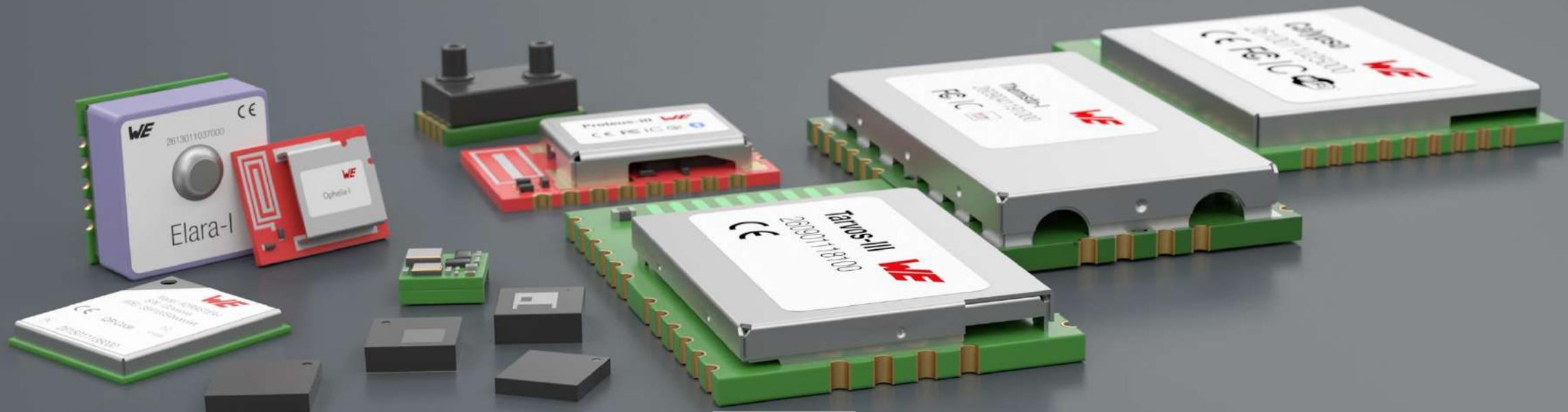


RF TRANSCEIVER

Carpov Pascual – Field Application Engineer

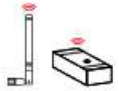
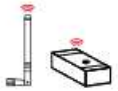
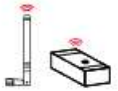
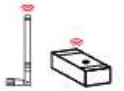
RADIO FREQUENCY TRANSCEIVER

Contents

- Radio technologies
- RF Transceiver circuit blocks
- LTCC
- Components and specifications
- WE Support

** Some presentation images have clickable web links*

RADIO TECHNOLOGIES

PARAMETER	LICENSED FREE ISM (INDUSTRIAL, SCIENTIFIC, MEDICAL) BANDS							LICENSED CELLULAR BANDS					
Frequency [MHz]	169	433	868	915	1500	2400	5000	700	900	1800	2100	2600	3500
Wavelength [cm]	178	69	35	33	20	13	6	43	33	17	14	12	9
Radio Protocol	WE-PRO WARE M-Bus wireless	WE-PRO WARE	WE-PRO WARE M-Bus wireless Long-Range sigfox zigbee Z-WAVE enocean mioty	WE-PRO WARE M-Bus wireless Long-Range sigfox zigbee Z-WAVE enocean	GALILEO	WE-PRO WARE Bluetooth Wi Fi zigbee matter THREAD Wirepas IEEE 802.15.4 ANT+	Wi Fi	lte 5G			NB-IoT LTE-M GSM UMTS		
Range	middle	middle	high	high	high	low	low	high			high		
Data Rate	low	low	middle	middle	low	high	high	high			low		
Würth Elektronik Antennas													
Typical Certification	CE	CE	CE	FCC, IC	worldwide	worldwide	worldwide	worldwide			worldwide		

REDEXPERT®

RADIO TECHNOLOGIES

Applications

Transport robot logistics

Smart BIllboard

Handheld Oxygen Meter

Sewer Inspection

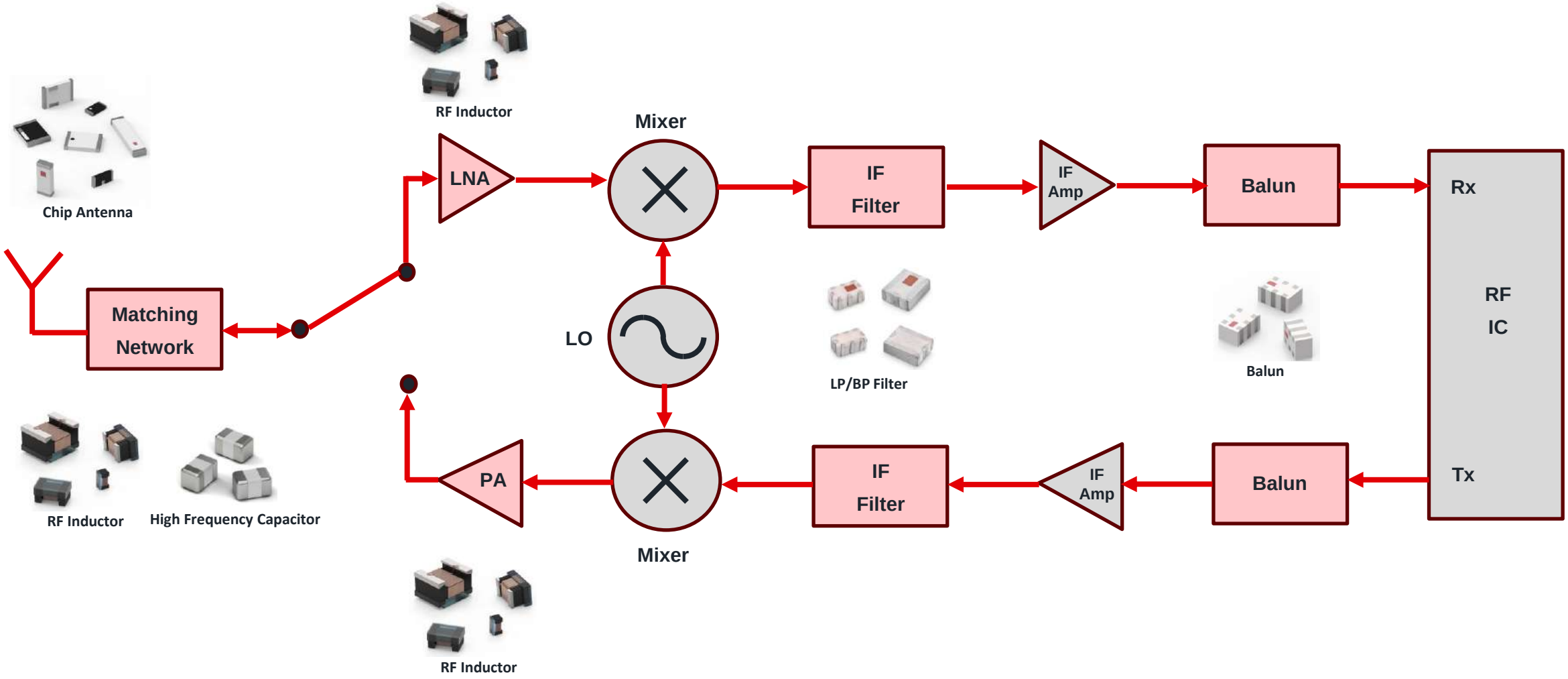
USB Radio Stick Dongle

Forestry Tool – Felling Wedge

RF TRANSCEIVER

Typical Block Diagram

WE Technical References:
eiSmart Product Guide
IC Reference Designs
Würth Elektronik Application Guide.
Low Temperature Co-Fired Ceramic



LTCC COMPONENTS

Advantages

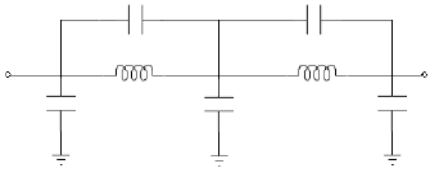
Low Temperature Co-fired Ceramic

- Mixture of Alumina, Glass, Ceramic
- Many components in "one“
- Small size
- Low losses (up to 60 GHz)
- High reliability
- Stable temperature behavior

WE-MCA Antennas

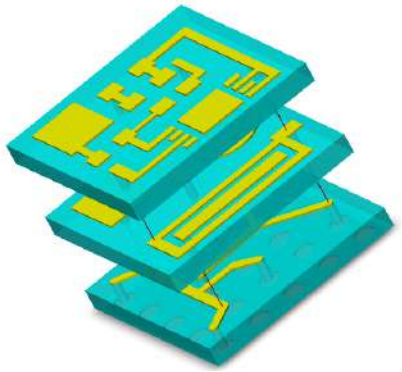
Signal Filters

WE-BAL Multilayer Chip Balun



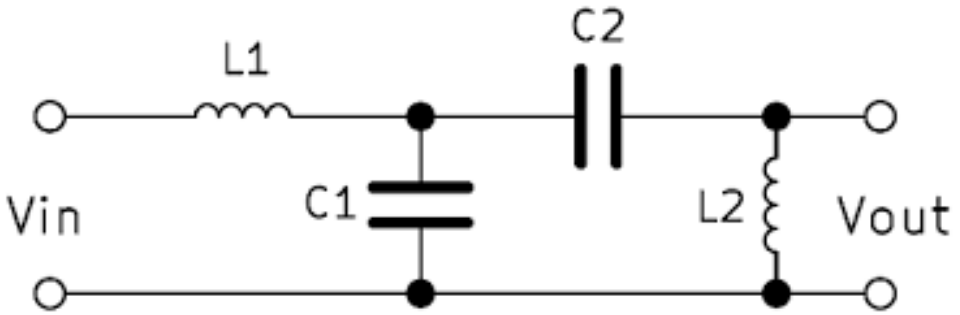
REDEXPERT®

LTCC VS DISCRETES



http://www.minicaps.com/ltcc3d.html

vs.



LTCC

+ Small Size
+ More Accurate

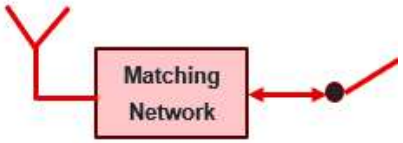
- Less flexibility

Discretes

+ More flexibility

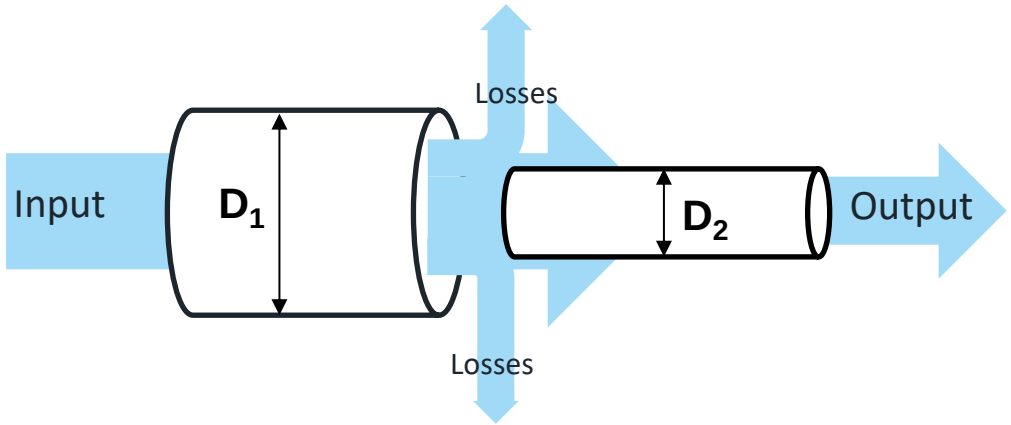
- More components
- Less accuracy
- Bigger size

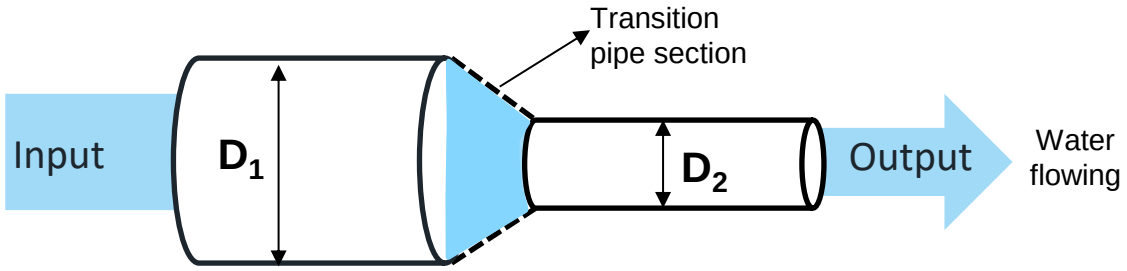
MATCHING NETWORK



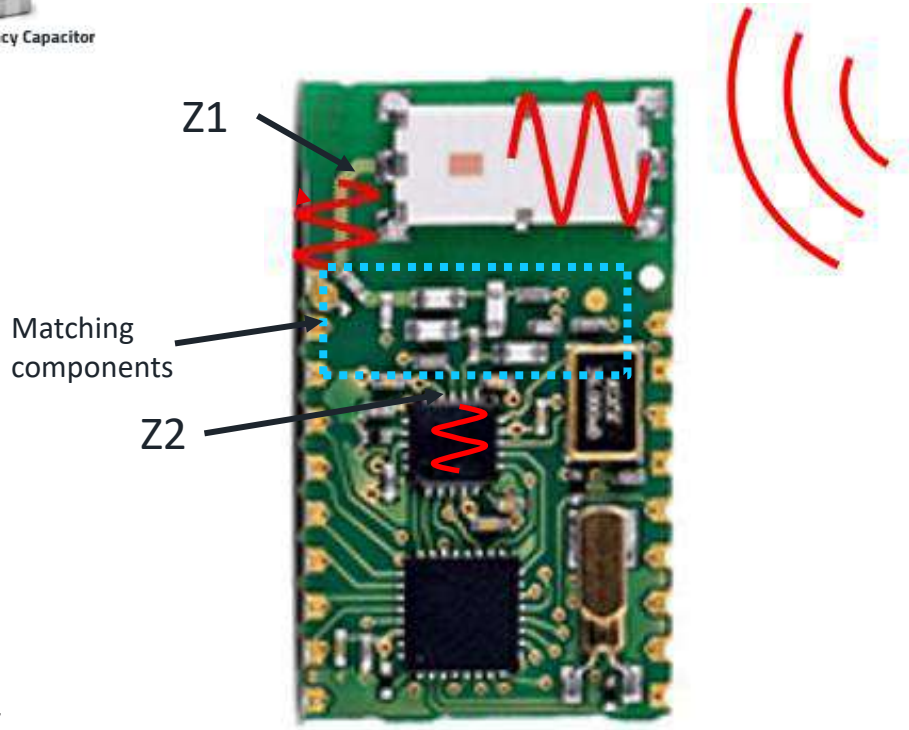
If Electronic signal will be water, and a PCB trace will be the pipe

A part of the water will be lost if we use different tube size without transition pipe section





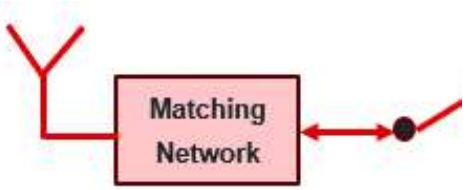
The transition pipe section help to concentrate the water in the second tube to avoid losses



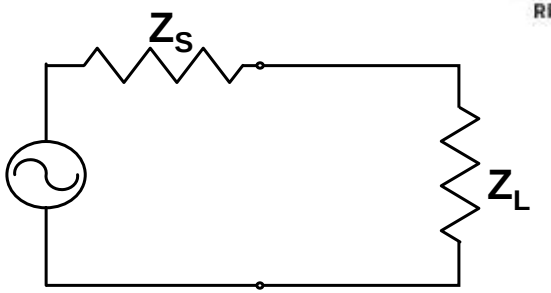
Board from eiSmart (Amber)

In RF application we use RF inductors and RF Capacitors to ”match” the different line when we have different impedance

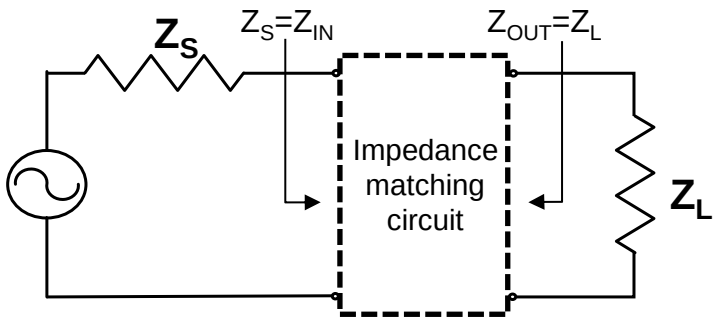
MATCHING NETWORK



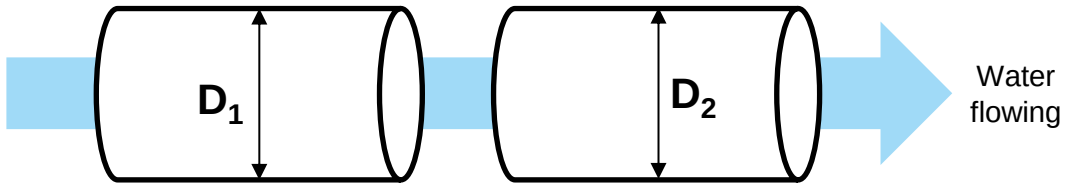
- Matched case: $Z_S = Z_L$



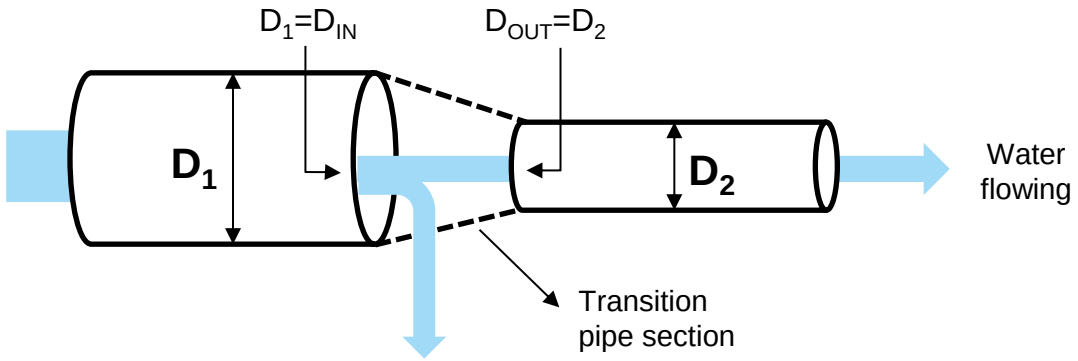
- Unmatched case: $Z_S \neq Z_L$



- $D_1 = D_2$: All water flows through the pipe

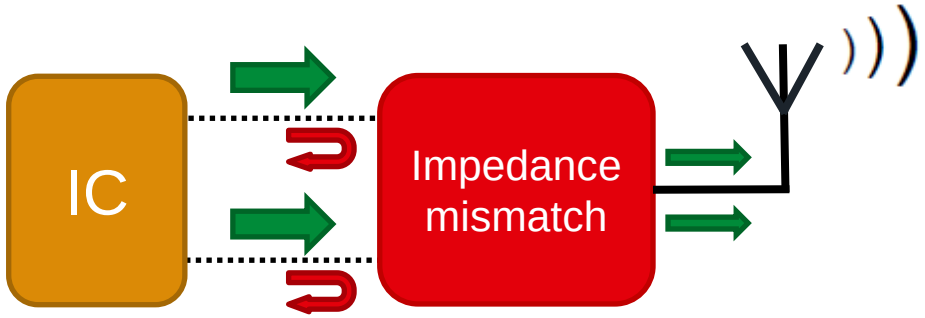


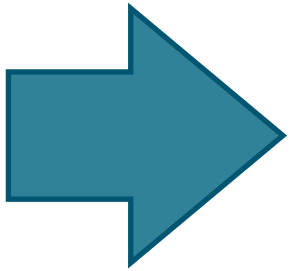
- $D_1 \neq D_2$: Water wasted

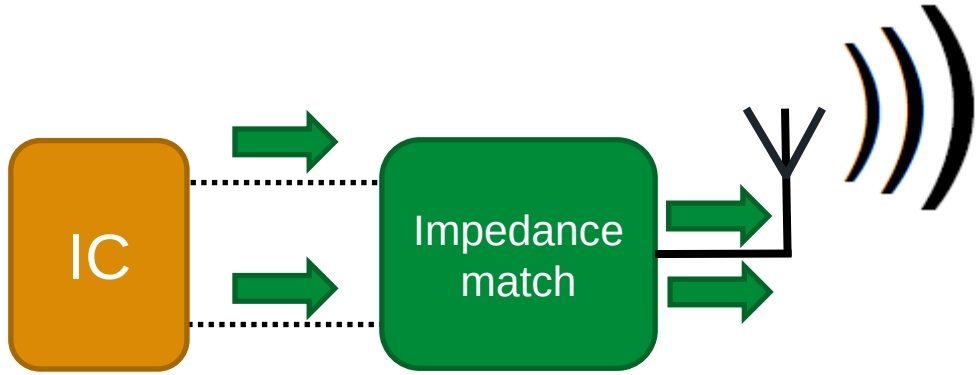


MATCHING NETWORK

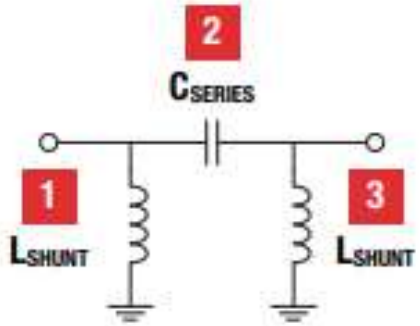
- At any transition of different impedances, an impedance matching filter is necessary
  - Minimize signal reflection
  - Maximize the power transfer
  - Best possible energy transfer from stage to stage
  - Improves the consumption

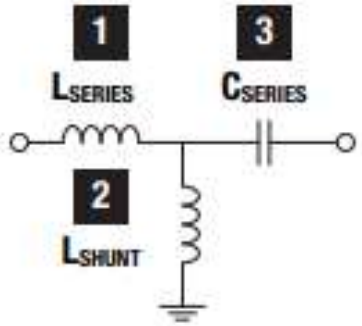






Impedance matching circuit

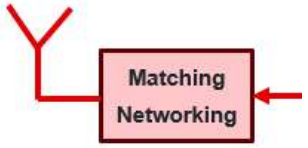


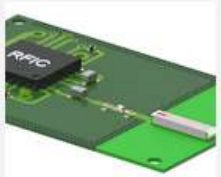


- Some use capacitor in series for DC blocking.

ANTENNA

WE Portfolio





Antenna Matching and Characterization Support

Würth Elektronik is offering not just the components for a matched Antenna Network, we can also support in the process of designing.

Learn more

Antenna

WE-MCA

Highest size to performace ratio

- SMD multilayer chip antenna
- Extremely low profile
- Omni-directional radiation
- Operating temperature: -40 °C to +85 °C
- Very high performance to size ratio
- Applications: GSM, WLAN, Bluetooth, Home RF, IoT

WÜRTH ELEKTRONIK — REDEXPERT RF Antennas

Order Code	Series	Size	Spec	f_{min}	f_{max}	Peak Gain	VS...	Z
7488910043	WE-MCA	25 x 5		423 MHz	443 MHz	-4.00 dBi	2	50.0 Ω
7488920245	WE-MCA	7.6 x 3.5		2.40 GHz	2.50 GHz	1.30 dBi	2	50.0 Ω
7488920157	WE-MCA	5.2 x 3.7		1.55 GHz	1.60 GHz	3.40 dBi	2	50.0 Ω
7488922455	WE-MCA	5.2 x 3.7		2.40 GHz	6.00 GHz	3.30 dBi	2	50.0 Ω
74889102450	WE-MCA	9.0 x 2.0		2.40 GHz	2.50 GHz	3.00 dBi	2	50.0 Ω
74889302450	WE-MCA	3.2 x 1.6		2.40 GHz	2.50 GHz	0.500 dBi	2	50.0 Ω
74889402450	WE-MCA	7.0 x 2.0		2.40 GHz	2.50 GHz	2.70 dBi	2	50.0 Ω

ANTENNA

Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Frequency Range Min & Max			423-443	MHz	
Frequency Range	f		423-443 MHz		
VSWR		423 - 443 MHz	2		max.
Impedance	Z		50	Ω	typ.
Peak Gain	G_{peak}	423 - 443 MHz	-4	dBi	typ.

More than 90% of the signal is transferred.

Return loss (dB)	Return loss (Absolute Value)	VSWR
∞	0	1
26.848	0.0454	1.1
20.827	0.0909	1.2
15.563	0.1667	1.4
12.736	0.2307	1.6
10.881	0.2857	1.8
9.542	0.3333	2
6.020	0.5000	3
4.436	0.6000	4
3.521	0.6667	5
1.743	0.8181	10
0.8693	0.9047	20
0.3474	0.9607	50
0.1737	0.9801	100

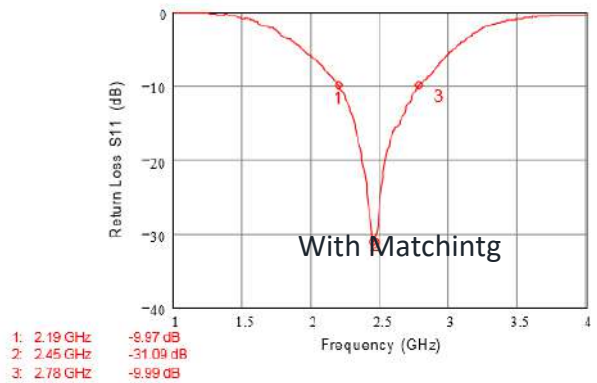
Good

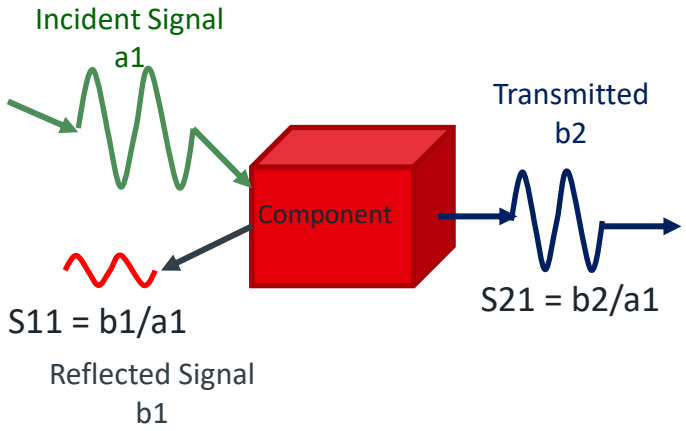
Bad

VSWR stands for **V**oltage **S**tanding **W**ave **R**atio

is an indication of the amount of mismatch between an antenna and the feed line connecting to it.

The smaller the better.



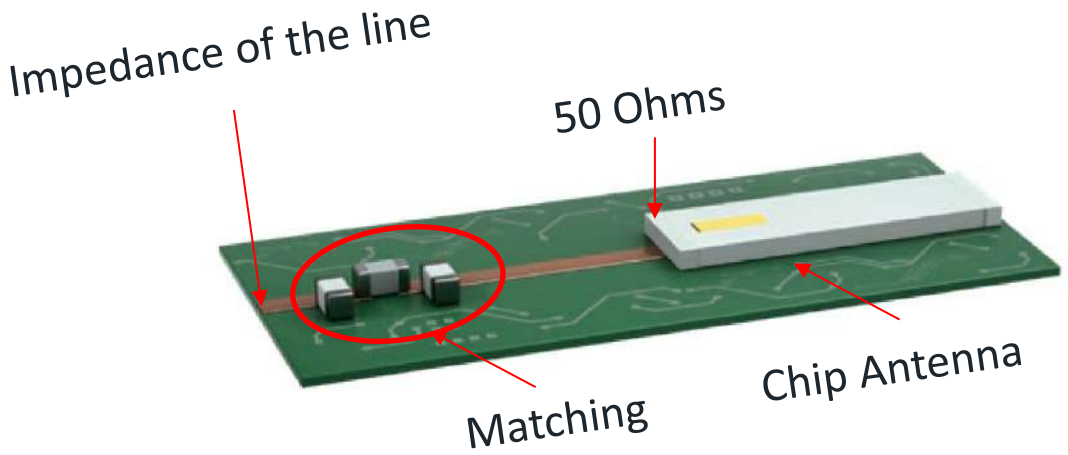


ANTENNA

Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Frequency Range Min & Max			423-443	MHz	
Frequency Range	f		423-443 MHz		
VSWR		423 - 443 MHz	2		max.
Impedance	Z		50	Ω	typ.
Peak Gain	G_{peak}	423 - 443 MHz	-4	dBi	typ.



The impedance of the Antenna should match as much as possible to the impedance of the circuit.

ANTENNA

Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Frequency Range Min & Max			423-443	MHz	
Frequency Range	f		423-443 MHz		
VSWR		423 - 443 MHz	2		max.
Impedance	Z		50	Ω	typ.
Peak Gain	G_{peak}	423 - 443 MHz	-4	dBi	typ.

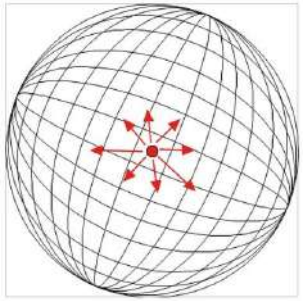
dBi : isotropic Gain
Define the Gain of the antenna compare to an isotropic Antenna.
(Isotropic antenna does not exist, it's only theoretical point of view)

(G) – how much stronger the antenna transmits or receives signal compared to the isotropic antenna (in a linear scale).

$$G(dBi) = 10\log(G)$$

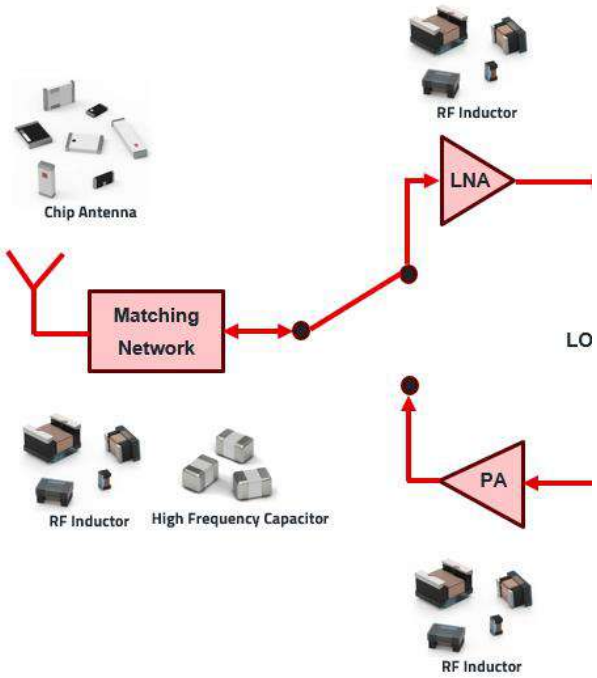
$$G = 10^{\frac{G(dBi)}{10}}$$

Theoretically, the isotropic antenna is an infinitesimally small point in space, radiating ideally uniformly in all directions in space, without reflections and losses (its radiation characteristics is spherical).

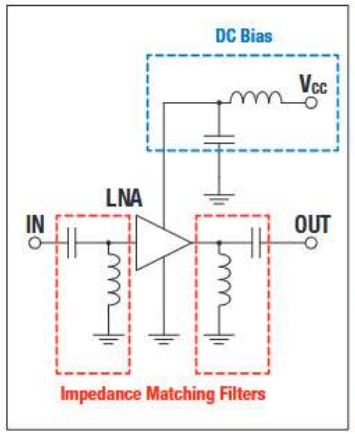


RF INDUCTOR

Applications



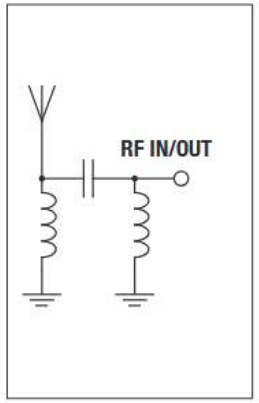
LNA (Low-Noise-Amplifier)

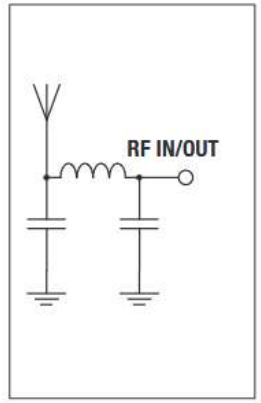


Inductor
e. g. WE-TCI
Highest precision in smallest package

- SMD RF thin film inductors
- Very tight inductance tolerances: up to 1 %
- Very low profile
- Sizes: 0201 / 0402

Matching Network Examples



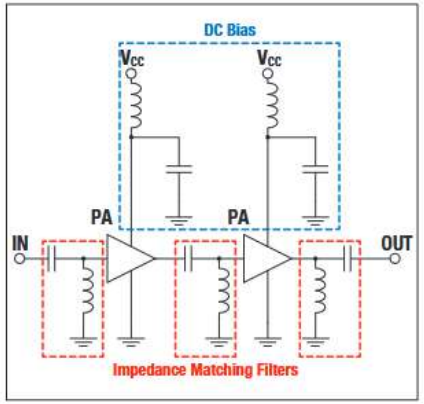


Inductor
e. g. WE-MK
Highest robustness

Capacitor
WCAP-CSRF
Optimized inner structure for RF applications

- SMD RF multilayer ceramic inductors
- Very high SRF
- High reliability chip inductors
- Sizes: 0201 / 0402 / 0603

PA (Power Amplifier)



Inductors
e. g. WE-KI / WE-KI HC
Best quality-to-price ratio

- SMD RF wire wound ceramic inductors
- High Q-factor
- Large currents supported
- Inductance tolerances: 2 % and 5 %
- Sizes: 0402 / 0603 / 0805 / 1008

e. g. WE-CAIR
Best performance

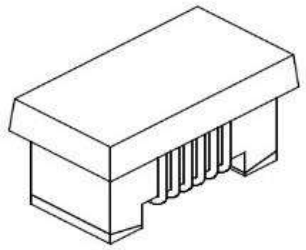
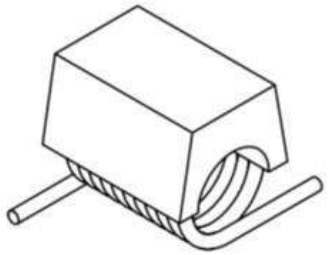
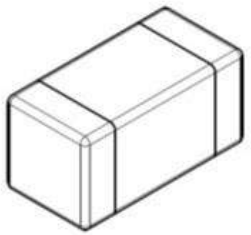
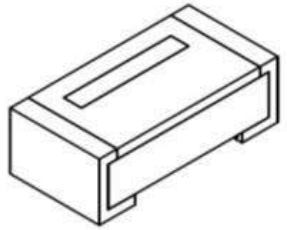
- SMD RF air core inductors
- Very high Q-factor
- Very large currents supported
- Inductance tolerances: 2 % and 5 %
- Sizes: 1322 / 1340 / 3136 / 3168 / 4248 / 5910

REDEXPERT®

RF INDUCTOR

WE Portfolio

- Construction

Wire wound inductors		Multilayer inductors	Thin film inductors
With core	Air core		
			
WE-KI / WE-KI HC / WE-RFI / WE-RFH	**WE-CAIR / WE-AC HC**	**WE-MK**	**WE-TCI**

WE-KI SMT Wire Wound Ceramic Inductor

L 1 to 1800 nH | $Q_{min.}$ 13 to 60 % | I_R 100 to 1360 mA

WE-KI HC SMT High Current Wire Wound Ceramic Inductor

L 1 to 390 nH | $Q_{min.}$ 10 to 46 % | I_R 170 to 2300 mA

WE-RFI Ferrite SMT Inductor EXTENDED

L 20 nH to 47 µH | $Q_{min.}$ 11 to 45 % | I_R 45 to 1910 mA

WE-RFH Ferrite SMT Inductor

L 0.47 to 10 µH | $Q_{min.}$ 15 to 45 % | I_R 300 to 760 mA

WE-TCI Thinfilm Chip Inductor

L 1 to 27 nH | $Q_{min.}$ 8 to 13 % | I_R 75 to 700 mA

WE-MK Multilayer Ceramic SMT Inductor

L 1 to 470 nH | $Q_{min.}$ 4 to 18 % | I_R 110 to 1300 mA

WE-CAIR Air Coil

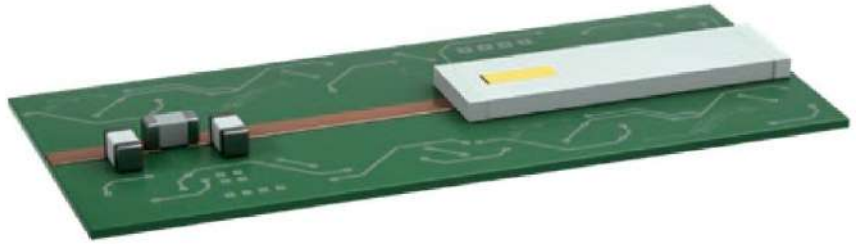
L 1.65 to 538 nH | $Q_{min.}$ 100 to 140 % | I_R 1.5 to 4 A

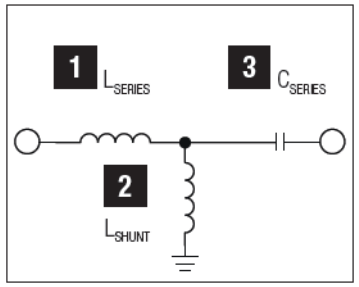
WE-AC HC High Current Air Coil

L 22 to 146 nH | $Q_{min.}$ 163 to 280 % | I_R 19 to 40 A

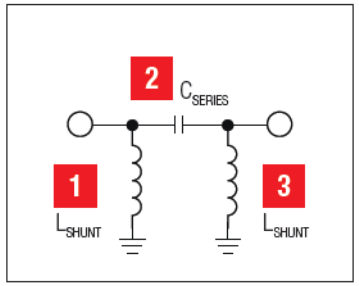
RF INDUCTOR

Specifications





T matching for Point A



The **inductance** value is always defined with a tolerance in % (1%, 2% or 5%) or in value (+/- 0,2nH).

The frequency for test condition is also important.

Electrical Properties:

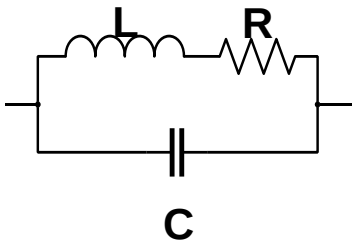
Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 MHz	1.5	nH	±0.1nH
Q-Factor	Q	100 MHz	4		min.
DC Resistance	R_{DC}	@ 20 °C	0.13	Ω	max.
Rated Current	I_R	ΔT = 20 K	430	mA	max.
Self Resonant Frequency	f_{res}		10000	MHz	min.

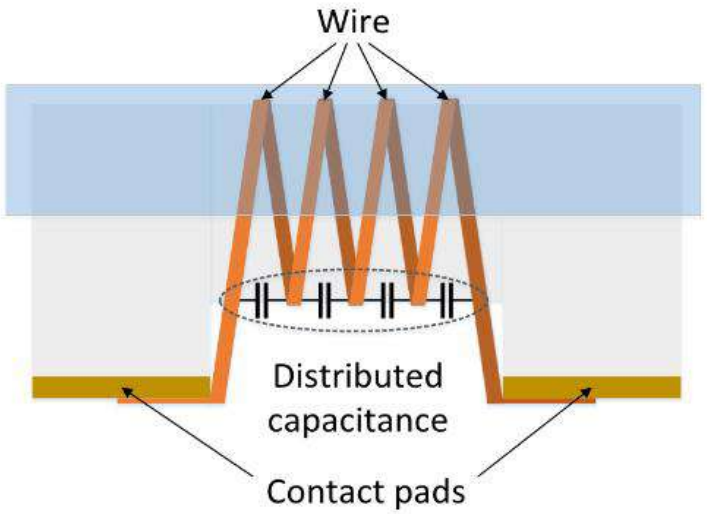
RF INDUCTOR

Specifications

Self Resonant Frequency (SRF)

- In low frequency the impedance only comes from the inductive part.
- In very high frequency the impedance of the inductor become capacitive.
- In the middle when ZL and Zc compensate each other the inductor become purely resistive, at this frequency the Impedance is Maximum and the frequency is name SRF

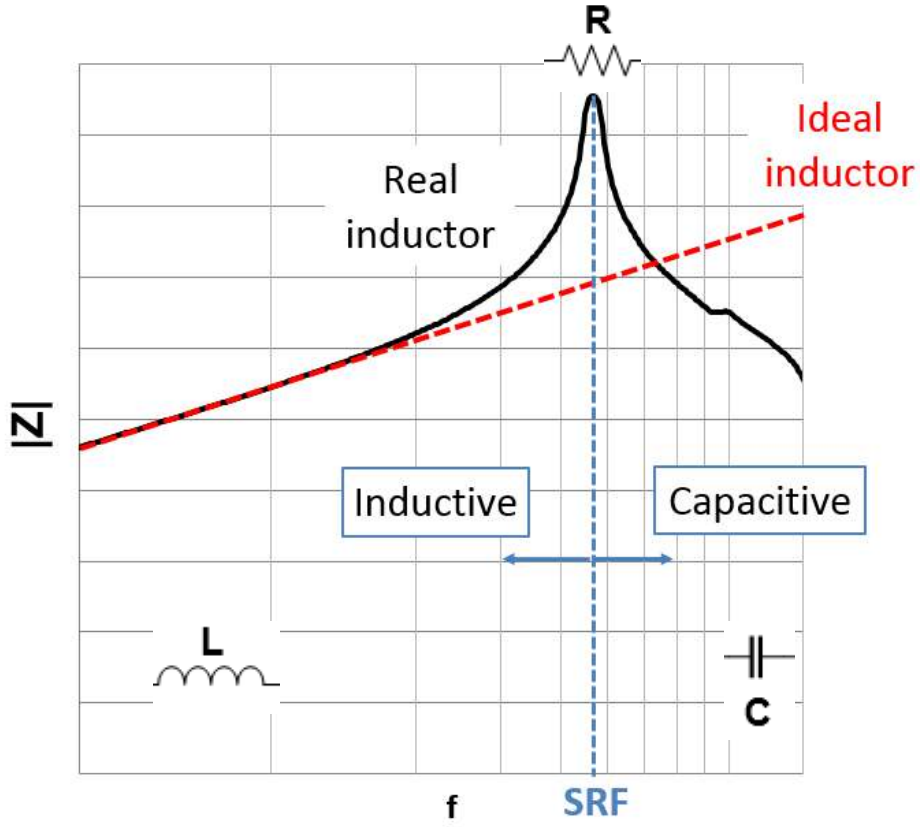




To use the inductor as an inductance the operating frequency must be lower than the SRF.

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 MHz	1.5	nH	±0.1nH
Q-Factor	Q	100 MHz	4		min.
DC Resistance	R_{DC}	@ 20 °C	0.13	Ω	max.
Rated Current	I_R	ΔT = 20 K	430	mA	max.
Self Resonant Frequency	f_{res}		10000	MHz	min.



RF INDUCTOR

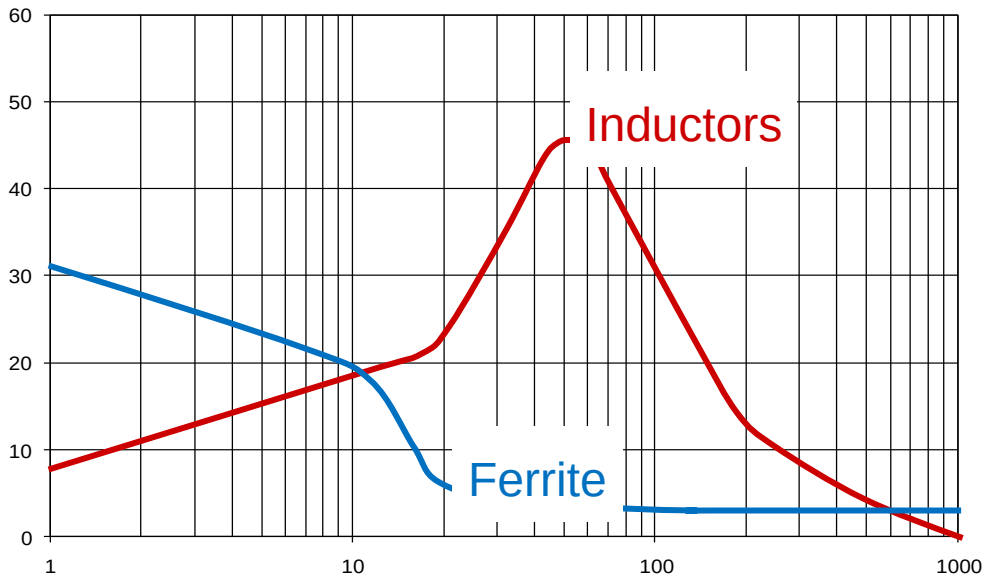
Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 MHz	1.5	nH	±0.1nH
Q-Factor	Q	100 MHz	4		min.
DC Resistance	R_{DC}	@ 20 °C	0.13	Ω	max.
Rated Current	I_R	ΔT = 20 K	430	mA	max.
Self Resonant Frequency	f_{res}		10000	MHz	min.

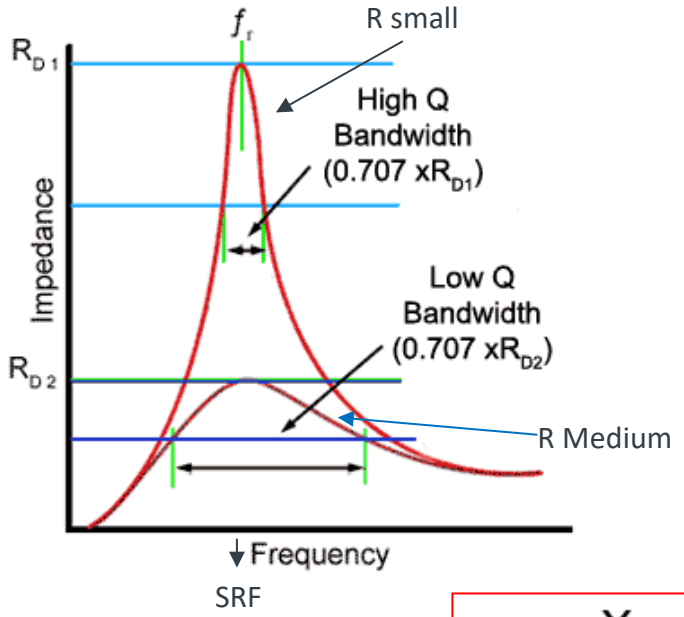
Q-Factor

- It defines the “quality” of the inductor
- “Q” is defined as the ratio of the amount of energy stored versus the amount of energy dissipated per cycle.
- A higher Q factor means lower losses and better suitability for high-frequency applications.



Ferrites are also inductors but with high losses.

For a ferrite the Q is below a value of 3



$$Q = \frac{X_L}{R} \text{ or } \frac{2\pi f_r L}{R}$$

REDEXPERT®

RF INDUCTOR

Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 MHz	1.5	nH	±0.1nH
Q-Factor	Q	100 MHz	4		min.
DC Resistance	R_{DC}	@ 20 °C	0.13	Ω	max.
Rated Current	I_R	ΔT = 20 K	430	mA	max.
Self Resonant Frequency	f_{res}		10000	MHz	min.

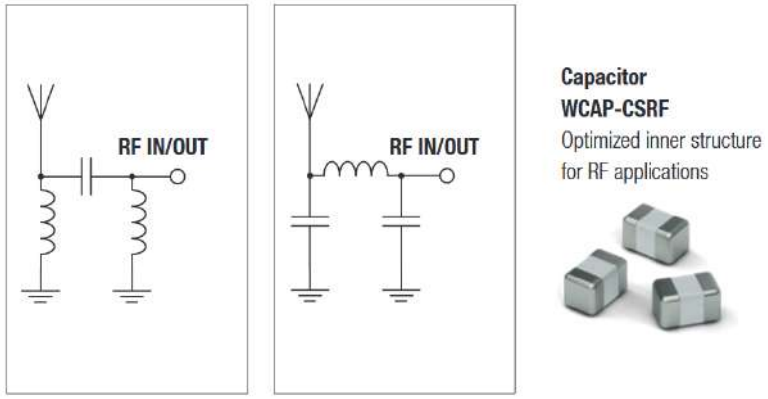
Like for power inductor the **Rated current** is defined for a self heating generated by a DC current.
The self heating can be low (for example 15K)

The **DC Resistance is** generally specified as a Max value
The DC Resistance influence the Q factor

RF CAPACITOR

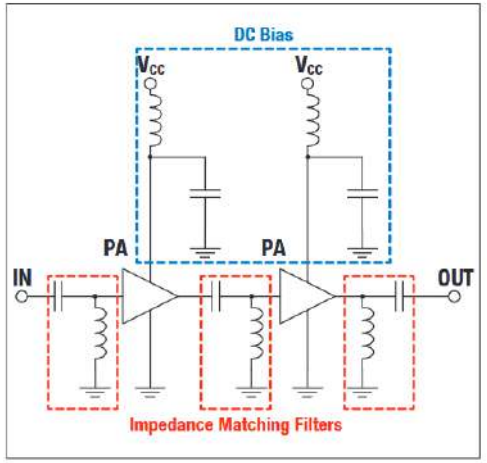
Applications

Matching Network Examples

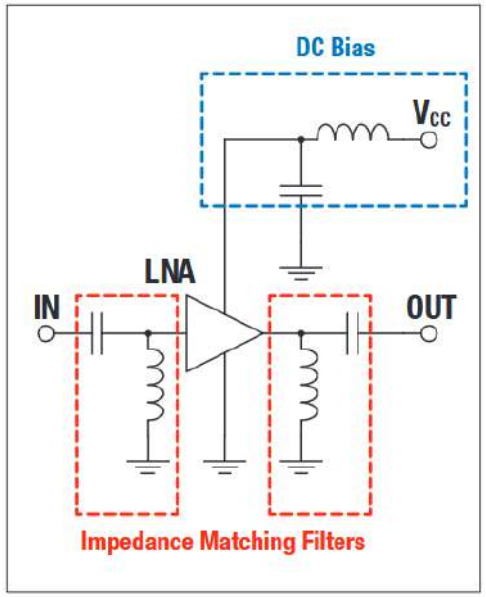


Capacitor
WCAP-CSRF
Optimized inner structure for RF applications

PA (Power Amplifier)



LNA (Low-Noise-Amplifier)



- **Characteristics**
  - High frequency product series
  - Mounting style: SMT-Chip
  - Ceramic: NP0 (Class I)
  - Capacitance range: 0.2 pF – 33 pF
  - Temperature Coefficient: ±30 ppm/°C
  - Voltage range (UR): 25 – 50 V(DC)
  - Operating temperature: -55 °C up to + 125 °C
  - Sizes: 0201 / 0402
  - Termination: Cu/Ni/Sn
  - Recommended soldering: Reflow soldering

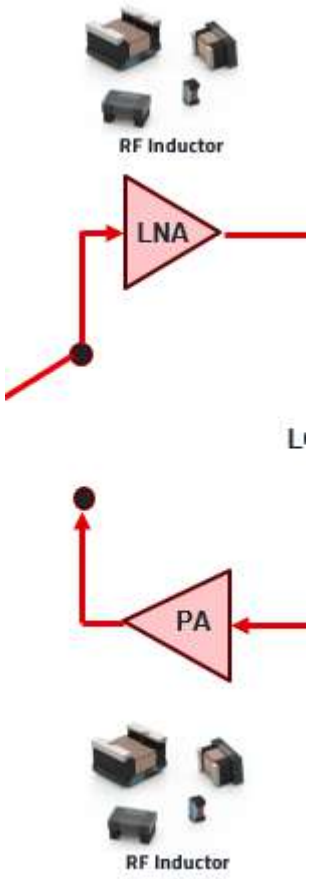
QUESTION #1

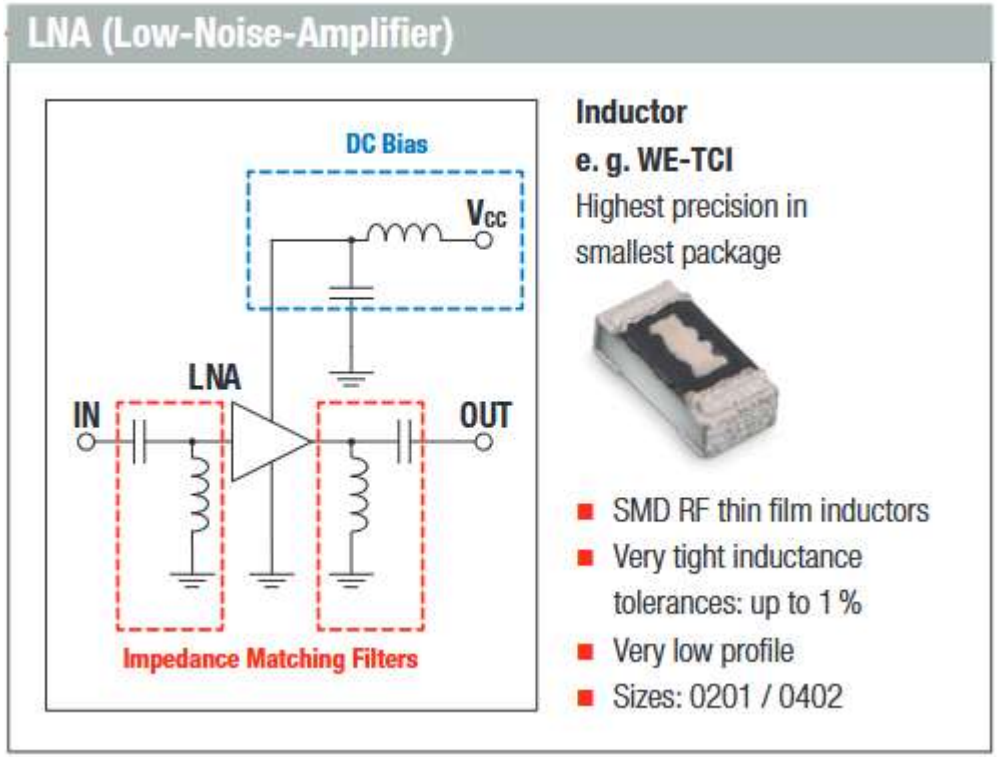
Which is/are not part of a typical RF transceiver?

a) Balun
b) Antenna
c) Matching circuit
d) Sensors 
e) Intermediate frequency, Low-noise and Power amplifiers
f) Memory 
g) RF System on Chip (SoC)

LOW NOISE AMPLIFIER

WE Portfolio





- **Characteristics**
  - High self resonant frequency
  - Tight tolerances of 2% (1% on request) or ± 0.1 nH and small inductance values
  - Outstanding temperature stability
  - In high frequency circuit the inductance is very stable
  - Small inductance values
  - Recommended solder profile: Reflow
  - Operating temperature: –40 ºC to +125 ºC

All | 0201 | 0402

Order Code	Data-sheet	Simu-lation	Downloads	Status	L (nH)	Tol. L	Test Condition L
744900010	SPEC	RE	10 FILES	Active	1	±0.2nH	500 MHz
744901010	SPEC	RE					500 MHz
744900012	SPEC	RE					500 MHz
744901012	SPEC	RE					500 MHz
744900013	SPEC	RE					500 MHz
744900014	SPEC	RE					500 MHz
744900015	SPEC	RE					500 MHz
744901015	SPEC	RE					500 MHz
744900018	SPEC	RE					500 MHz
744901018	SPEC	RE					500 MHz
744900019	SPEC	RE					500 MHz
744900020	SPEC	RE					500 MHz
744900022	SPEC	RE					500 MHz

EDA models: Components ZIP
ALT Altium_WE-TCI (rev22e).IntLib | 84 KB
ZUK Cadstar_WE-TCI (rev19a).zip | 6 KB
CDS Cadence_WE-TCI (rev22a).zip | 129.1 KB
EAG Eagle_WE-TCI (rev22b).lbr | 32.6 KB

CAD files ZIP
IGS Download_IGS_WE-TCI_0201 (rev1).igs | 100.3 KB
STP Download_STP_WE-TCI_0201 (rev1).stp | 107 KB

RF & Microwave simulation models
MDL Modelithics

Electric models ZIP
ADS ADS_WE-TCI (rev24a).zip | 3.6 MB
S S-Parameter_744900010 (rev23a).s2p | 83.5 KB
PSP PSpice_WE-TCI (rev22b).zip | 11.3 KB

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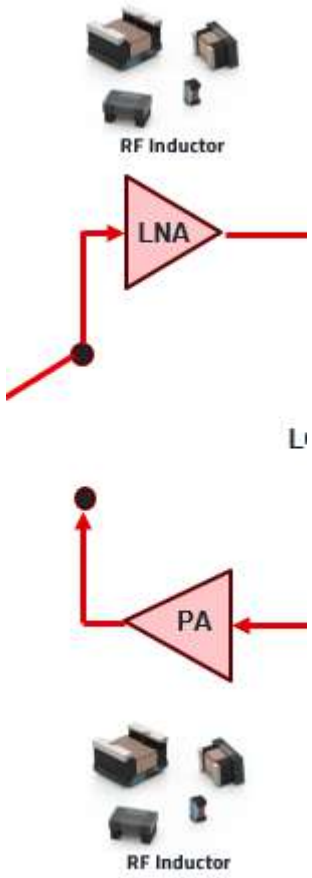
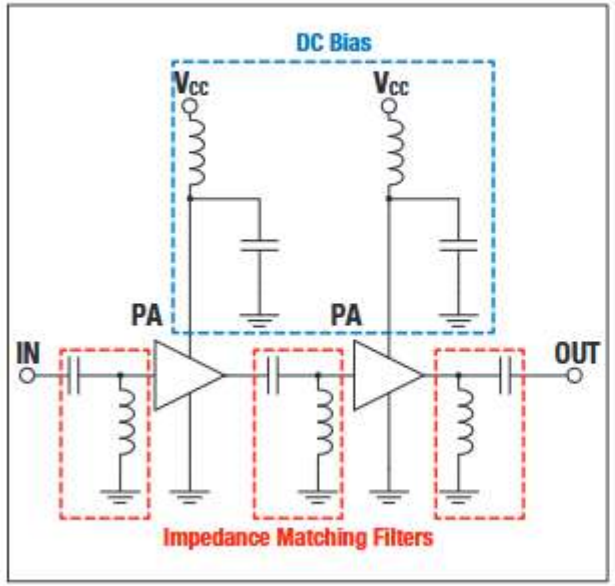
POWER AMPLIFIER

WE Portfolio



PA (Power Amplifier)



Inductors

e. g. WE-KI / WE-KI HC

Best quality-to-price ratio

- SMD RF wire wound ceramic inductors
- High Q-factor
- Large currents supported
- Inductance tolerances: 2 % and 5 %
- Sizes: 0402 / 0603 / 0805 / 1008

e. g. WE-CAIR

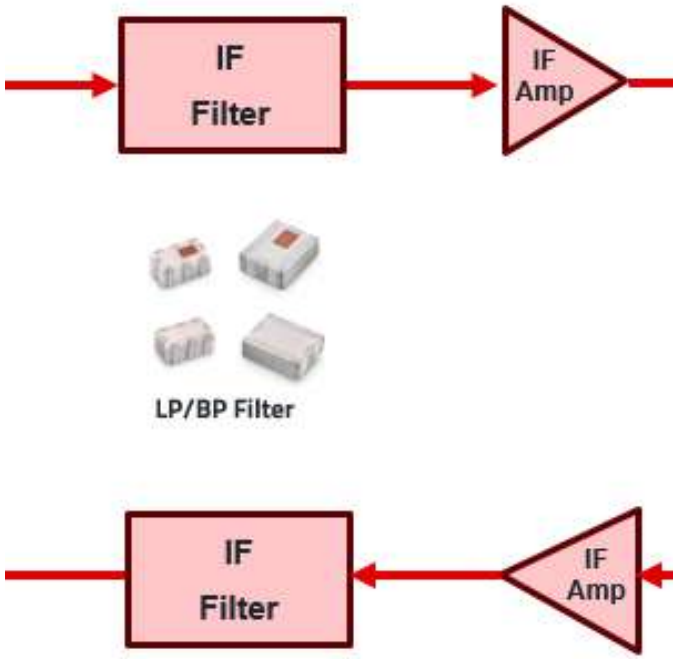
Best performance

- SMD RF air core inductors
- Very high Q-factor
- Very large currents supported
- Inductance tolerances: 2 % and 5 %
- Sizes: 1322 / 1340 / 3136 / 3168 / 4248 / 5910

Up to 2.3 Amp for WE-KI HC, 4 Amp for WE-CAIR

INTERMEDIATE FREQUENCY (IF) FILTER

Signal Filters



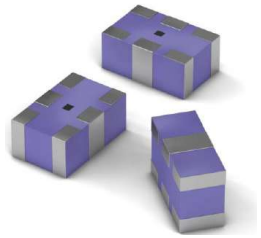
IF (Intermediate Frequency) Filter

Low-Pass Filter:
WE-LPF
Low insertion loss

Band-Pass Filter:
WE-BPF
High stopband rejection

- Power capacity up to 3 W
- Guaranteed filter characteristics over a wide temperature range
- Applications: GSM, WLAN, Bluetooth, wireless communication systems

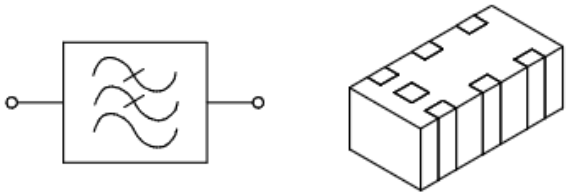
Common Mode Filter
WE-CCMF

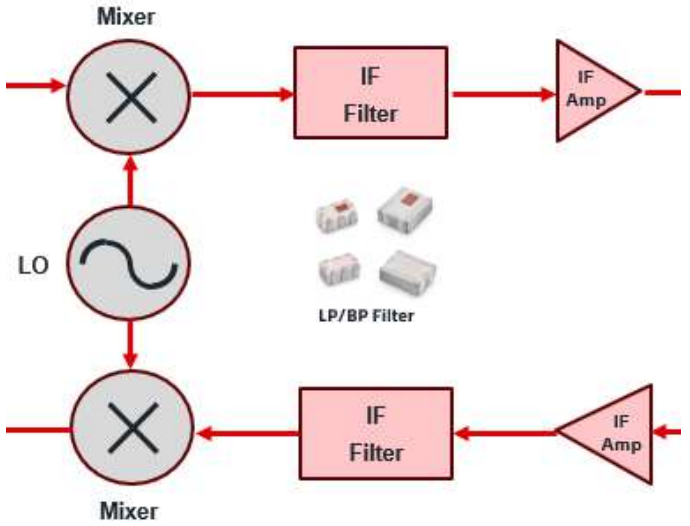


- Ultra-high-speed differential signal transmission
- LTCC based low-loss and highly reliable structure
- High thermal stability

INTERMEDIATE FREQUENCY (IF) FILTER

Signal Filters – Low Pass





WÜRTH ELEKTRONIK

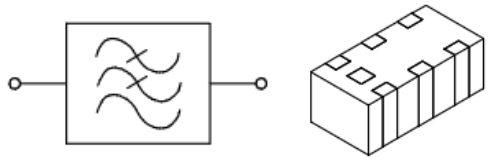
REDEXPERT RF Filters

Filters: Series = WE-LPF

Order Code	Series...	Size	Spec	Type	f_{min}	f_{max}	I_L	VSWR
748112024	WE-LPF	0603		Low Pass	2.40 GHz	2.50 GHz	0.500 dB	1.5
748125024	WE-LPF	0805		Low Pass	2.40 GHz	2.50 GHz	0.500 dB	1.8
748121055	WE-LPF	0805		Low Pass	5.15 GHz	5.88 GHz	0.600 dB	1.8
748111009	WE-LPF	0805		Low Pass	902 MHz	928 MHz	0.500 dB	1.5

REDEXPERT®

INTERMEDIATE FREQUENCY (IF) FILTER



Signal Filters – Low Pass

All | 0603 | 0805

Order Code	Data-sheet	Simu-lation	Downloads	Status	f
748111009	SPEC	RE	8 FILES	Active	902-928 MHz
748112024	SPEC	RE			
748125024	SPEC	RE			
748121055	SPEC	RE			

Learn more

- Standard Transceiver Schematic PDF

EDA models: Components ZIP

ALT Altium_WE-LPF (rev22a).IntLib | 71 KB
ZUK Cadstar_WE-LPF (rev19a).zip | 5.2 KB
CDS Cadence_WE-LPF (rev18a).zip | 144.6 KB
EAG Eagle_WE-LPF (rev19a).lbr | 19.6 KB

CAD files ZIP

IGS WE-LPF_0805_LPF (rev1).igs | 526.3 KB
STP WE-LPF_0805_LPF (rev1).stp | 191.1 KB

Electric models ZIP

ADS ADS_WE-LPF (rev24a).zip | 547.2 KB
S S-Parameter_748111009 (rev20a).S2P | 104 KB

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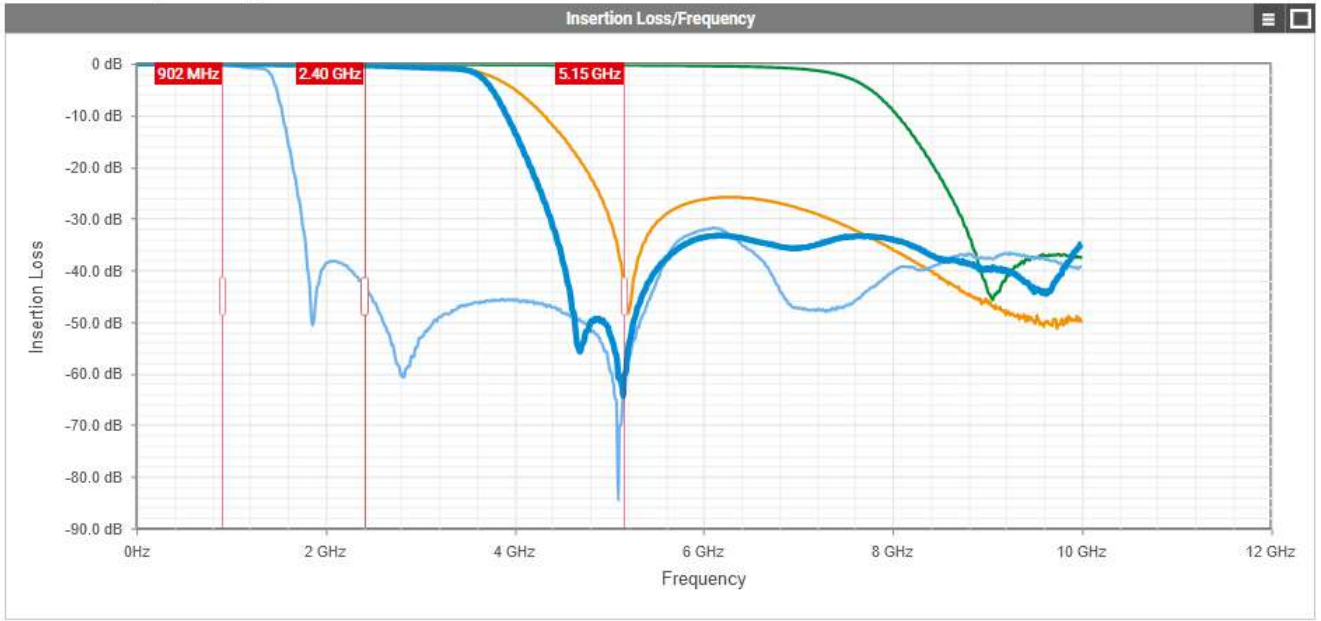
748112024 — WE-LPF · 0603 — 0.500 dB · 2.40 GHz · 2.50 GHz
748125024 — WE-LPF · 0805 — 0.500 dB · 2.40 GHz · 2.50 GHz
748121055 — WE-LPF · 0805 — 0.600 dB · 5.15 GHz · 5.88 GHz
748111009 — WE-LPF · 0805 — 0.500 dB · 902 MHz · 928 MHz
Click and type or drop an Order Code here

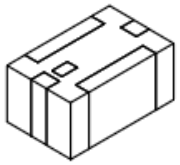
Show Panel: ILoss vs. F | RLoss vs. F

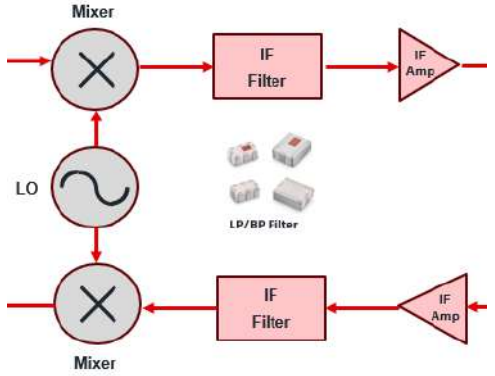


REDEXPERT®

INTERMEDIATE FREQUENCY (IF) FILTER

Signal Filters – Band Pass





WÜRTH ELEKTRONIK

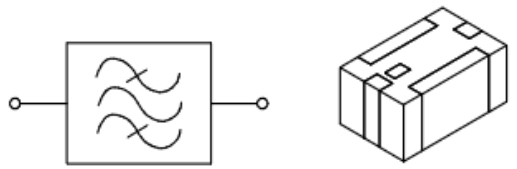
REDEXPERT RF Filters

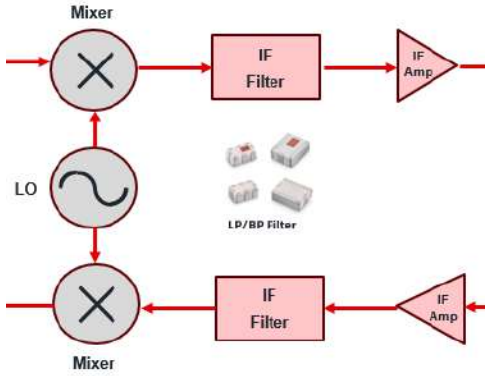
Filters: Series = WE-BPF

Order Code	Series...	Size	Spec	Type	f_{min}	f_{max}	I_L	VSWR
748323024	WE-BPF	0805		Band Pass	2.40 GHz	2.50 GHz	2.20 dB	2
748323056	WE-BPF	0805		Band Pass	4.90 GHz	5.92 GHz	1.50 dB	2
748323155	WE-BPF	0805		Band Pass	5.15 GHz	5.88 GHz	1.50 dB	2
748351024	WE-BPF	1008		Band Pass	2.40 GHz	2.50 GHz	1.80 dB	2
748351124	WE-BPF	1008		Band Pass	2.40 GHz	2.50 GHz	2.50 dB	2

INTERMEDIATE FREQUENCY (IF) FILTER

Signal Filters – Band Pass





All | 0805 | 1008

Order Code	Data-sheet	Simu-lation	Downloads	Status	f
748323024	SPEC	RE	8 FILES	Active	2400-2500 MHz
748351024	SPEC	RE			
748351124	SPEC	RE			
748323056	SPEC	RE			
748323155	SPEC	RE			

Learn more

- Standard Transceiver Schematic PDF

EDA models: Components ZIP

- ALT Altium_WE-BPF (rev22a).IntLib | 68.5 KB
- ZUK Cadstar_WE-BPF (rev19a).zip | 4.8 KB
- CDS Cadence_WE-BPF (rev18a).zip | 157 KB
- EAG Eagle_WE-BPF (rev19a).lbr | 18 KB

CAD files ZIP

- IGS WE-BPF_0805_BPF (rev1).igs | 299.8 KB
- STP WE-BPF_0805_BPF (rev1).stp | 113.6 KB

Electric models ZIP

- ADS ADS_WE-BPF (rev24a).zip | 651 KB
- S S-Parameter_748323024 (rev20a).S2P | 103.9 KB

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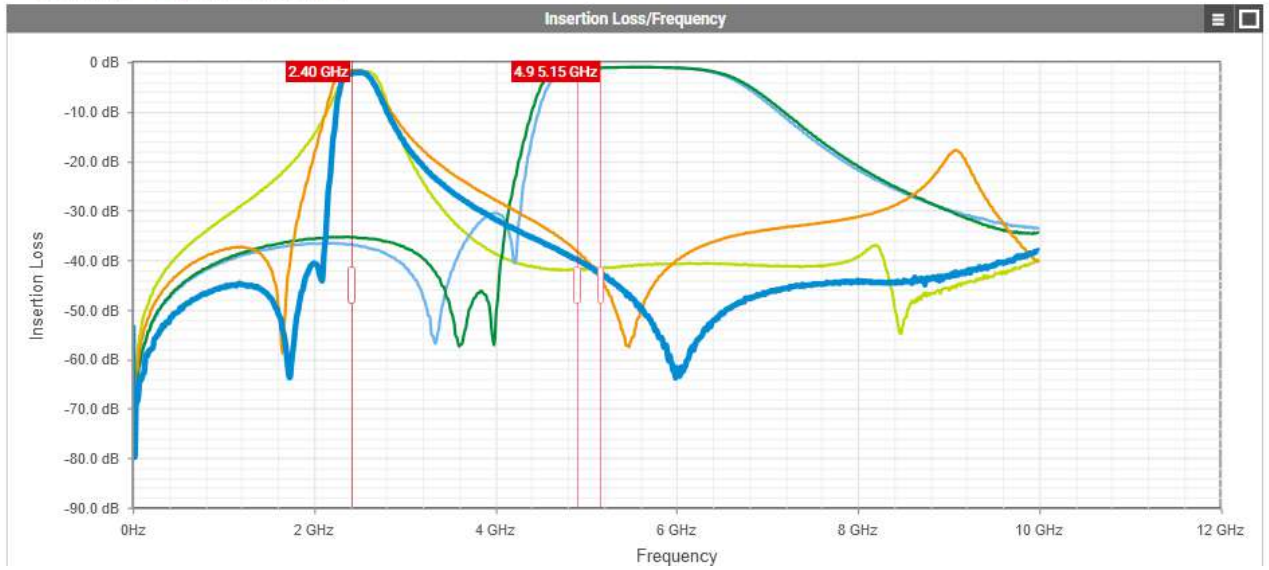
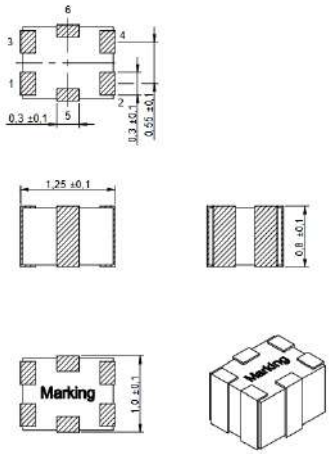
748351124 × WE-BPF · 1008 · 2.50 dB · 2.40 GHz · 2.50 GHz | 748351024 × WE-BPF · 1008 · 1.80 dB · 2.40 GHz · 2.50 GHz | 748323155 × WE-BPF · 0805 · 1.50 dB · 5.15 GHz · 5.88 GHz | 748323024 × WE-BPF · 0805 · 2.20 dB · 2.40 GHz · 2.50 GHz | 748323056 × WE-BPF · 0805 · 1.50 dB · 4.90 GHz · 5.92 GHz | Click and type or drop an Order Code here

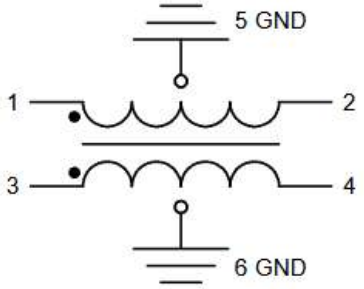
Show Panel: ILoss vs. F | RLoss vs. F

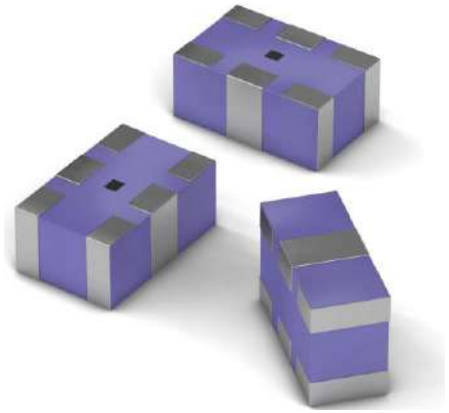


REDEXPERT®

COMMON MODE CHOKE FILTERS







Characteristics

- Compact multilayer common mode choke/filter
- High common mode attenuation on WiFi frequencies (> 30 dB @ bandwidth)
- Ultra-high-speed differential signal transmission
- 12 GHz differential mode cutoff frequency
- LTCC based low-loss and highly reliable structure
- High thermal stability
- Recommended soldering: Reflow
- Operating temperature: -40 °C up to +85 °C

WÜRTH ELEKTRONIK — REDEXPERT — CM Chokes for Low Voltage and Data Lines

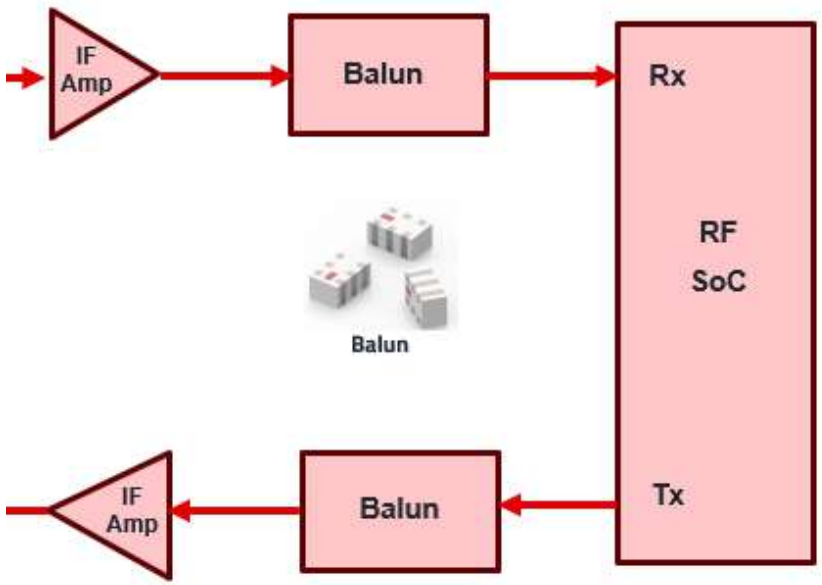
Filters: Series = WE-CCMF

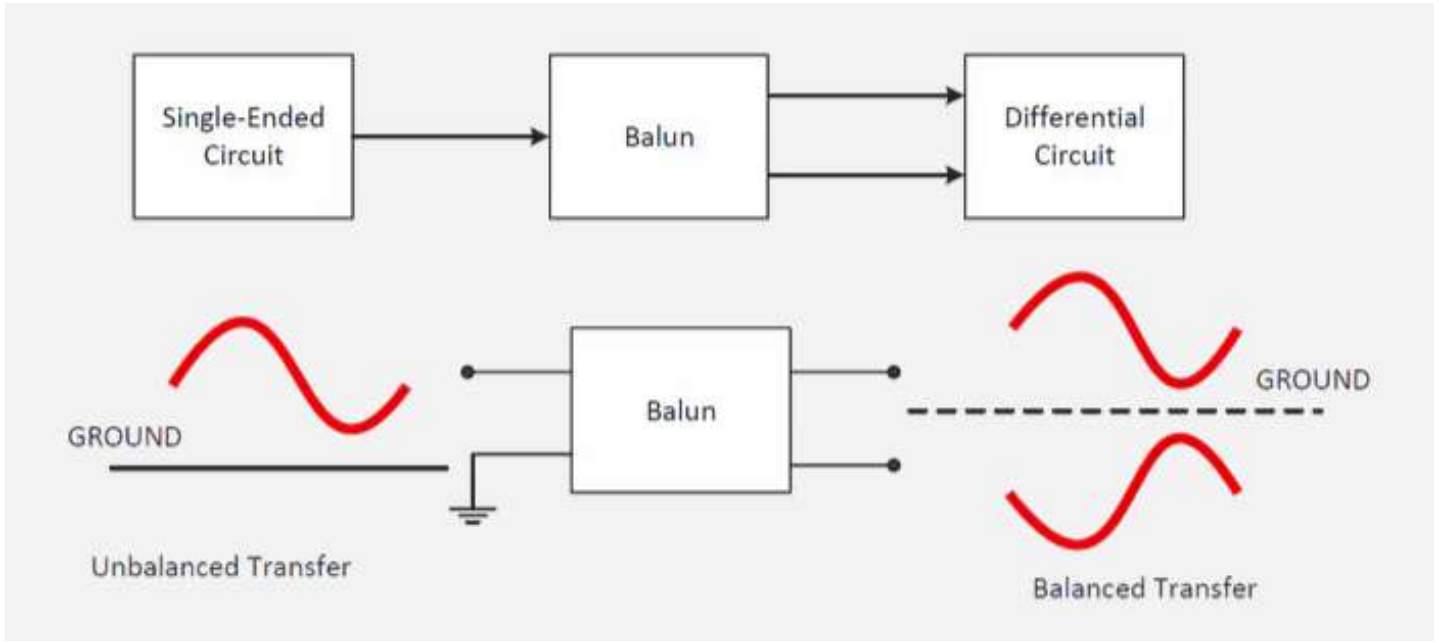
System

Order Code	Series...	Size	Spec	V_R	Z	L_0	I_R	R_{DC}	Winding Style	Length	Width	Height
748020024	WE-CCMF	0504		5.00 V	2.20 Ω	245 pH	300 mA	2.00 Ω	Multilayer	1.25 mm	1.00 mm	0.800 mm
748030024	WE-CCMF	0504		5.00 V	2.00 Ω	245 pH	300 mA	2.00 Ω	Multilayer	1.25 mm	1.00 mm	0.800 mm
748032455	WE-CCMF	0504		5.00 V	1.60 Ω	245 pH	300 mA	2.00 Ω	Multilayer	1.25 mm	1.00 mm	0.800 mm

BALUN

Balanced - **Un**balanced





BALUN

Converts from balanced signal (e.g. IN/OUT of IC) to unbalanced signal (e.g. Antenna) and vice versa

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Frequency Range	f		4900 - 5900	MHz	
Insertion Loss	IL	4900 - 5900 MHz	1.2	dB	max.
Return Loss	RL	4900 - 5900 MHz	-10	dB	min.
VSWR		4900 - 5900 MHz	1.7		max.
Phase Imbalance		4900 - 5900 MHz	180	°	±10°
Amplitude imbalance		4900 - 5900 MHz	2	dB	max.
Unbalanced Impedance		4900 - 5900 MHz	50	Ω	
Balanced Impedance		4900 - 5900 MHz	100	Ω	

Working Frequency

Attenuation of the useful signal.
The lower the better.

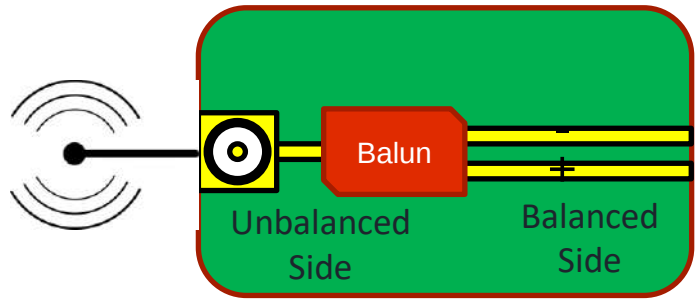
The ratio between reflected and incident in dB.
The higher the better.

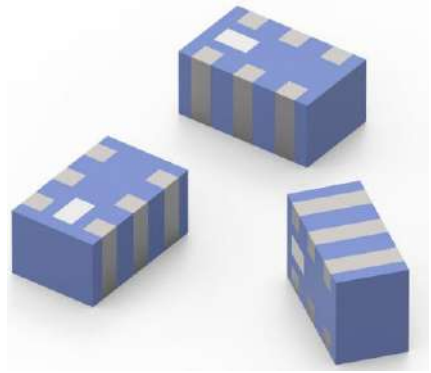
VSWR stands for **V**oltage **S**tanding **W**ave **R**atio

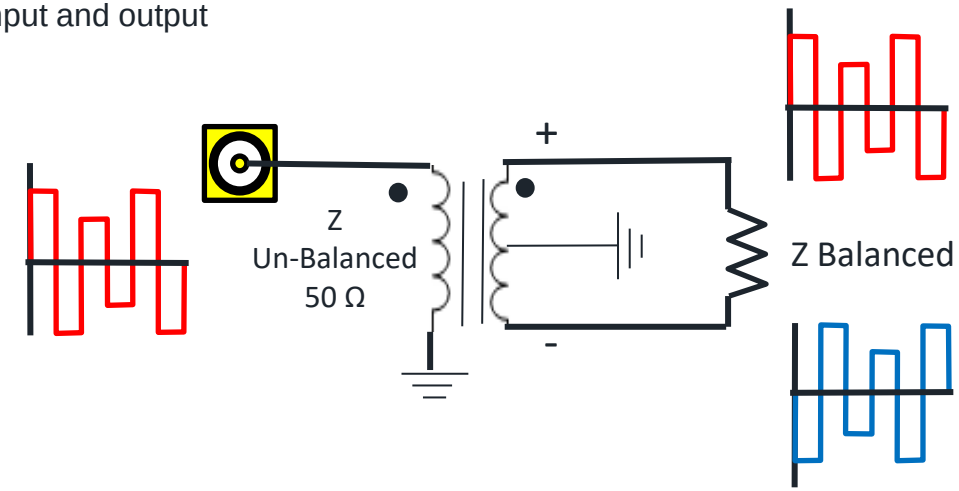
The lower the better.

Impedance of the line

Input and output





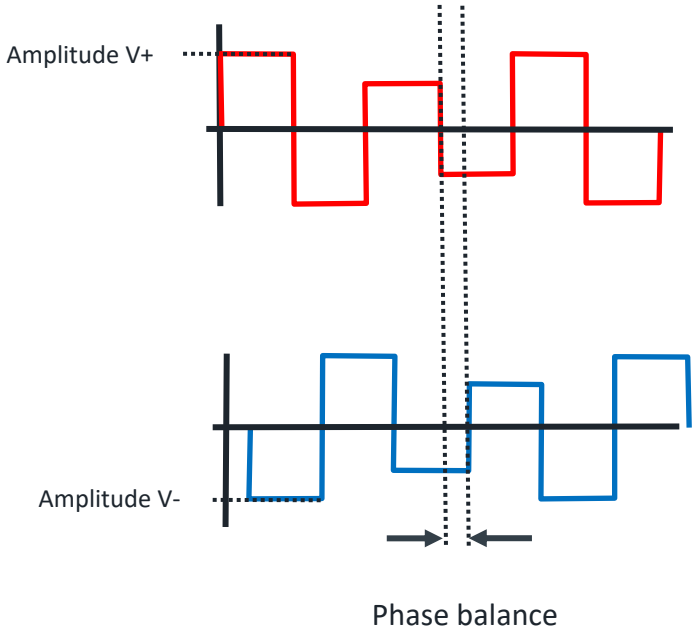


BALUN

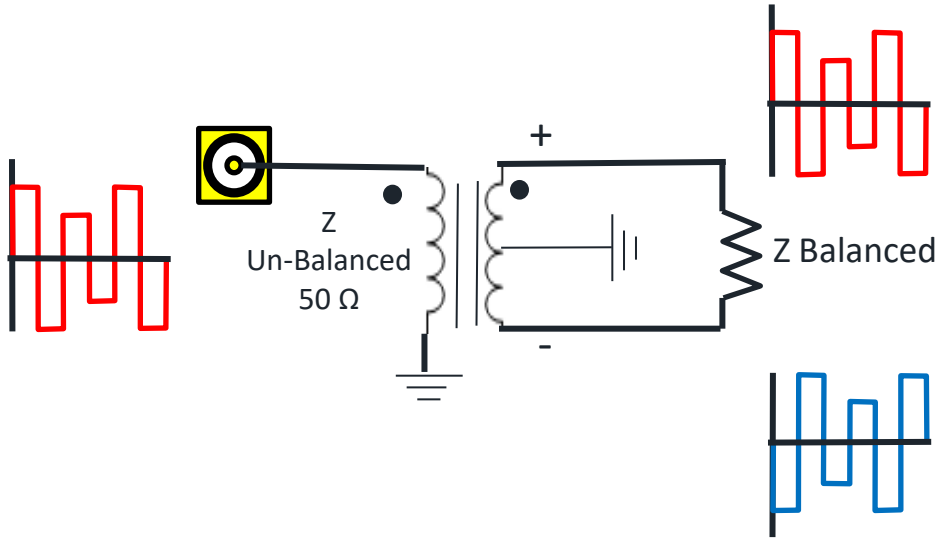
Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Frequency Range	f		2400 - 2500	MHz	
Insertion Loss	IL	2400 - 2500 MHz	1.2	dB	typ.
Insertion Loss	IL	2400 - 2500 MHz	2	dB	max.
VSWR		2400 - 2500 MHz	2		max.
Phase Imbalance		2400 - 2500 MHz	180	°	±10°
Amplitude imbalance		2400 - 2500 MHz	2	dB	max.
Unbalanced Impedance			50	Ω	typ.
Balanced Impedance			50	Ω	typ.



Phase balance



Phase balance

- is given as the measurement in degrees
- the difference in phase between the inverted output from the non-inverted output.
- Baluns with a phase balance closer to 0° (or 180°) are higher performing baluns.

Amplitude balance

- is a measure of the match of the output power magnitude between the two balanced ports.
- An Amplitude match closer to 0 dB is an indicator of a higher performance balun.

BALUN

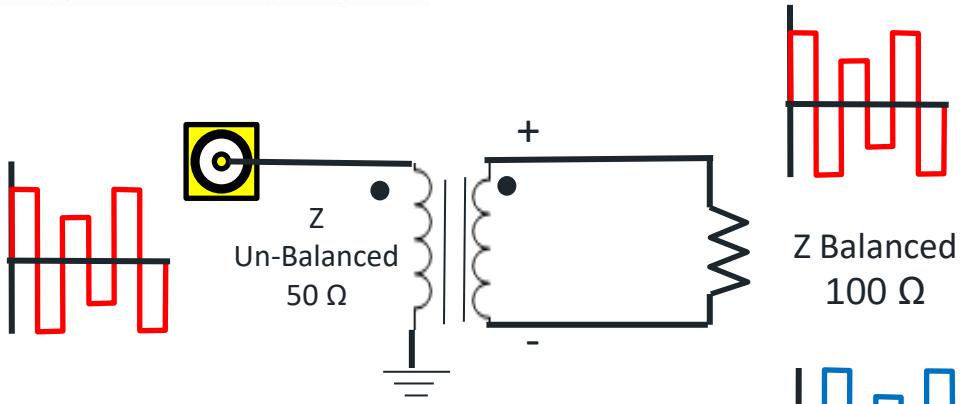
Specifications

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Frequency Range	f		2400 - 2500	MHz	
Insertion Loss	IL	2400 - 2500 MHz	1.2	dB	typ.
Insertion Loss	IL	2400 - 2500 MHz	2	dB	max.
VSWR		2400 - 2500 MHz	2		max.
Phase Imbalance		2400 - 2500 MHz	180	°	±10°
Amplitude imbalance		2400 - 2500 MHz	2	dB	max.
Unbalanced Impedance			50	Ω	typ.
Balanced Impedance			50	Ω	typ.

REDEXPERT RF Balun

VSWR	$\|S_{21}\|-\|S_{31}\|$	$\angle S_{21}-\angle S_{31}$	Z_{unbal}	Z_{bal}
1.70	2.00 dB	180°	50.0 Ω	100 Ω
1.70	2.00 dB	180°	50.0 Ω	100 Ω
2.00	2.00 dB	180°	50.0 Ω	100 Ω
1.70	2.00 dB	180°	50.0 Ω	50.0 Ω
2.00	2.00 dB	180°	50.0 Ω	100 Ω
2.45	1.50 dB	180°	50.0 Ω	100 Ω
2.00	2.00 dB	180°	50.0 Ω	50.0 Ω



Impedance ratio
1:2

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Würth Elektronik is offering not just the components for a matched Antenna Network, we can also support in the process of designing.

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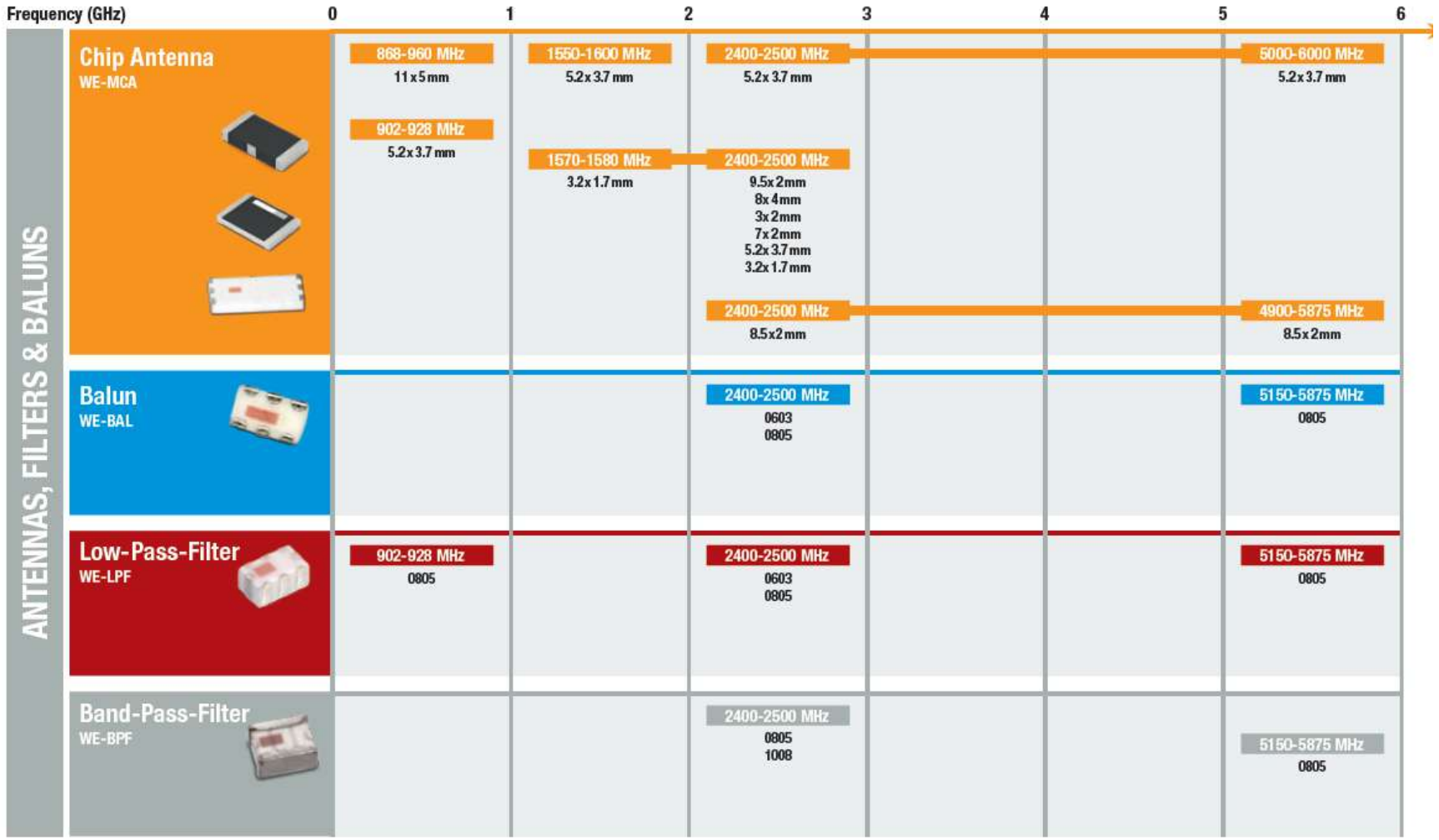
Characteristics

- Includes components like Chip antennas, RF inductors, RF capacitors and coaxial cable working up to 18 GHz
- Complete solution for antenna selection and matching needs
- Ability to accommodate high frequency designs and the associated parasitics
- Antenna frequency range: 868 – 5800 MHz
- Inductance: 1.0 – 100 nH
- Capacitance: 0.3 – 27 pF

RF PRODUCT FINDER



Frequency ranges:										
	ISM	433/868 MHz	GPS	1559/1610 MHz	WLAN	2400/2483 MHz	WiMAX	3410/3594 MHz	WLAN	5150/5250 MHz
	ZigBEE EU	868 MHz	4G	1710/2690 MHz	ZigBee	2402/2480 MHz				5250/5350 MHz
	ZigBEE USA	915 MHz			Bluetooth	2402/2480 MHz				5470/5725 MHz
	Mobil-DB	878/880 MHz			HomeRF	2402/2480 MHz				5725/5825 MHz
	GSM	890/914 MHz			4G	1710/2690 MHz			DECT2	5725/5825 MHz
		935/959 MHz								
	4G	700/960 MHz								

ADDITIONAL PARTS TO OFFER

WE Technical References:
eiSmart Product Guide
IC Reference Designs
Würth Elektronik Application Guide.
Low Temperature Co-Fired Ceramic


Chip Antenna

Coaxial Connectors


RF Inductor


High Frequency Capacitor


RF Inductor

LP/BP Filter

RF CMC

Balun

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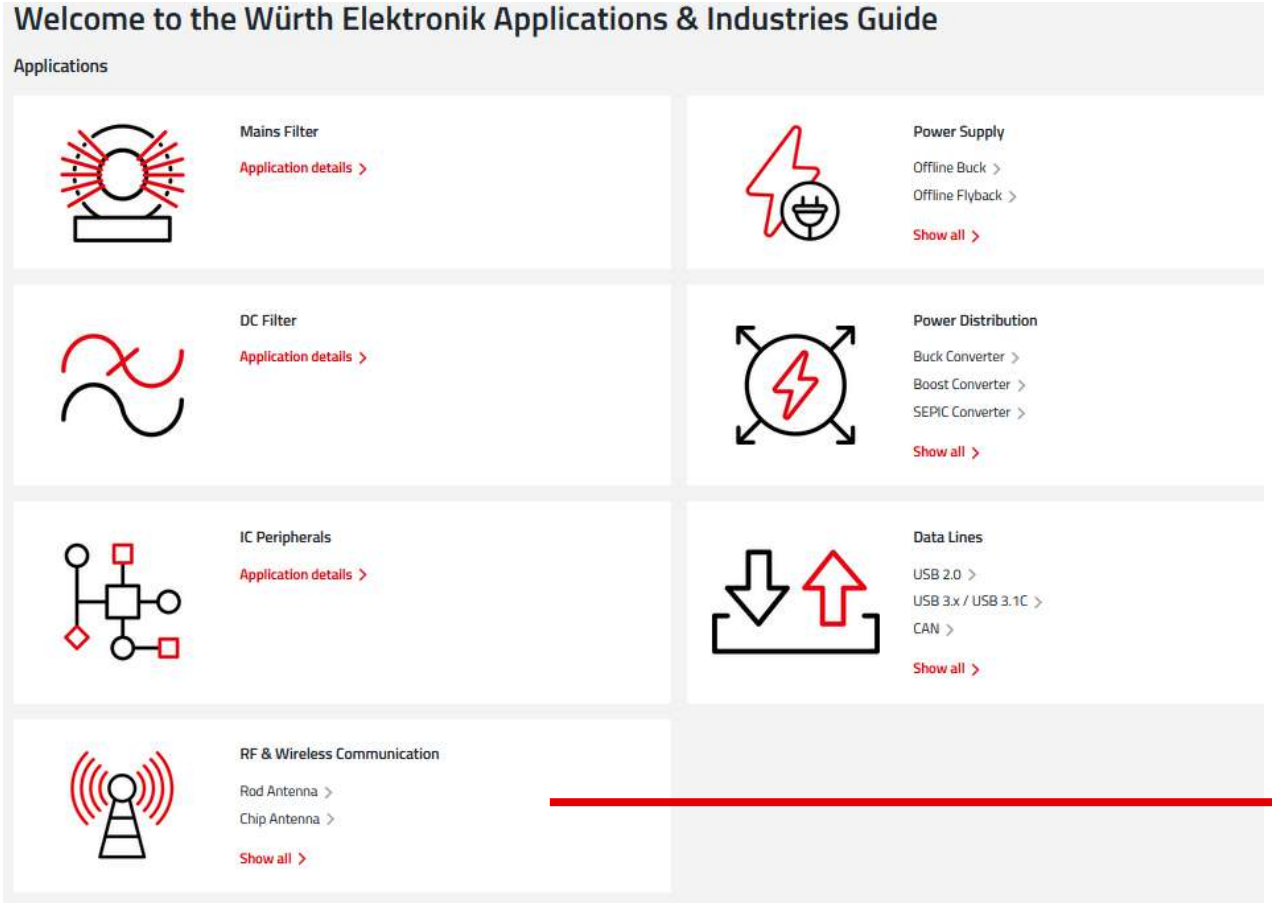

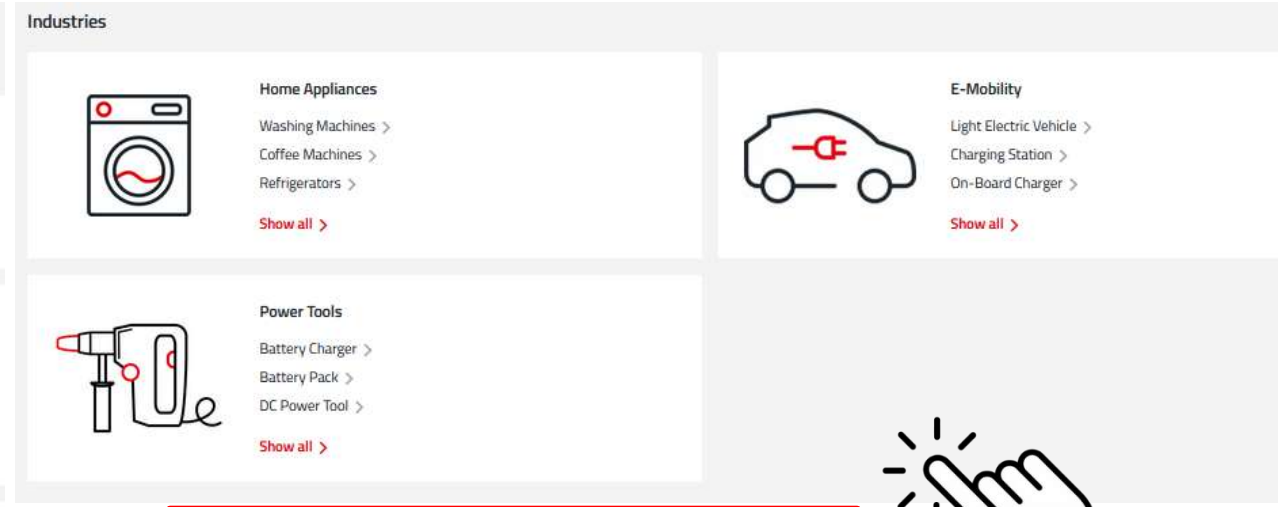

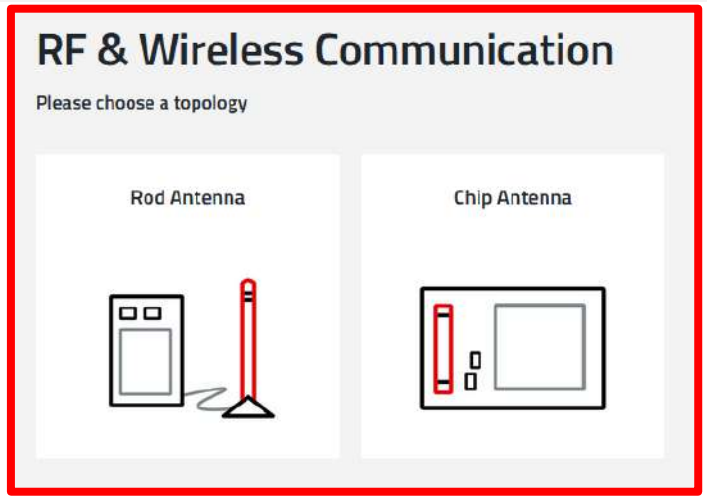

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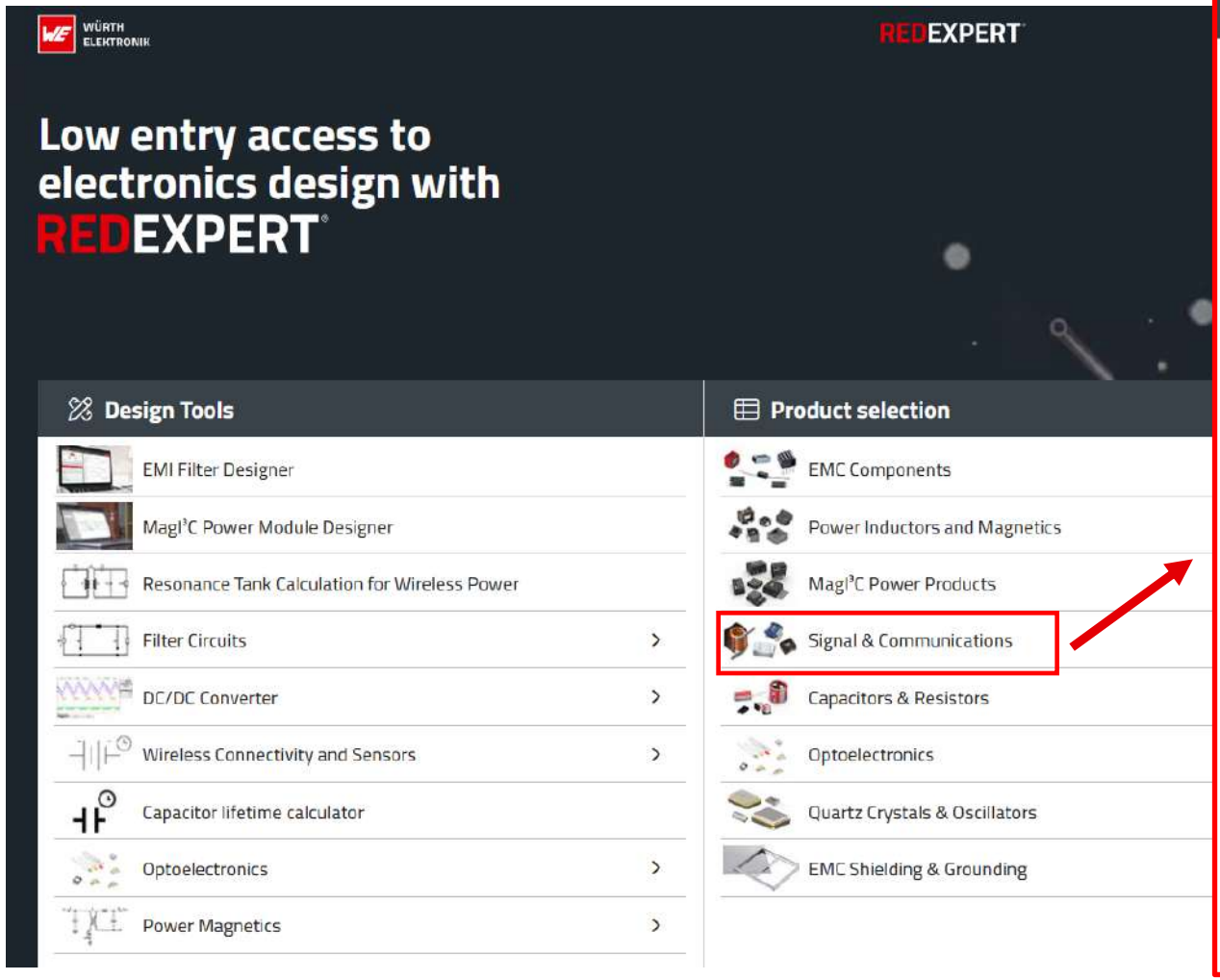

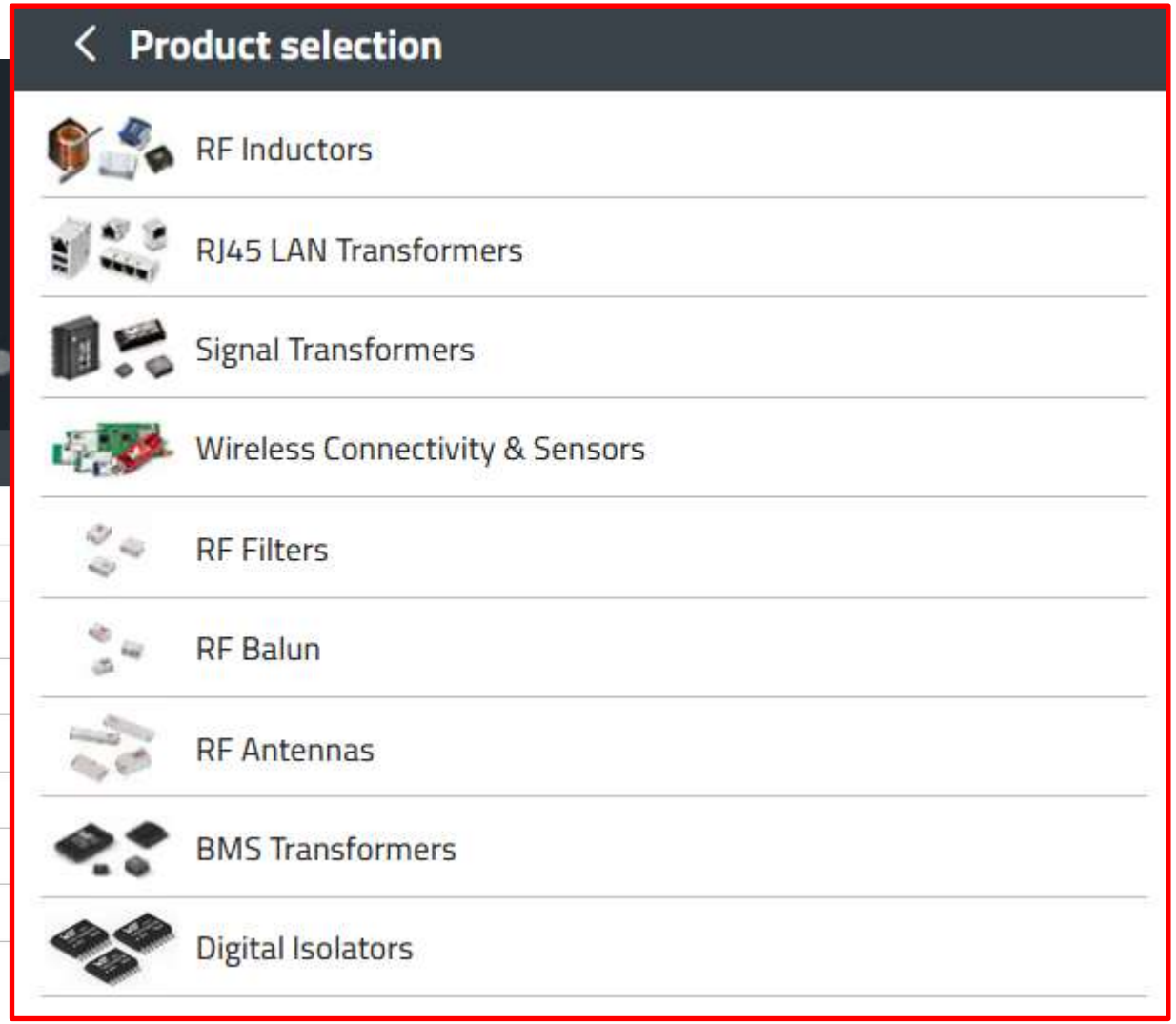

QUESTION #2

LTCC stands for? And name at least two advantages.

LTCC – Low Temperature Co-fired Ceramic

- Small size.
- Low losses.
- High reliability.
- Stable temperature behavior.

THANK YOU

Auckland: Tasi.Samu@we-online.com

Christchurch: Mark.Toi@we-online.com

FAE: Carpov.Pascual@we-online.com