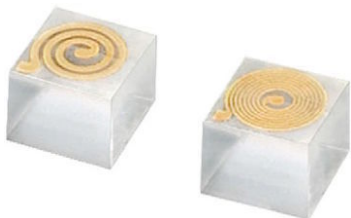




## High Frequency Wire Bondable RF Spiral Inductor, 0.030" x 0.030"



RFLW series of thin film spiral inductors on quartz are designed for RF circuits that require wire bondable components. High precision equivalent circuit modeling enables accurate computer simulation of component performance. Measured S parameter files are also available upon request.

In many RF applications, correct component selection is achieved through experimentation. To help designers during the design process, a sample kit of standard values is available.

Additional values and form factors available upon request.

## FEATURES

- High frequency
- Wire bond assembly
- Small size: 0.030" x 0.030" x 0.020"
- Low DCR, high Q
- Low parasitic capacitance, high SRF
- Equivalent circuit model enclosed
- S parameter files available for download
- Sample kit available
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
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(5-2008)

## APPLICATIONS

- RF choking for DC biasing
- RF tuning circuits
- Lumped element filters

## STANDARD ELECTRICAL SPECIFICATIONS

| PARAMETER  | VALUE         | UNIT |
|--|---------------|------|
| Inductance Range <sup>(1)</sup>                              | 0.003 to 0.03 | μH   |
| Tolerance <sup>(2)</sup>                                     | ± 20          | %    |
| Max. Power Handling <sup>(3)</sup>                           | 125           | mW   |
| Operating Temperature  | -55 to +125   | °C   |
| Storage Temperature  | -55 to +125   | °C   |
| Stability, 1000 h, +125 °C, 125 mW                           | 2.0 max. ΔR/R | %    |
| ESD: AEC-Q200-002, component classification 5B (up to 16 kV) | 5.0 max. ΔR/R | %    |

## Notes

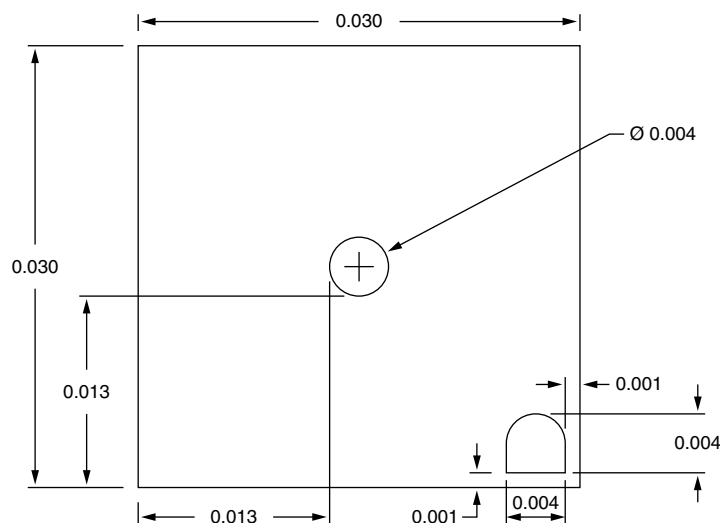
- <sup>(1)</sup> Custom values available upon request. See custom design section below  
<sup>(2)</sup> Main source of value tolerance is due to variation in wire bonds. See "test fixture" section below  
<sup>(3)</sup> Maximum rated power of 125 mW at 70 °C, linearly de-rated to zero at 125 °C

## RF CHARACTERISTICS - TYPICAL VALUES

| PART NUMBER | INDUCTANCE (nH) |          | DCR (Ω) | IN-CIRCUIT INDUCTANCE <sup>(1)</sup> (nH) | IN-CIRCUIT DCR <sup>(1)</sup> (Ω) | Q (UNITLESS) |          | SRF (GHz) |
|-------------|-----------------|----------|---------|---|-----------------------------------|--------------|----------|-----------|
|             | 250 MHz         | 1000 MHz |         |   |                                   | 250 MHz      | 1000 MHz |           |
| RFLW3N3900C | 3.9             | 3.9      | 0.3     | 5   | 0.4                               | 14           | 17       | > 6       |
| RFLW3N6700C | 6.7             | 6.7      | 0.6     | 8   | 0.7                               | 13           | 16       | > 6       |
| RFLW3N9000C | 9               | 9        | 1.0     | 10  | 1.1                               | 12           | 15       | > 6       |
| RFLW3N1100B | 11              | 11       | 1.2     | 12  | 1.3                               | 11           | 14       | > 6       |
| RFLW3N2000B | 20              | 20       | 1.6     | 21  | 1.7                               | 12           | 12       | > 6       |
| RFLW3N3000B | 30              | 30       | 2.5     | 31  | 2.6                               | 13           | 13       | > 6       |

## Note

- <sup>(1)</sup> Including the added inductance and resistance of typical bond wires at 250 MHz. See equivalent circuit section below

**DIMENSIONS** in inches (millimeters)


| LENGTH               | WIDTH                | THICKNESS           | BOND PAD DIAMETER |
|----------------------|----------------------|---------------------|-------------------|
| 0.030 (0.75) ± 0.003 | 0.030 (0.75) ± 0.003 | 0.020 (0.5) ± 0.001 | 4 (0.1)           |

**MECHANICAL SPECIFICATIONS**

|                         |             |
|-------------------------|-------------|
| Chip substrate material | Quartz      |
| Conductor material      | Gold        |
| Conductor thickness     | 5 µm ± 20 % |
| Bond pad diameter       | 0.004"      |

**ATTACHMENT NOTES**

RFLW inductors are a robust wirebondable thin film product that requires careful attention to tooling set-up during the wire bonding process. Excessive thermo-mechanical wire bonding forces may result in damaging the underlying quartz substrate and cause wire bond failures.

**GLOBAL PART NUMBER INFORMATION**

Global Part Number: **RFLW3N2000BMNWS**

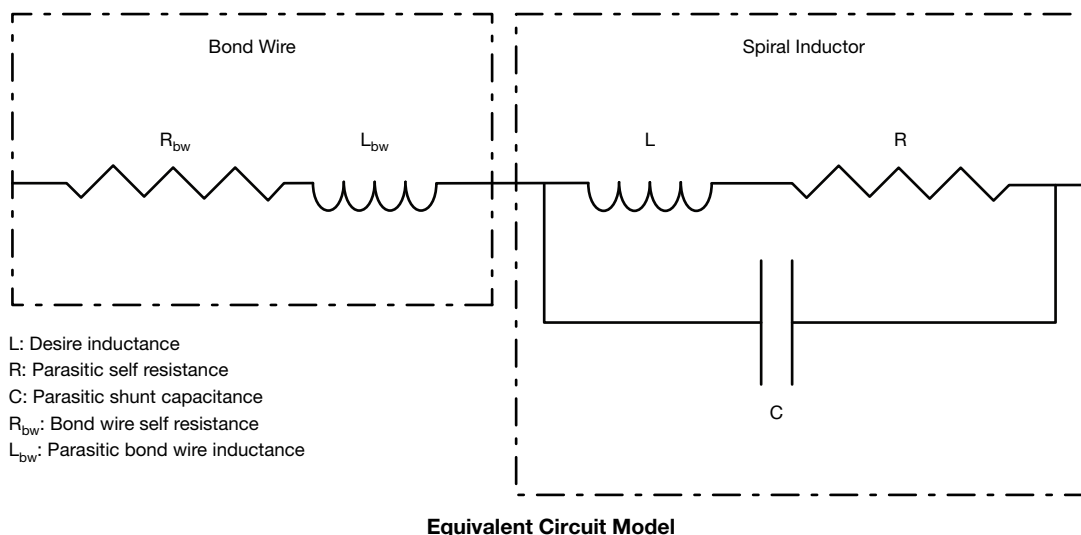
Global Part Number Description: **RFLW 30 x 30 NO PASS 20 nH 20 % WS**

| R     | F                          | L           | W   | 3                                | N                    | 2        | 0                                | 0 | 0 | B | M | N | W | S |
|-------|----------------------------|-------------|---|----------------------------------|----------------------|----------|----------------------------------|---|---|---|---|---|---|---|
| MODEL | SIZE                       | PASSIVATION | INDUCTANCE (nH)                                       | INDUCTANCE MULTIPLIER CODE       | TOLERANCE CODE       | SPECIAL  | PACKAGING CODE                   |   |   |   |   |   |   |   |
| RFLW  | 3 = 30 x 30<br>5 = 50 x 50 | N = none    | First 4 digits are significant figures of capacitance | C = 0.001<br>B = 0.01<br>A = 0.1 | M = 20 %<br>L = 25 % | N = none | WAFFLE<br>WS = 100 min., 1 mult. |   |   |   |   |   |   |   |

**EQUIVALENT CIRCUIT**

The inductor's spiral trace presents a substantial amount of series resistance, and the close spacing of spiral turns present measurable amounts of stray capacitance that interact with the inductive characteristics.

For accurate modeling of the RFLW component in-circuit performance, measured S parameter files are available upon request. Another useful tool commonly used to model the behavior of electronic components at high frequency is the equivalent circuit model. While the equivalent circuit model accurately predicts the reactive part of the total impedance, it fails to determine the real part of the response at high frequency. This is due to the fact that the model does not include skin and proximity effects that significantly increase the real part of the impedance as the frequency rises.



The equivalent circuit values are presented in the table below:

| <b>EQUIVALENT CIRCUIT MODEL - TYPICAL VALUES</b> |                                    |                                  |                  |   |
|--|------------------------------------|----------------------------------|------------------|---|
| INDUCTANCE<br>(nH)<br>$L$                        | DCR<br>( $\Omega$ ) <sup>(1)</sup> | SHUNT CAPACITANCE<br>(fF)<br>$C$ | $L_{bw}$<br>(nH) | $R_{bw}$ <sup>(2)</sup><br>( $\Omega$ ) |
| 3.9  | 0.3                                | 1                                | 1.2              | 0.09                                    |
| 6.7  | 0.6                                | 1                                | 1.2              | 0.09                                    |
| 9  | 1.0                                | 1                                | 1.2              | 0.09                                    |
| 11   | 1.2                                | 5                                | 1.2              | 0.09                                    |
| 20   | 1.6                                | 10                               | 1.2              | 0.09                                    |
| 30   | 2.5                                | 11                               | 1.2              | 0.09                                    |

#### Notes

<sup>(1)</sup> DCR tolerance  $\pm 20\%$

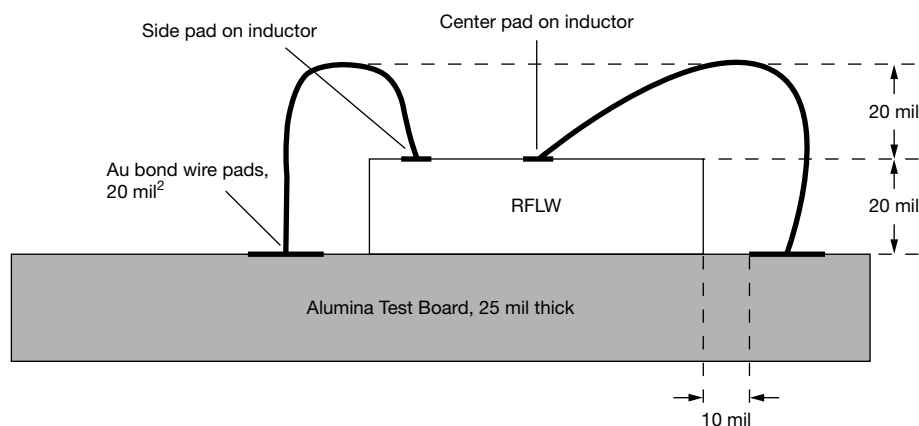
<sup>(2)</sup> Typical bond wires are approximated as being 1.25 mil in diameter gold, totaling a length of 3 mil. The resistance listed above includes the added effect of the bond wire adhesion to the circuit board and component

#### TEST FIXTURE

The results presented in the datasheet were obtained by assembling the components onto a thin film test fixture using non-conducting epoxy and 1.25 mil diameter gold bond wires.

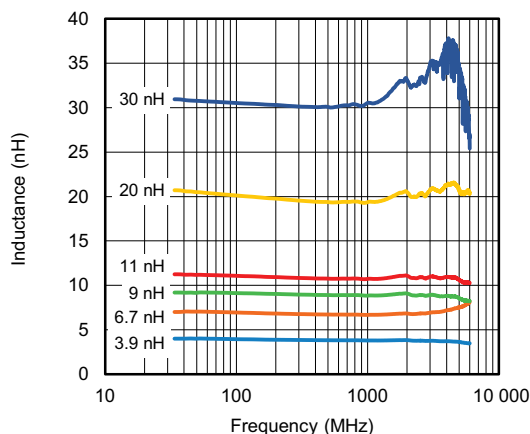
Measurements were conducted using an HP 8753E network analyzer with cascade micro-tech air coplanar probes.

The parasitic elements of the bond wires are a major contributor to the tolerance of the lower value components. We consider the following bond-wire geometry to be typical for the assembly of the RFLW parts:

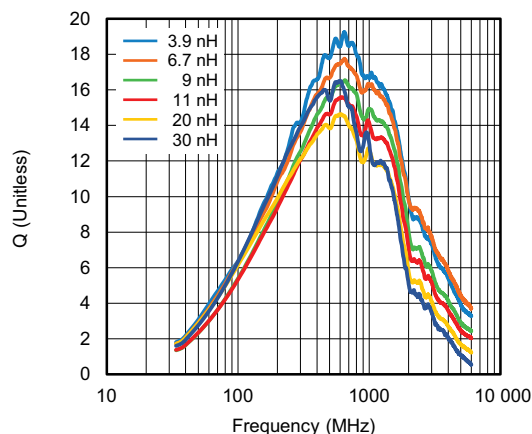


**Text Fixture Diagram**

## TYPICAL COMPONENT PERFORMANCE



**Inductance vs. Frequency**



**Quality Factor vs. Frequency**

## LAYOUT CONSIDERATIONS

The RF spiral inductor is electrically connected to the circuit by wire bonds. All wire bonds add parasitic inductance and resistance, as shown in the schematic drawing above.

It is important to note that setup variations might affect the performance of the component. Special care must be given to minimize these effects by careful design of the component host circuit board. The following aspects should be considered:

- Bond wire length should be minimized. The bond wire added inductance can be roughly estimated at 0.75 nH per mil of 1.25 mil diameter gold wire.
- Any ground plane directly under the component will increase the parasitic shunt capacitance. This will cause self resonance at lower frequencies.
- The epoxy used to attach the component is the limiting factor in power handling. Applications that require high power handling are recommended to use high temperature epoxy and to insure adequate heat sinking.

## CUSTOM DESIGNED SPIRAL INDUCTORS

Vishay EFI will custom design and measure additional values and form factors upon request.

Typical inductance density is limited to:  $\sim 110 \text{ nH/mm}^2$

It is important to note, that both series resistance and SRF characteristics will degrade as inductance values approach the inductance density limit presented above.



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