AN4315
Application note

BAL-NRF02D3 matched balun with integrated harmonics filter for Nordic Semiconductor chips with ultralow power transceivers

Introduction

The nRF51422-CEAA and nRF51822-CEAA from Nordic Semiconductor are 2.45 GHz combo chips with an ultralow power transceiver.

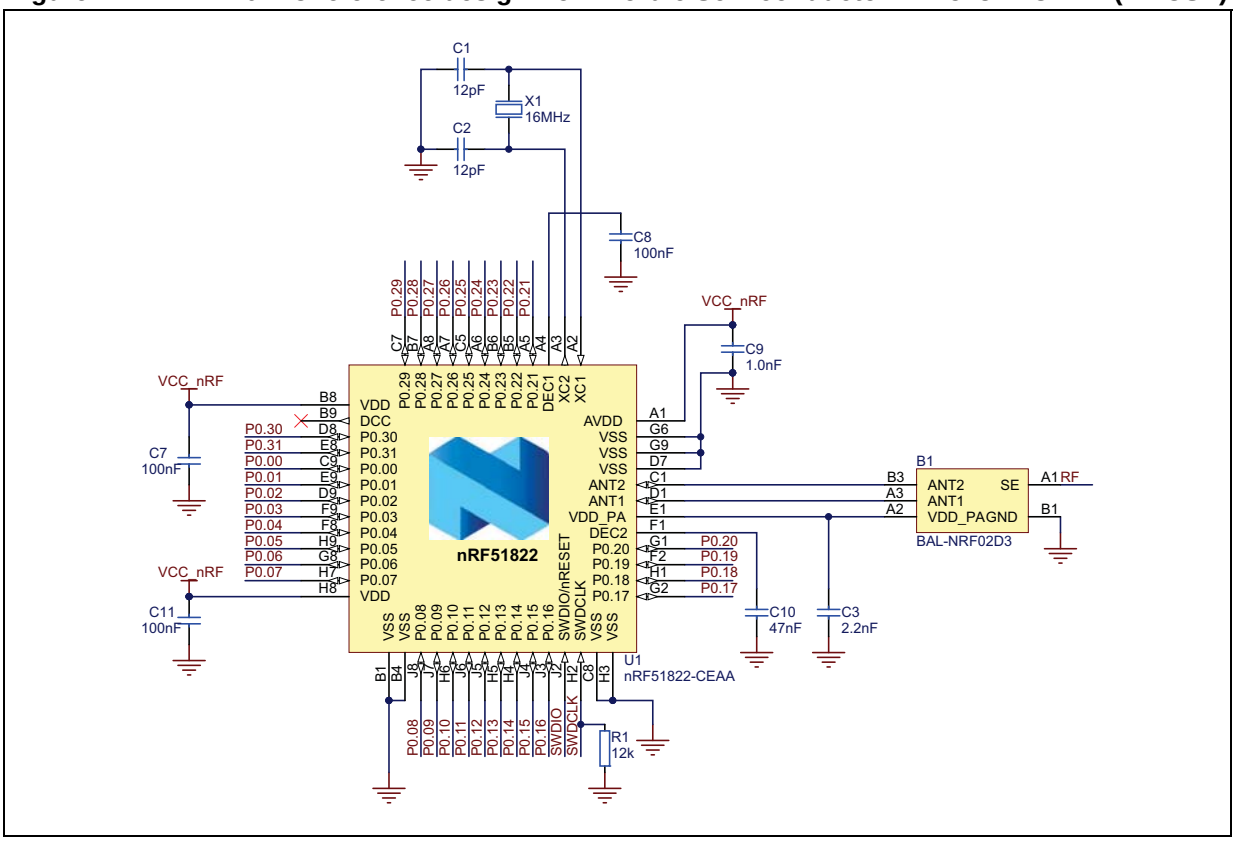
The BAL-NRF02D3 from STMicroelectronics is an ultraminiature balun for which the matching impedance has been customized for the nRF51422-CEAA, and nRF51822-CEAA Nordic Semiconductor circuits.

The BAL-NRF02D3 integrates matching network and harmonics filters. It uses STMicroelectronics' IPD technology on non-conductive glass substrate which optimizes RF performance.

The BAL-NRF02D3 has been tested and approved by Nordic Semiconductor on the PCA10018 nRFgo module.The BAL-NRF02D3 demonstrates a higher system performance compared to traditional solutions. This document presents the test and performance results.

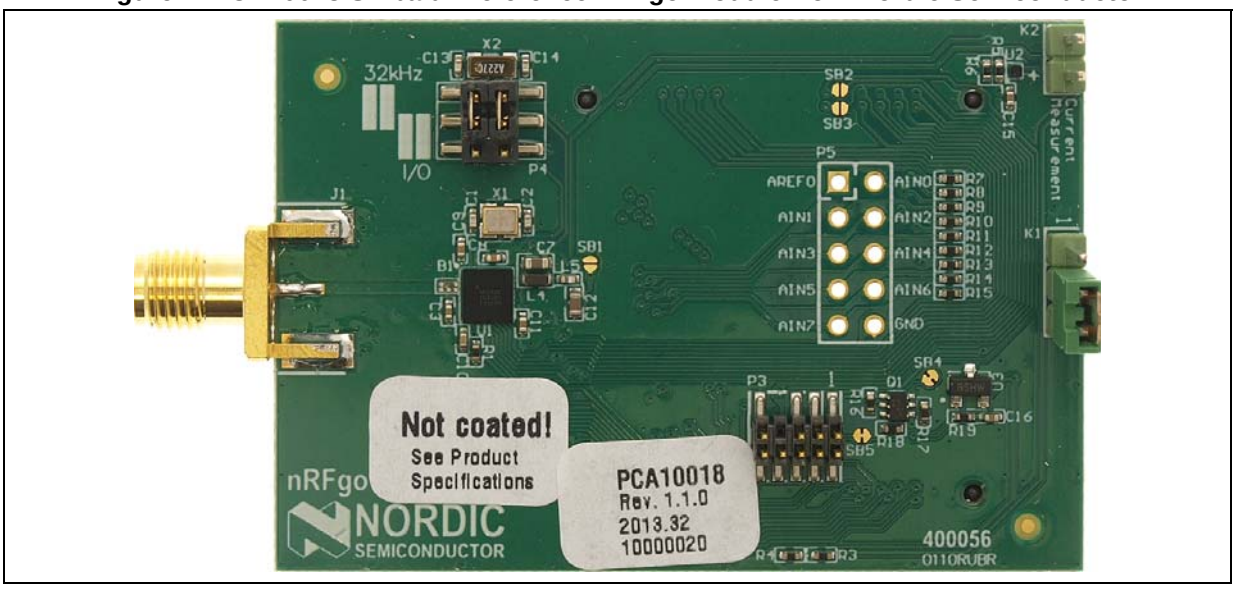
1 Test and performances

Figure 1. BAL-NRF02D3 reference design from Nordic Semiconductor nRF51822-CEAA (WLCSP)



Using BAL-NRF02D3 **no external components** are required for matching and for harmonic filtering. Only a 2.2 nF external capacitor is required for V_{DD} decoupling.

Figure 2. PCA10018 ST balun reference nRFgo module from Nordic Semiconductor



2 Benefits of BAL-NRF02D3 reference design

The BAL-NRF02D3 provides two essential benefits:

- Decrease in the BOM count by 80%, from 5 components to 1 component
- More than 80% PCB area reduction compared to the original design with the BAL-NRF01D3 and discrete components

Compared to discrete solutions, the BAL-NRF02D3 solution is much easier to implement.

Thanks to this smart implementation:

- No RF measurement tools and RF skills are required to design and validate the function.
- Performance is less sensitive to component placement.
- PCB design is symmetrical from differential output to antenna, providing much shorter traces between transceiver outputs to the balun.

As a result, ST BAL-NRF02D3 reduces harmonics generation.

3 Measured performances

3.1 Nordic Semiconductor PCA10018 nRFgo module (nRF51822-CEAA)

The results presented in this section are based on measurements performed with the PCA10018 nRFgo module and the BAL-NRF02D3. The BAL-NRF02D3 balun offers high suppression of 2nd to 4th harmonics and simplifies implementation of nRF51822 WLCSP as regards FCC and ETSI compliance tests.

Table 1. Main parameter compensated measurements (2402 to 2480 MHz)

Parameter	Values	Parameter	Values
PA_TX_FUND (0 dBm) (low)	0.56	PA_TX_2H (4 dBm)	-49.4
PA_TX_FUND (0 dBm) (mid)	0.85	PA_TX_3H (0 dBm)	-53.8
PA_TX_FUND (0 dBm) (high)	1.28	PA_TX_3H (4 dBm)	-41.7
PA_TX_FUND (4 dBm) (low)	4.18	PA_TX_4H (0 dBm)	-61.8
PA_TX_FUND (4 dBm) (mid)	4.2	PA_TX_4H (4 dBm)	-56.0
PA_TX_FUND (4 dBm) (high)	4.55	LO (0 dBm)	-60.3
PA_TX_2H (0 dBm)	-40.9	Receiver sensitivity [dBm]	-90.1

Figure 3. Output power carrier in 4dBm mode (not compensated)

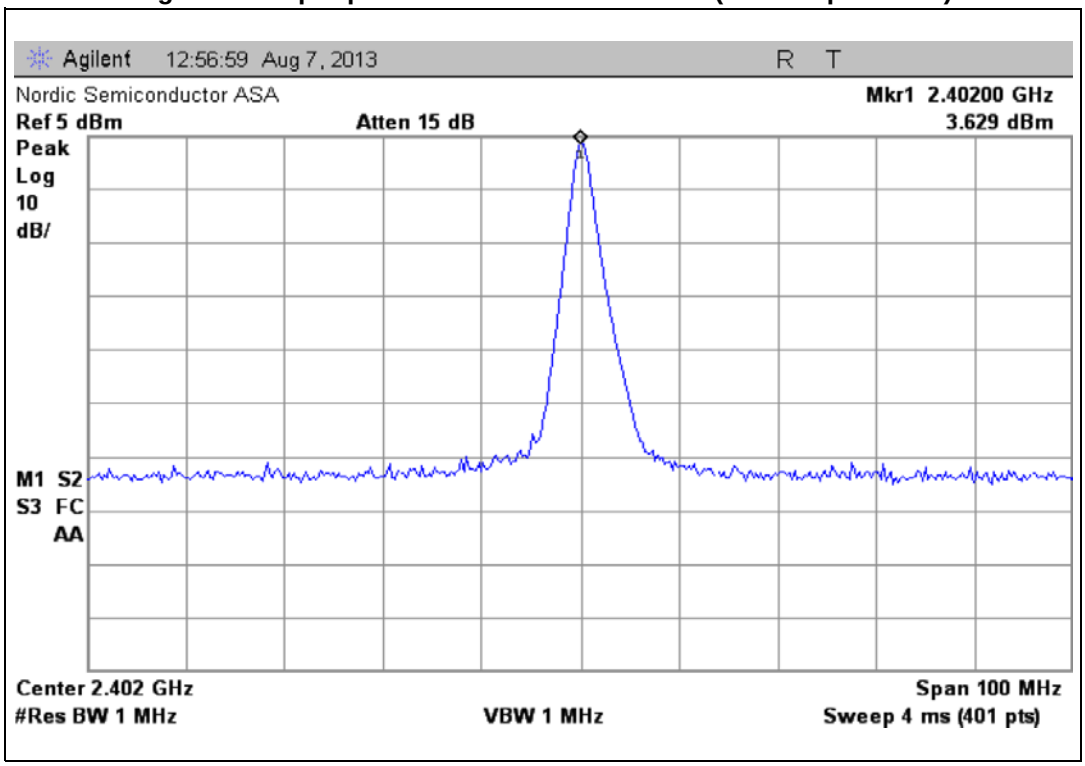


Figure 4. Second harmonic in 4dBm mode (not compensated)

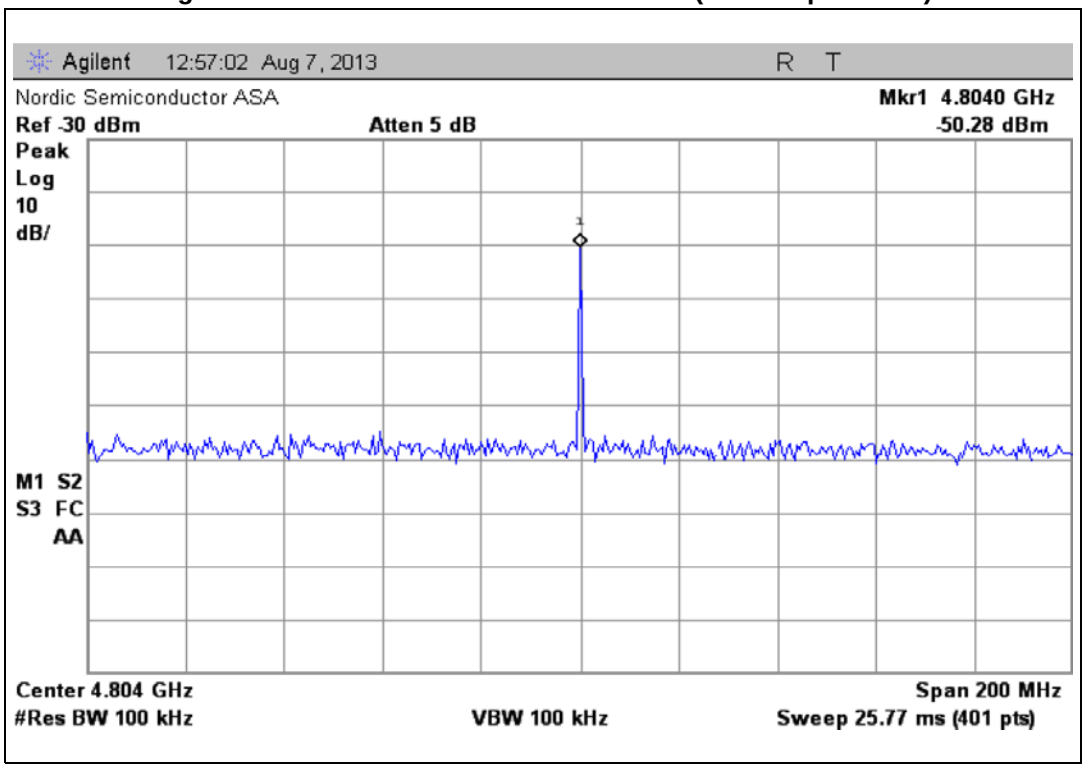


Figure 5. Third harmonic in 4dBm mode (not compensated)

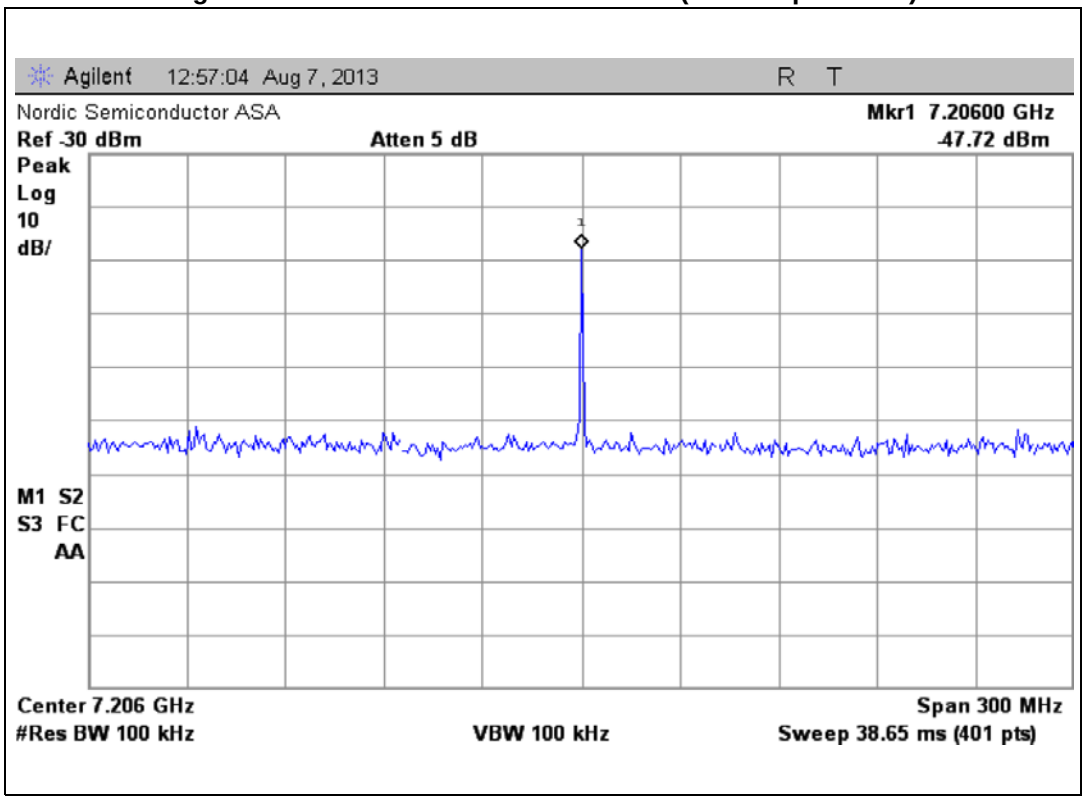


Figure 6. Fourth harmonic in 4dBm mode (not compensated)

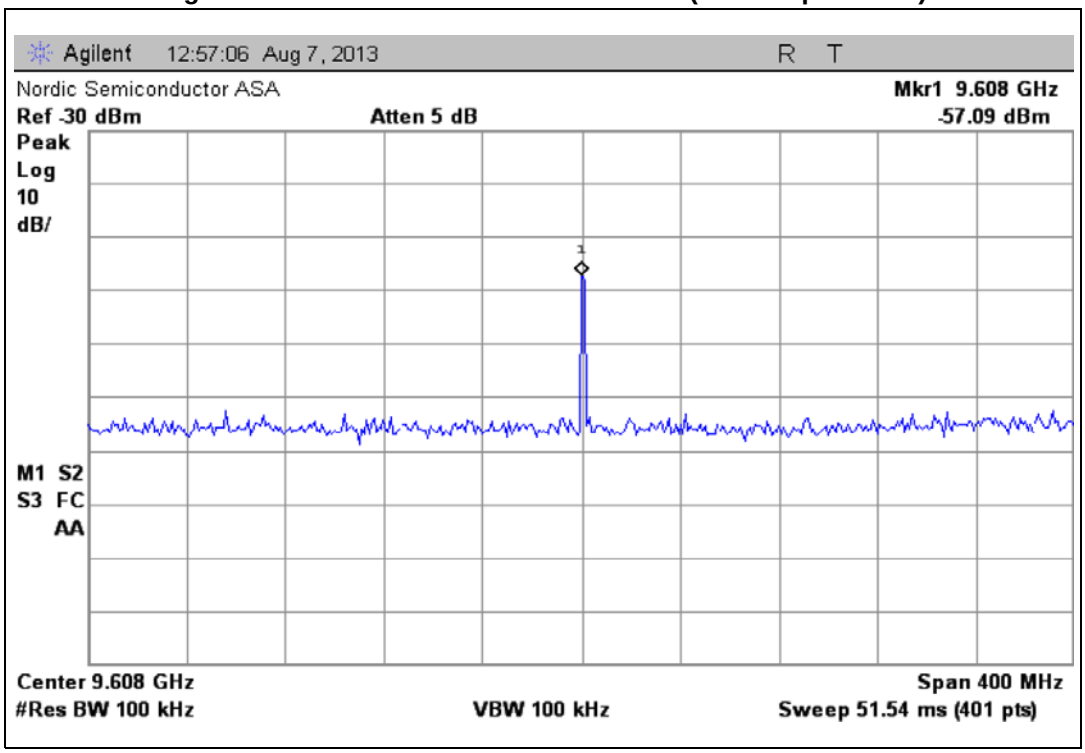
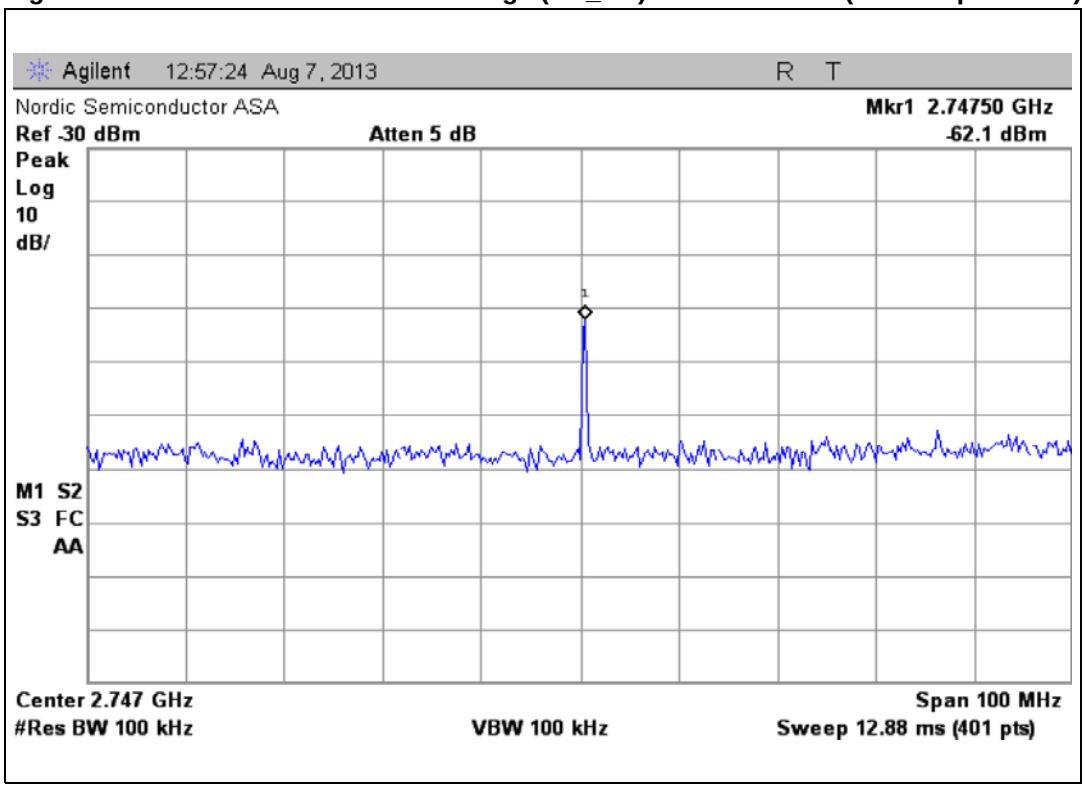


Figure 7. Receiver local oscillator leakage (RX_LO) in 4dBm mode (not compensated)



3.2 Layout recommendations for nRF51822 and nRF51422

Figure 8. BAL-NRF02D3 land pattern metrics

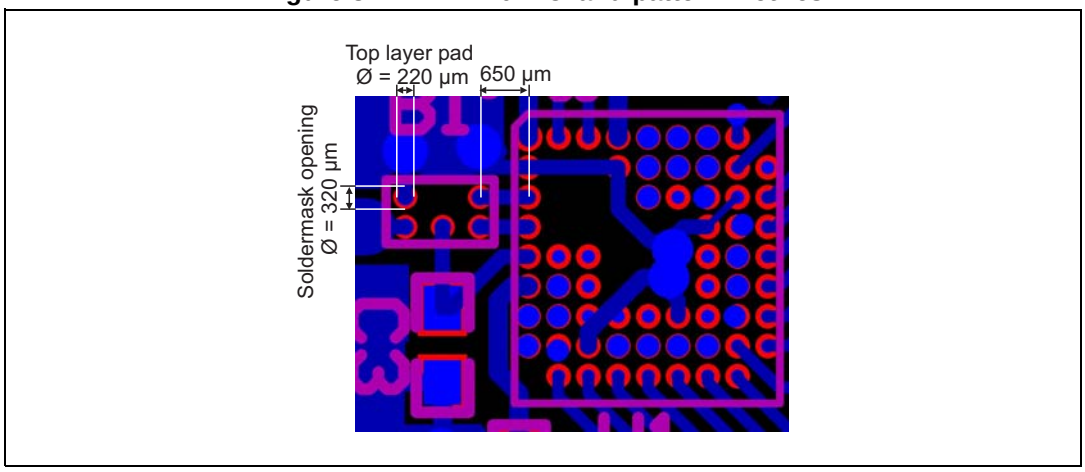


Figure 9. PCB stack-up recommendation



Figure 10. More layout information at Nordic Semiconductor's web site



4 Ordering information

Table 2. Ordering information

Part number	Marking	Weight	Base Qty	Delivery mode
BAL-NRF02D3	SC	1.82 mg	5000	Tape and reel

5 Revision history

Table 3. Document revision history

Date	Revision	Changes
05-Sep-2013	1	Initial release.

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