

# RF/IF building blocks for niche handheld devices

Compact, highly integrated solutions that deliver proven performance in Unlicensed Part 15 frequencies



# Smart solutions for standout systems

## SA6xx RF/IF building blocks

NXP's SA6xx series of RF/IF building blocks are ideal for a variety of niche RF products. Available in small-footprint packages, SA6xx solutions save PCB space while providing better RF performance.

## Product highlights

### SA614AHR (HXQFN16)

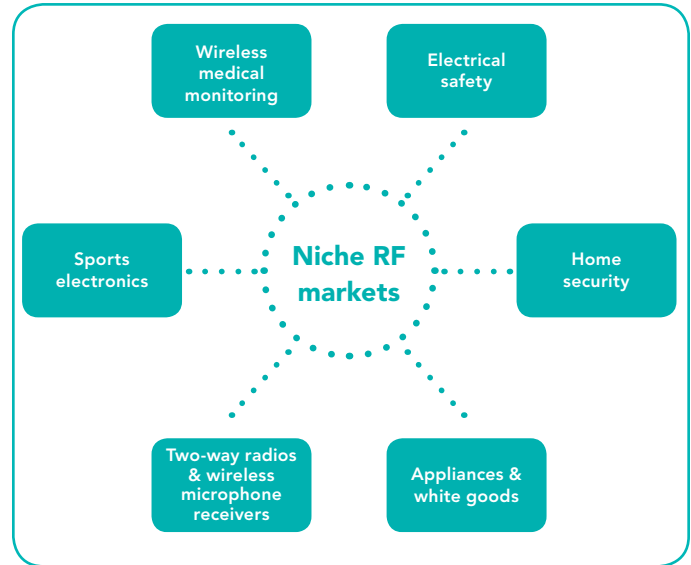
An excellent choice for implementing the ultrasound receivers used in things like arc fault interrupt detectors and fish finders.

### SA616BS (HVQFN20)

Provides enhanced receiver sensitivity and SINAD performance for applications like two-way radios and wireless medical monitoring.

### SA636BS (HVQFN20)

Functions as a low-noise, high-fidelity wireless microphone receiver with UHF diversity.



# A history of RF innovation

NXP's portfolio of highly integrated solutions for low-voltage, battery-operated applications, which includes RF/IF building blocks, user-interface products, and RF discretes, incorporates the best of our industry-leading expertise in wireless technology.

Every product in this category reflects the know-how gained from a history of RF innovation in cellular communications, peer-to-peer wireless networking, RFID tags, and high-end manufacturing.

The result is a series of RF solutions that bring high integration and superior performance to a wide range of low-voltage, battery-operated wireless applications in Unlicensed Part 15 frequencies.

## Wide selection of package options

All our RF/IF solutions are available in a wide range of package options that support miniaturization and increase design flexibility. Included in that list are innovative QFN packages that deliver a footprint significantly smaller than a standard SSOP20 or SO16 package.

## Demo board kits

Many of our demo board kits are free in single quantities, so you can turn designs quickly. Others are available for order through various NXP distributors.

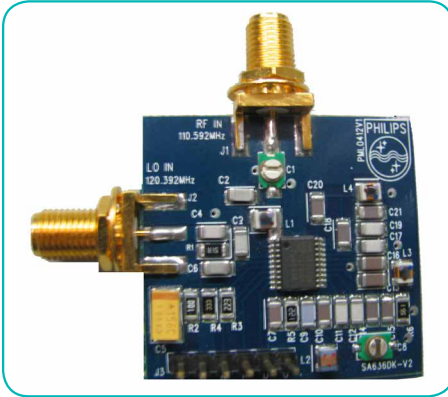
## Free application support

We know how vital it is to provide developers with more than just technology. To make design-in as fast and easy as possible, we support all our RF products with ready-made design kits and provide in-depth application support – all absolutely free of charge.

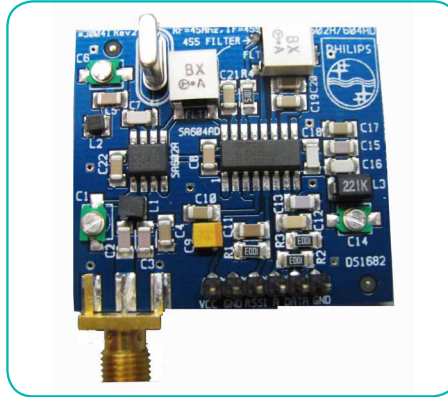
For application support visit [nxp.com](http://nxp.com).



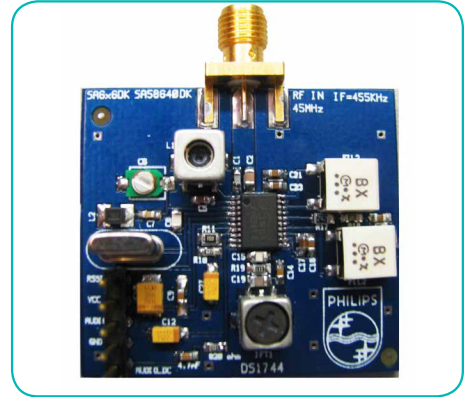
# RF/IF evaluation demo boards



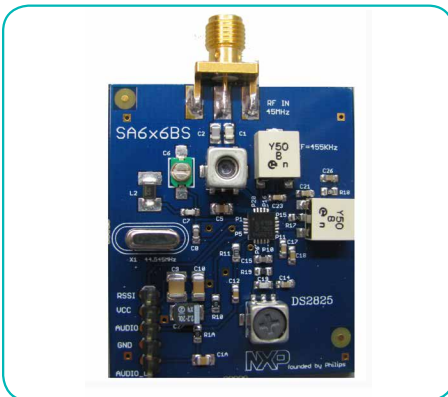
**SA636DK OM13312**  
RF = 110.59 MHz; IF 9.8 MHz



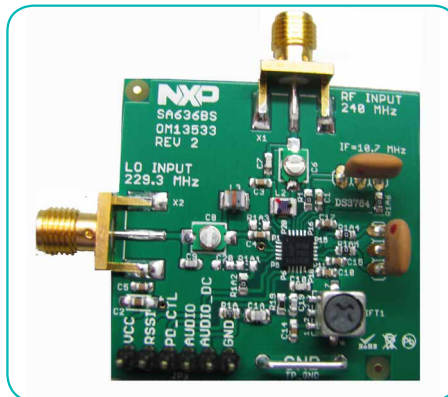
**SA602AD + SA604AD OM13535**  
RF = 45 MHz; IF = 455 KHz



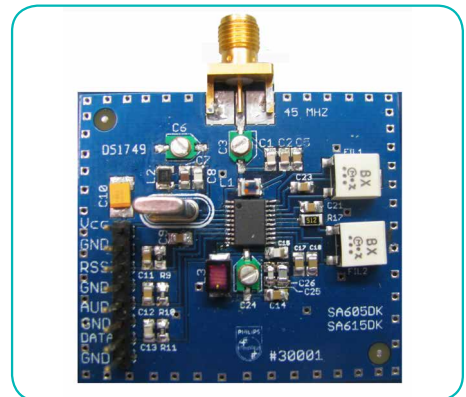
**SA6X6DK OM13531**  
RF = 45 MHz; IF = 455 KHz



**SA616BS OM13532**  
RF = 45 MHz; IF = 455 KHz



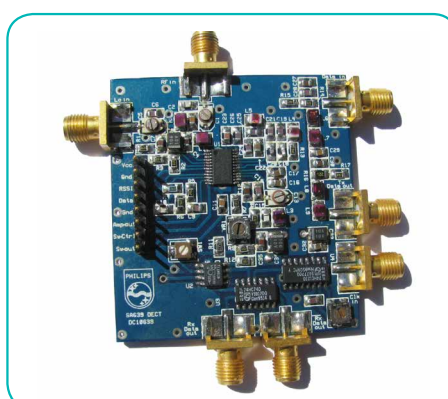
**SA636BS OM13533**  
RF = 240 MHz; IF = 10.7 MHz



**SA605DK OM13534**  
RF = 45 MHz; IF = 455 KHz



**SA614AHR OM13530**  
IF = 10.7 MHz



**SA639DH OM13536**  
RF = 110 MHz; IF = 9.8 MHz



**SA630D OM13537**  
RF = 1 GHz

Unlicensed Part 15 frequency allocations										
Frequency	50 kHz to 600 kHz	27 MHz	40.66 to 40.70 MHz	46 to 49 MHz	50 and 53 MHz 72 and 75 MHz	72 to 76 MHz	169 to 172 MHz	260 to 470 MHz	901 to 902 MHz 930 to 931 MHz 940 to 941 MHz 902 to 928 MHz ISM bands	2.4 GHz ISM band
Applications	Ultrasound transducer applications: fish finders, arc fault interrupt detectors	Radio-controlled cars and toys	FCC Part 15 periodic applications	Baby monitors, wireless microphones	Model aircraft	Hearing aids	Wireless microphones	FCC Part 15 periodic applications: keyless entry/OOK, wireless switches (315 MHz in USA, 433.6 MHz in EU), family radio services (462.562 to 467.7125 MHz)	Cordless phones, wireless data and security, meter readers, narrowband PCS, HAM radio	Cordless phones, wireless data and security, home automation, low- power PCS, HAM radio

Applications by RF-IF device type			
Type	Applications	Device	Package
Low-voltage FM IF systems	<ul style="list-style-type: none"> <li>Auto-refill water dispensers in refrigerators</li> <li>Fish finders</li> <li>Ultrasound sensor log amps @ 200 kHz</li> <li>Arc fault detectors</li> </ul>	SA604A SA614A	SO16, HXQFN16 SO16, HXQFN16
Narrowband/wideband FM RF/ IF receivers	<ul style="list-style-type: none"> <li>Home security system receivers</li> <li>Car toll readers</li> <li>NFC/RF ID tag receivers</li> <li>Remote keyless entry/OOK receivers</li> </ul>	SA605 SA615	SO20, SSOP2
Narrowband FM RF/IF receivers	<ul style="list-style-type: none"> <li>Professional two-way radios</li> <li>Emergency locating receivers in VHF band for GNSS (Global Navigation Satellite System)</li> <li>Animal tracking receivers and direction finders</li> <li>Wireless hearing aid receivers</li> </ul>	SA606 SA616	SSOP20 SSOP20, HVQFN20
Wideband FM RF/IF receivers	<ul style="list-style-type: none"> <li>Data controllers in Pay TV</li> <li>Wireless keyboard receivers</li> <li>Wireless meter readers</li> <li>Wireless microphone receivers</li> </ul>	SA636 SA639	SSOP20, HVQFN20 TSSOP24
SPDT switches	<ul style="list-style-type: none"> <li>SPDT antennas &amp; filter switches</li> </ul>	SA630	SO8
Mixers with VCO	<ul style="list-style-type: none"> <li>VCOs (FM &amp; FSK)</li> <li>RF front-end down converters</li> </ul>	SA602A SA612A	SO8



# RF transceivers made simple

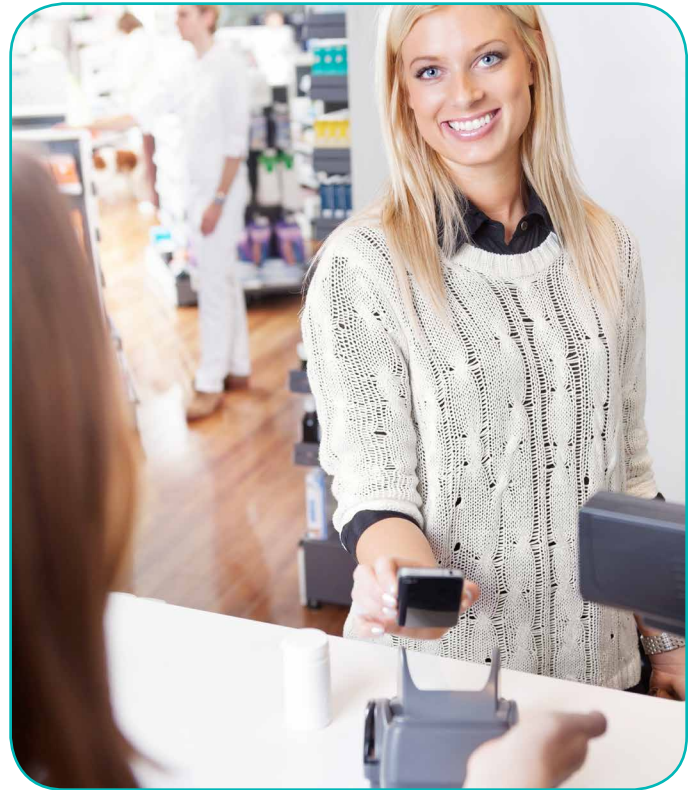
By providing key components for every stage of RF transmission and reception, NXP makes it simple to create a wireless transceiver.

The block diagram shows that, in the frontend receiver, our RF/IF components, RF MMICs, and discrete components implement an SPDT switch, an LNA, an RF mixer, and a first LO.

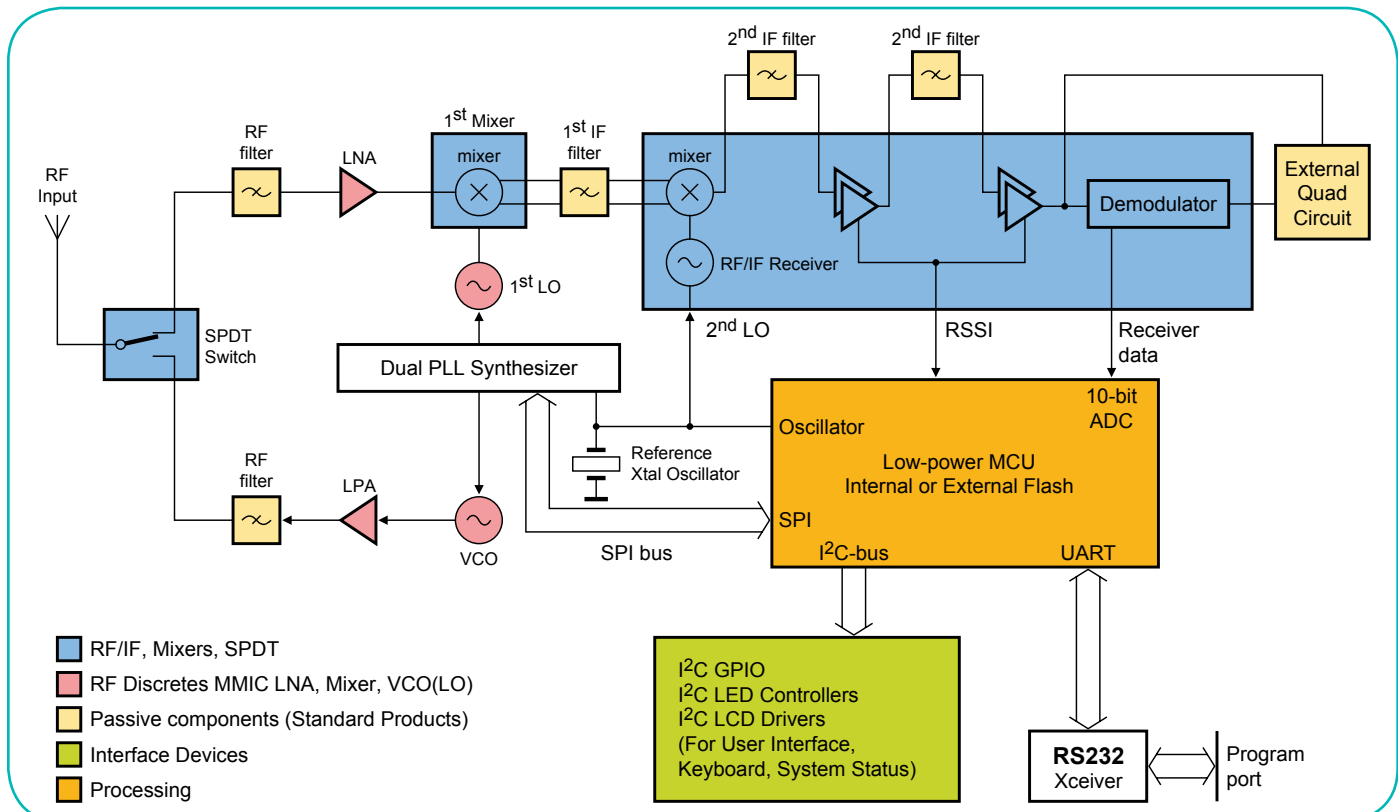
In the backend receiver, an RF/IF receiver serves as the second mixer and second LO, and provides the baseband functions for RSSI and recovered audio.

In the transmitter, RF MMICs and RF discretes implement the VCO and LPA.

To complete the solution, other NXP products, including the microprocessor, UART, and I<sup>2</sup>C devices, manage the system and perform user-interface functions.

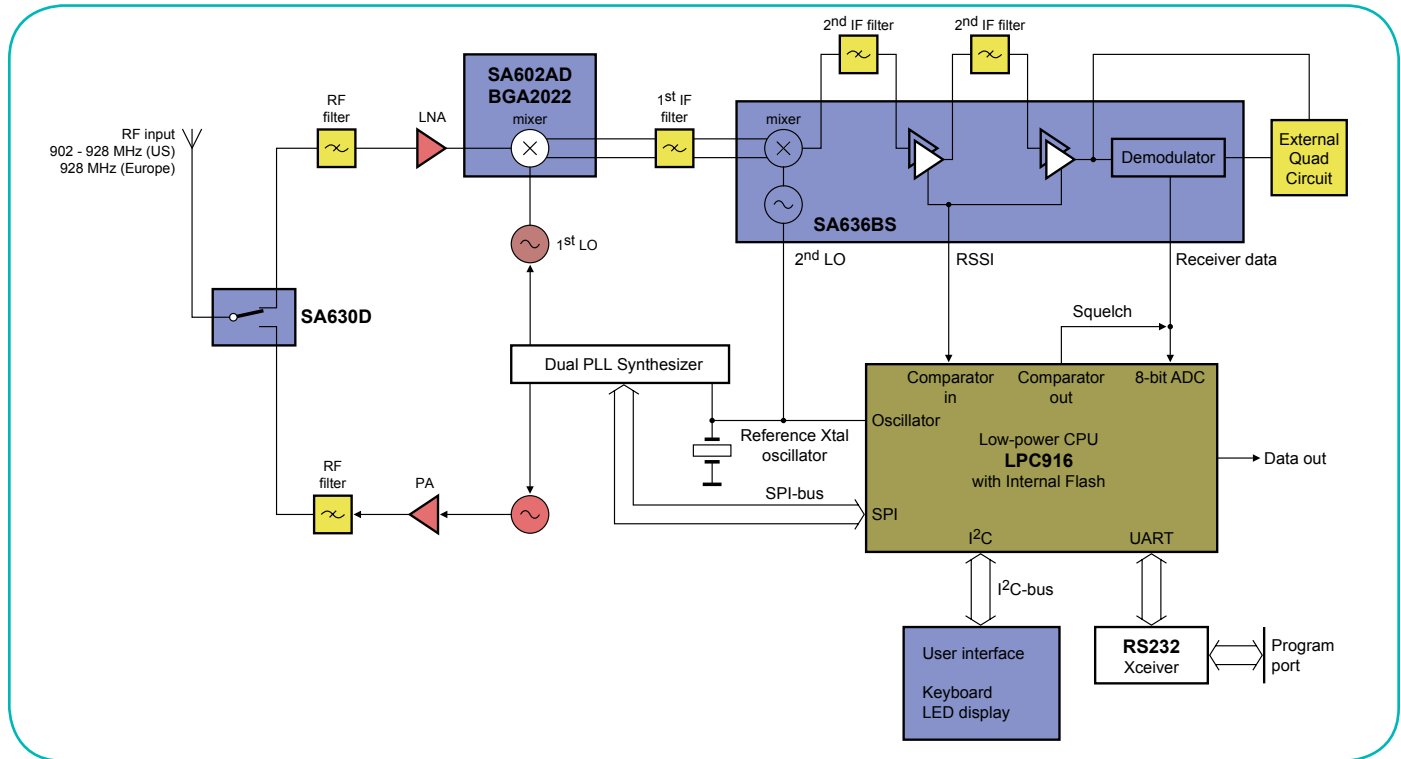


## WIRELESS TRANSCEIVER BLOCK DIAGRAM

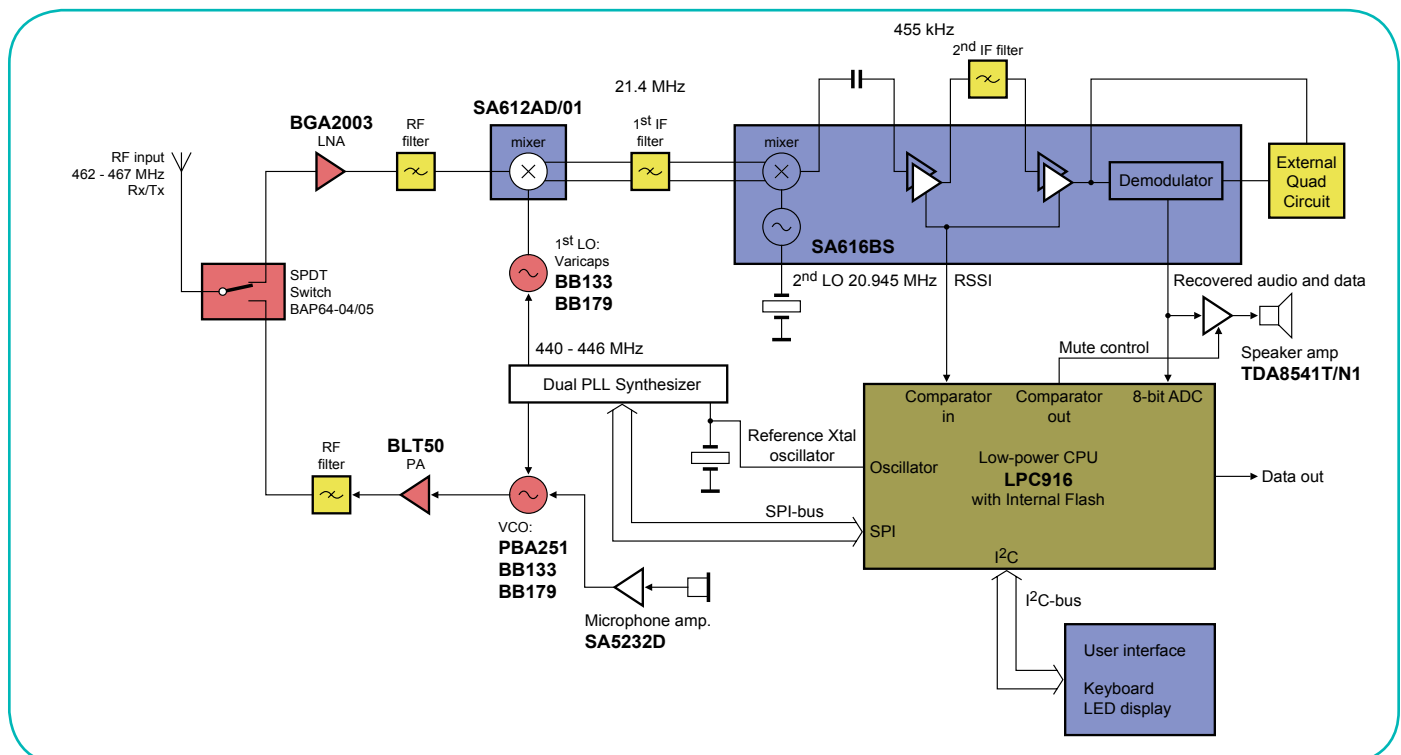


# RF/IF building blocks: applications

## WIRELESS DATA TRANSCEIVER FOR 2.4 GHZ AND 900 MHZ ISM BAND

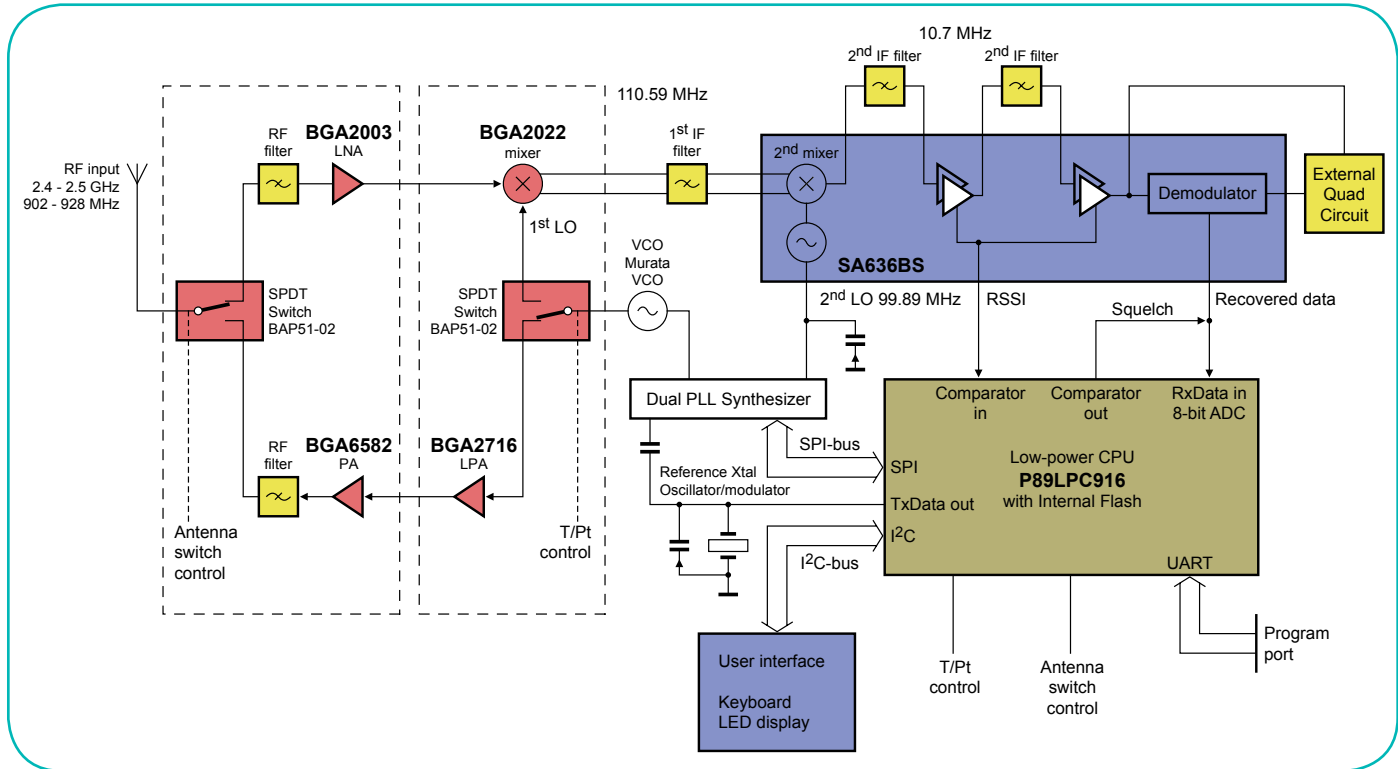


## FAMILY RADIO SERVICES WALKIE-TALKIE

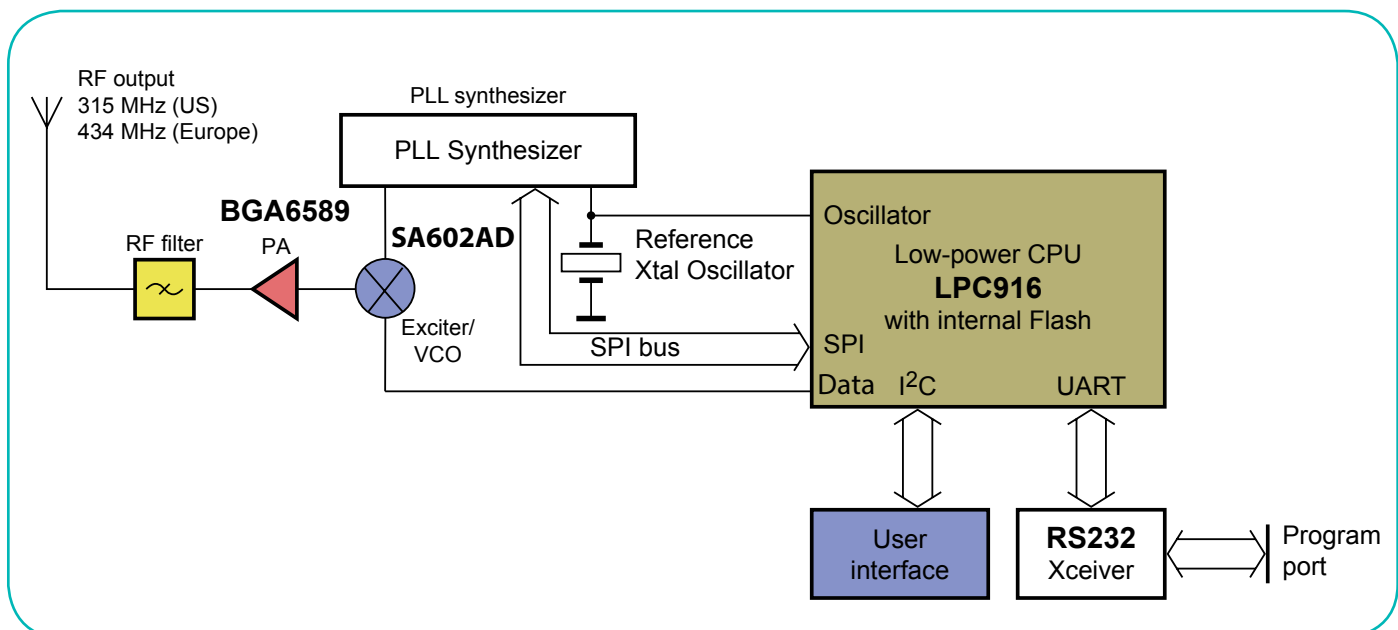


# RF/IF building blocks: applications

## WIRELESS DATA TRANSCIVER FOR US AND EUROPEAN ISM BANDS



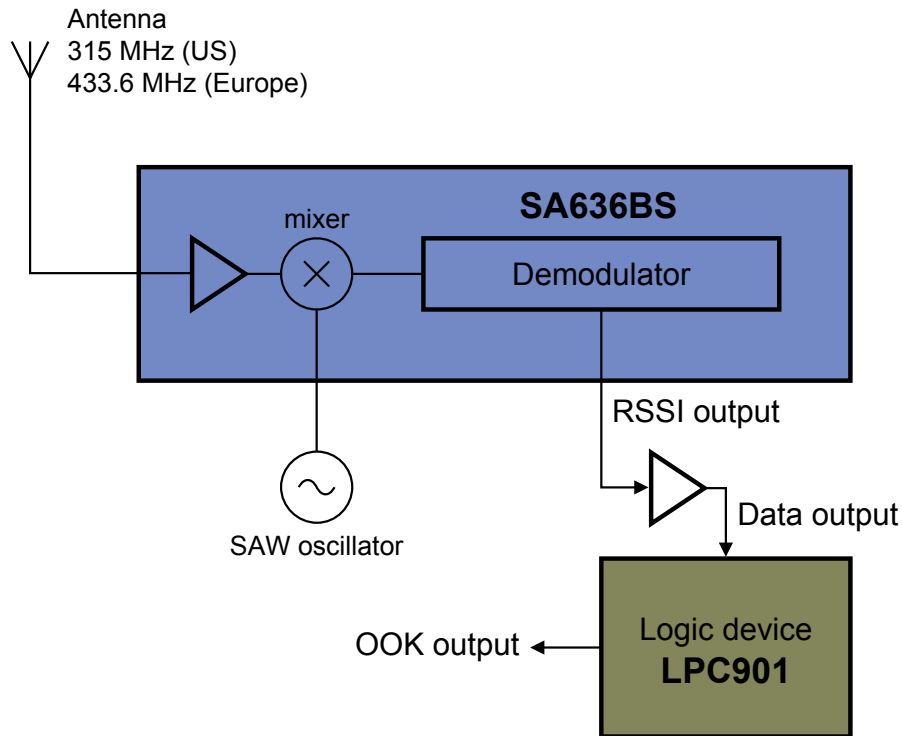
## OOK TRANSMITTER USING PLL SYNTHESIZER/EXCITER OSCILLATOR



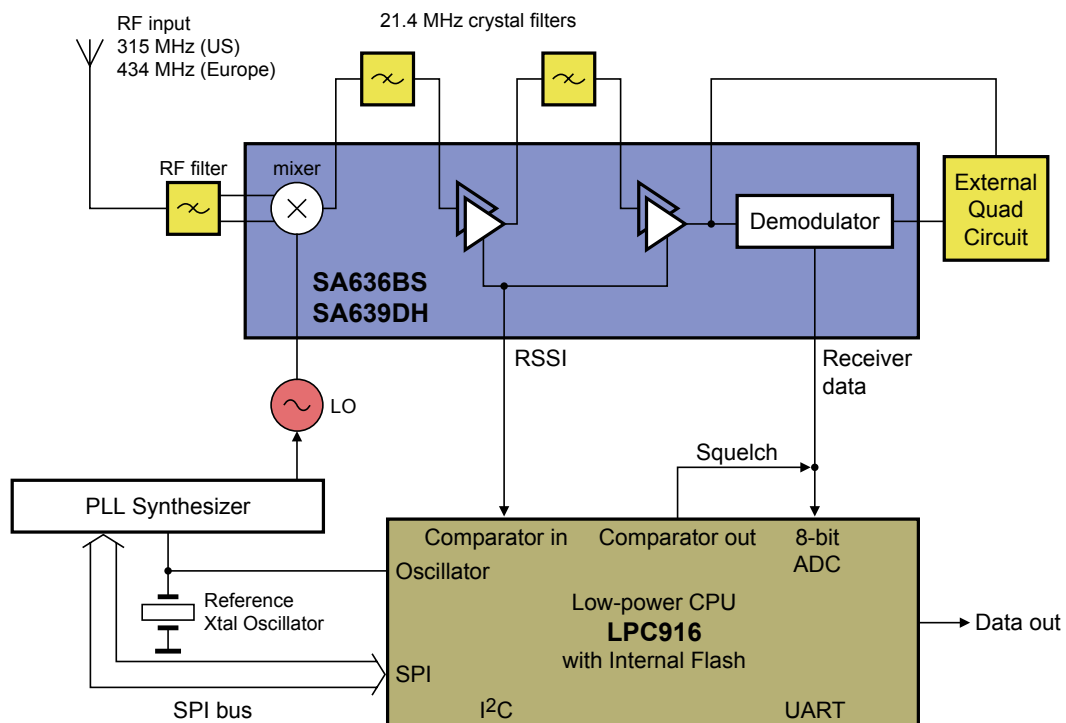


# RF/IF building blocks: applications

## OOK RECEIVER USING SAW OSCILLATOR

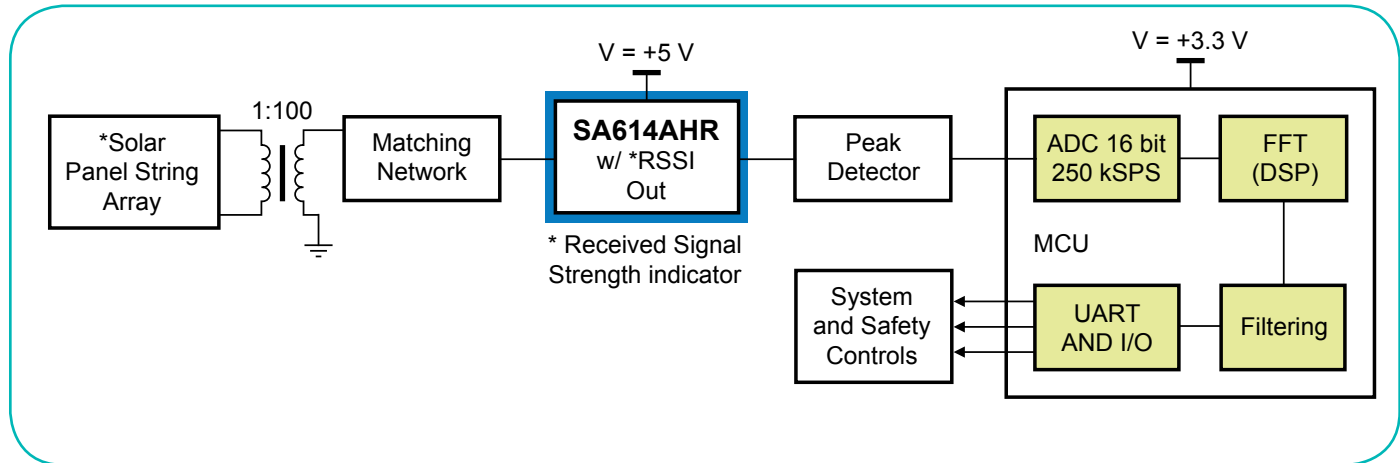


## UHF RECEIVER FOR REMOTE CONTROL

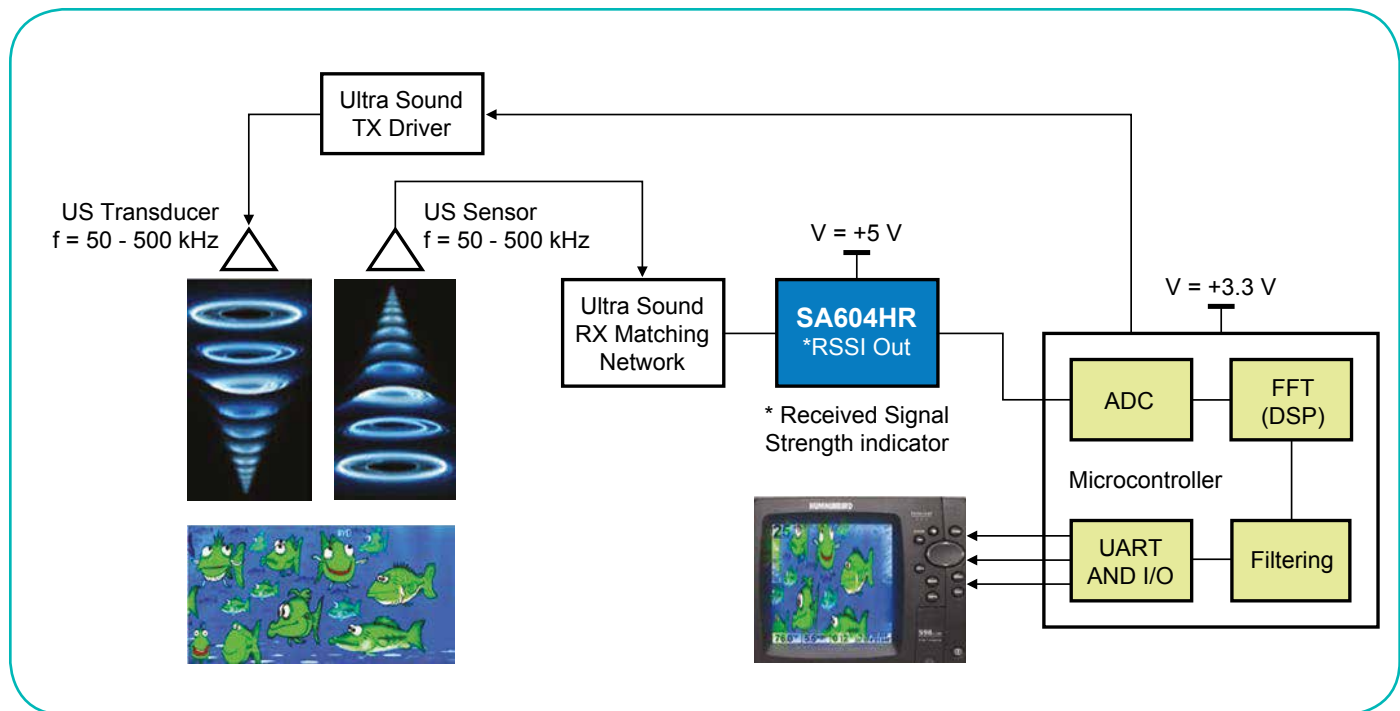


# RF/IF building blocks: applications

## THE SA614A IN AN ARC FAULT DETECTOR



## THE SA604A IN A FISH FINDER



# RF/IF building blocks: selector guide

RF/IF building blocks: selector guide						
Device	Description	Frequency range	Bandwidth	Voltage (V)	Package	Applications
SA602A, SA612A	LNA, mixer, and oscillator	1 GHz	500 MHz RF	4.5 to 8.0	SO8	<ul style="list-style-type: none"> <li>• Transmitters</li> <li>• Wireless meter readers</li> <li>• Wireless local loops</li> <li>• Police, fire radios</li> </ul>
SA606, SA616	Narrowband FM IF receiver with audio and RSSI op amps	150 MHz	150 MHz RF, 2 MHz narrowband IF	2.7 to 5.5	SSOP20, SO20, HVQFN20	<ul style="list-style-type: none"> <li>• Portable cellular radio FM IF</li> <li>• Cordless phones</li> <li>• Wireless systems</li> <li>• RF level meters</li> <li>• Spectrum analyzers</li> <li>• Instrumentation</li> <li>• FSK and ASK data receivers</li> <li>• Log amps</li> <li>• Portable high-performance communication receivers</li> </ul>
SA604A, SA614A	FM IF system for 455 kHz and 10.7 MHz FM IF	1 GHz	25 MHz IF	4.5 to 8.0	SO16, HXQFN16	<ul style="list-style-type: none"> <li>• Secure garage-door openers</li> <li>• Fish finders</li> </ul>
SA605, SA615	High- performance mixer and FM IF system for 455 kHz and 10.7 MHz FM IF	1 GHz	500 MHz RF, 25 MHz IF	4.5 to 8.0	SO20, SSOP20	<ul style="list-style-type: none"> <li>• Ultrasound receivers</li> <li>• Arc fault detectors</li> <li>• Cellular radio FM IF</li> <li>• High-performance communications receivers</li> <li>• Single-conversion VHF/UHF receivers</li> <li>• RF level meters</li> <li>• Spectrum analyzers</li> <li>• Instrumentation</li> <li>• FSK and ASK data receivers</li> <li>• Log amps</li> </ul>
SA636	High- performance mixer and wideband FM IF system with fast RSSI and power-down mode	500 MHz	500 MHz RF, 25 MHz wideband IF	2.7 to 5.5	SSOP20, HVQFN20	<ul style="list-style-type: none"> <li>• DECT cordless telephones</li> <li>• Digital cordless telephones</li> <li>• Digital cellular telephones</li> <li>• Portable high-performance communications receivers</li> <li>• Single-conversion VHF/UHF receivers</li> <li>• FSK and ASK data receivers</li> <li>• Wireless LANs</li> </ul>
SA639	Mixer and FM IF system with fast RSSI, power-down mode, post-detector- filter amplifier, and programmable data switch	500 MHz	500 MHz RF, 25 MHz wideband IF	2.7 to 5.5	TSSOP24	<ul style="list-style-type: none"> <li>• Patient monitoring systems</li> <li>• Set-top boxes</li> <li>• DECT cordless phones</li> <li>• FSK and ASK data receivers</li> </ul>
SA630	Single-pole, double-throw (SPDT) switch	1 GHz	1 GHz	3.0 to 5.0	SO8	<ul style="list-style-type: none"> <li>• Antenna switches for a variety of wireless applications</li> <li>• Set-top boxes</li> </ul>

# RF/IF building blocks: specifications

Wideband RF/IF specifications

Device	VCC range (V)	ICC (max) (mA)	Mixer Gain (dB)	12 dB SINAD	IF BW (MHz)	*Data Rate (Mbps)	RSSI dynamic range (typ) (dB)	RSSI 1 RFin @ -118 dBm (Vdc)	RSSI 2 RFin @ -68 dBm (Vdc)	RSSI 3 RFin @ -18 dBm (Vdc)	Audio & data pins	Power-down mode
SA602A	4.5 to 8.0	2.4 @ 6 V	12	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No
SA612A	4.5 to 8.0	2.7 @ 6V	11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No
SA604A	4.5 to 8.0	3.3@ 6V	n/a	-120 dBm / 0.22 $\mu$ V RF: 45 MHz IF: 455 kHz Tone: 1 kHz Deviation: 8 kHz	25	1.5	90	0.0 min; 0.16 typ; 0.65 max	1.9 min; 2.65 typ; 3.1 max	4.0 min; 4.85 typ; 5.6 max	Yes	No
SA614A	4.5 to 8.0	3.3@ 6V	n/a	-120 dBm / 0.22 $\mu$ V RF: 45 MHz IF: 455 kHz Tone: 1 kHz Deviation: 8 kHz	25	1.5	80	0.0 min; 0.16 typ; 0.65 max	1.9 min; 2.5 typ; 3.3 max	3.6 min; 4.8 typ; 5.8 max	Yes	No
SA605	4.5 to 8.0	5.7 @ 6 V	12 11	-120 dBm / 0.22 $\mu$ V RF: 45 MHz IF: 455 kHz Tone: 1 kHz Deviation: 8 kHz	25	1.5	90	0.0 min; 0.16 typ; 0.65 max	1.9 min; 2.5 typ; 3.1 max	4.0 min; 4.8 typ; 5.6 max	Yes	No
SA615	4.5 to 8.0	5.7 @ 6 V	12 11	-120 dBm / 0.22 $\mu$ V RF: 45 MHz IF: 455 kHz Tone: 1 kHz Deviation: 8 kHz	25	1.5	80	0.0 min; 0.16 typ; 0.80 max	1.9 min; 2.5 typ; 3.3 max	3.6 min; 4.8 typ; 5.8 max	Yes	No
SA636	2.7 to 5.5	6.5 @ 3 V	10	-111 dBm / 0.54 $\mu$ V RF: 240 MHz IF: 10.7 kHz Tone: 1 kHz Deviation: 125 kHz	25	1.2	90	0.0 min; 0.20 typ; 0.50 max	0.3 min; 0.6 typ; 1.0 max	RFin @ -10 dBm 0.9 min; 1.3 typ; 1.8 max	No	Yes
SA639	2.7 to 5.5	8.3 @ 3 V	10	-111 dBm / 0.54 $\mu$ V RF: 110.592 MHz IF: 9.8 kHz Tone: 576 kHz Devia- tion: 288 kHz	25	2.0	90	RFin @ -118 dBm 0.0 min; 0.40 typ; 0.75 max	RFin @ -45 dBm 0.5 min; 0.9 typ; 1.3 max	RFin @ -10 dBm 0.8 min; 1.2 typ; 1.6max	No	Yes

\* Approximate maximum data rate. With some modifications, higher data rates are possible.

# RF/IF building blocks: specifications

Narrowband RF/IF specifications									
Device	VCC range (V)	ICC (max) (mA)	Mixer gain (dB)	12 dB SINAD	IF BW (MHz)	RSSI dynamic range (typ) (dB)	RSSI 1 RFin @ -118 dBm (Vdc)	RSSI 2 RFin @ 68 dBm (Vdc)	RSSI 3 RFin @ -23 dBm (Vdc)
SA606	2.7 to 6.0	4.2	13.5 to 19.5	-117 dBm / 0.32 $\mu$ V RF: 45 MHz IF: 455 kHz Tone: 1 kHz Deviation: 8 kHz	2	90	0.3 typ, 0.8 max	0.7 min to 1.8 max	1.2 min to 2.5 max
SA616	2.7 to 6.0	5.0	11 min	-117 dBm / 0.32 $\mu$ V RF: 45 MHz IF: 455 kHz Tone: 1 kHz Deviation: 8 kHz	2	80	0.3 typ, 0.8 max	0.7 min to 2.0 max	1.0 min to 2.5 max



# RF glossary

**DBM – double-balanced mixer**

A special circuit that outputs sum and difference signals while minimizing the RF and LO signals.

**Down conversion**

Conversion of the RF or IF frequency to a lower IF frequency.

**FCC Unlicensed Part 15**

Federal Communication Commission Standard under Title 47 for unlicensed user operation of low power RF equipment

**FM – frequency modulation**

A method of data encoding where the RF signal is changed in frequency by the modulating signal (e.g. voice, data).

**FM receiver**

Uses a limiting IF and a quadrature demodulator to recover the modulating signal.

**IF – intermediate frequency**

A frequency lower than the RF frequency and generally the frequency at which demodulation/modulation is performed.

**Image frequency**

An unwanted RF frequency at the mixer input that gives the same IF frequency at the mixer output as the desired RF frequency.

**LO – local oscillator**

Derived from an external active device or an on-chip transistor oscillator.

**NBFM – narrowband FM**

Used in voice and low-speed data (< 9.6 kbps).

**Quadrature demodulator**

Used to recover the modulating signal while minimizing the IF signal.

**RF – radio frequency**

The carrier frequency or the frequency of the propagation media (e.g. air, cable, wireline, etc.).

**Selectivity**

The ability of a receiver to pass the desired frequency and reject all others.

**Sensitivity**

The minimum input signal required for a receiver to deliver an acceptable output.

**Single/dual conversion**

Single-conversion receivers down-convert to one IF. Dual-conversion receivers down-convert twice, to two different IFs, to enable better filtering of image frequencies.

**Up conversion**

Conversion of the IF frequency to a higher IF or RF frequency.

**WBFM – wideband FM**

Used in broadcast radio and high-speed data (>10 kbps).

# Notes

# Available Resources

BlueBox 2.0 For more information please visit

[nxp.com/BlueBox](http://nxp.com/BlueBox)

[nxp.com/NADK](http://nxp.com/NADK)

[nxp.com/BlueBoxBSP](http://nxp.com/BlueBoxBSP)



[www.nxp.com](http://www.nxp.com)

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