	-40 to +125 ºC		
Impedance	50 Ω		
Dimensions (L x W x H)	7.0 mm x 3.0 mm x 2.0 mm		

Table 1 – Technical Features. Measures from the Evaluation Board. See Figure 1.

2.2. EVALUATION BOARD

This Evaluation Board EB_NN03-320-m-GNSS integrates a UFL cable to connect the DUO mXTEND™ antenna booster with the SMA connector. The DUO mXTEND™ provides operation in three frequency regions, 1561MHz (BeiDou E1 band), 1575 MHz (GPS L1 band and GALILEO E1) and from 1598 MHz to 1606 MHz (GLONASS L1 band), through a single input/output port.



Measure	mm
A	80
B	40

Tolerance: ±0.2 mm

Material: The evaluation board is built on FR4 substrate. Thickness is 1 mm.

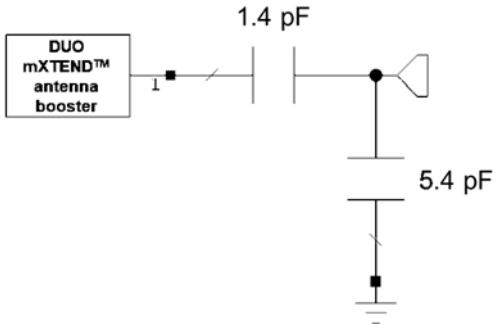
Figure 1 – EB_NN03-320-m-GNSS. Evaluation Board providing operation at BeiDou E1 band (1561 MHz), GPS L1 band and GALILEO E1 band (1575 MHz), and GLONASS L1 band (from 1598 MHz to 1606 MHz). Notice that the clearance area is equal to the DUO mXTEND™ footprint.

This product and/or its use is protected by at least one or more patents and patent applications. Please check related patent information at: Ignion patents.

2.3. MATCHING NETWORK

DUO mXTEND™ needs a matching network to connect to your GNSS receiver. This section describes in Figure 2 a suitable matching network for DUO mXTEND™ and the resulting product specs when measured in the reference evaluation board (EB_NN03-320-m-GNSS) described in the previous section. Please note that different tracking devices with different form factors, RF ground planes and nearby components may need a different matching network. If you need help designing your matching network beyond this application note, contact support@ignion.io or run your device through Oxion™ at https://oxion.ai, Ignion's free-of-charge[1] AI-powered antenna integration platform, for a custom matching network and a complete design report in 24h. Ignion's engineering services: https://ignion.io/design-center/engineering-support/

1561 MHz, 1575 MHz and 1598 – 1606 MHz



Value	Part Number
1.4 pF	GJM1555C1H1R4WB01
5.4 pF	GJM1555C1H5R4WB01

Figure 2 – Matching Network implemented in the evaluation board (Figure 1).

To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components is highly recommended (e.g. Murata components with part numbers as in Figure 2). The antenna performance is always conditioned by its operating environment so that different devices with different printed circuit board sizes, components nearby the antenna, LCD's, batteries, covers, connectors, etc. affect the antenna performance. Accordingly, it is highly recommended placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point of the antenna element. Do it in the ground plane area, not in the clearance area. By tuning the matching network in your final design with your final surrounding components (batteries, displays, covers, etc.) you will be able to optimize the antenna performance without changing the antenna part.

1 See terms and conditions for the free-of-charge Oxion™ service at: https://oxion.ai

2.4. VSWR AND TOTAL EFFICIENCY

VSWR (Voltage Standing Wave Ratio) and Total Efficiency versus Frequency (GHz).

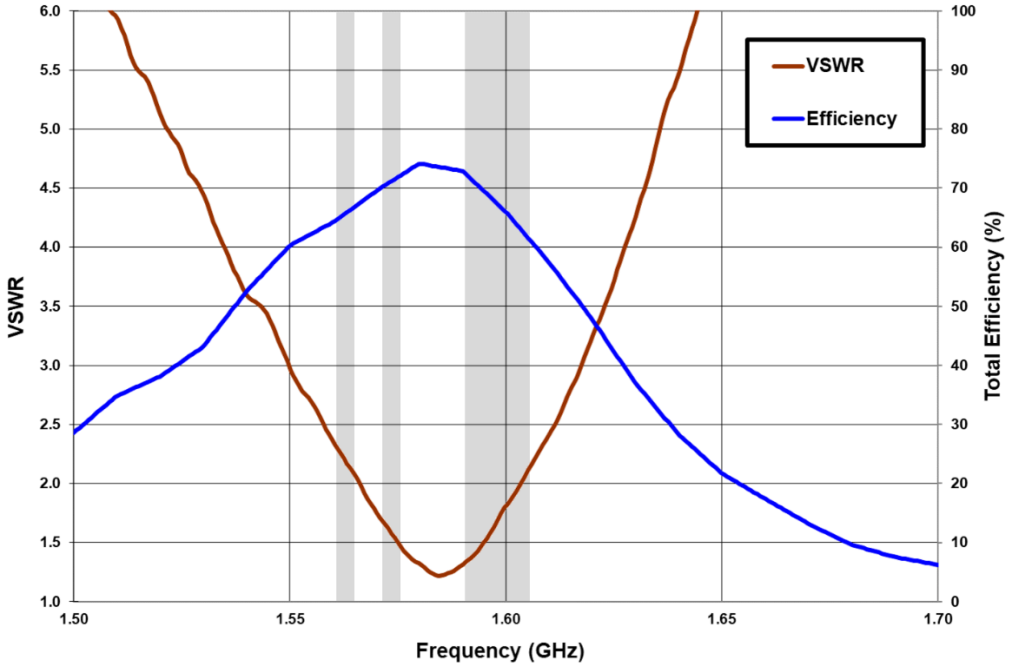
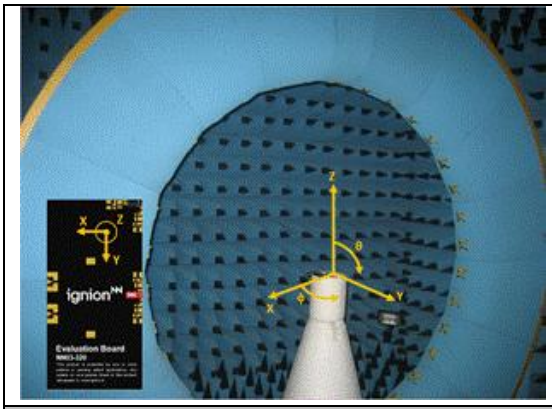
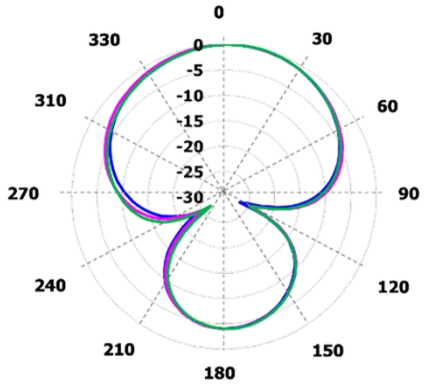


Figure 3 – VSWR and Total Efficiency for BeiDou E1 band (1561 MHz), GPS L1 band and GALILEO E1 band (1575 MHz), and GLONASS L1 band (1598 – 1606 MHz) (from the evaluation board (Figure 1)).

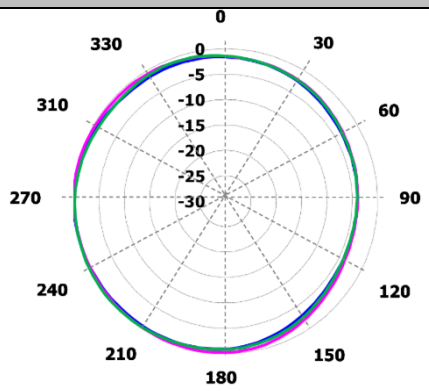
2.5. RADIATION PATTERNS (1561-1606 MHz), GAIN, AND EFFICIENCY



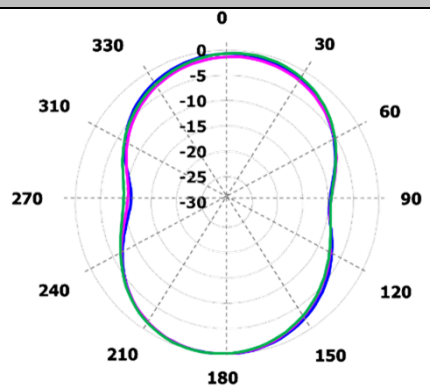
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1.561 GHz, 1.575 GHz and 1.602 GHz



ϕ = 0º Plane XZ at 1.561 GHz, 1.575 GHz and 1.602 GHz



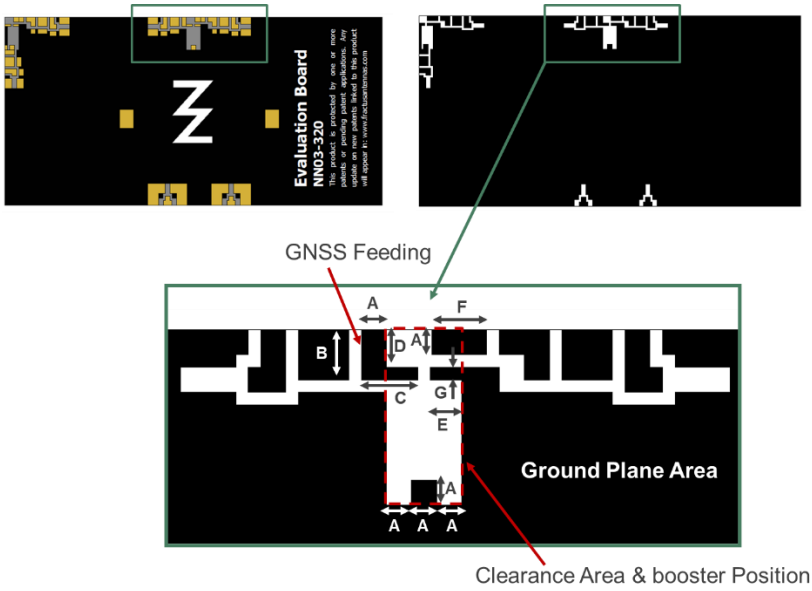
ϕ = 90º Plane YZ at 1.561 GHz, 1.575 GHz and 1.602 GHz

BeiDou	**Gain**		1.6 dBi
	Efficiency		64.9 %
GPS/GALILEO	**Gain**		1.8 dBi
	Efficiency		72.1 %
GLONASS	**Gain**	**Peak Gain**	1.6 dBi
		Average Gain across the band	1.1 dBi
		Gain Range across the band (min, max)	0.7 <–> 1.6 dBi
	Efficiency	**Peak Efficiency**	66.2 %
		Average Efficiency across the band	63.4 %
		Efficiency Range across the band (min, max)	60.4 – 66.2 %

Table 2 – Antenna Gain and Total Efficiency from the evaluation board (Figure 1) for BeiDou E1 (1561 MHz), GPS L1 band and GALILEO E1 band (1575 MHz), and GLONASS L1 (1598 – 1606 MHz) bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

2.6. ANTENNA FOOTPRINT

See below the recommended footprint dimensions for the DUO mXTEND™ antenna booster NN03-320.



Measure	mm
A	1.0
B	2.0
C	2.25
D	1.5
E	1.25
F	2.2
G	0.5

Tolerance: ±0.05mm

Figure 4 – Footprint dimensions for the DUO mXTEND™ (NN03-320) antenna booster.

For additional support in the integration process, please contact support@ignion.io.

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Ignion is an ISO 9001:2015 certified company. All our antennas are lead-free and RoHS compliant.

ISO 9001: 2015 Certified

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