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EZRadioPRO[®] Overview

December 2012

EZRadioPRO Transceiver Family

➤ Transceivers

- Si446x is the latest best-in-class transceiver family



- Si446x launched in Q1 2012
- Highest performance radio
- Highly configurable
- Standards and regulatory compliant

		TX	Frequency	RX	Cost
Si4464	➔	+20 dBm	Banded 119-960 MHz	-126 dBm	Highest
Si4463	➔	+20 dBm	Major Bands 142-1050 MHz	-126 dBm	↓
Si4461	➔	+16 dBm	Major Bands 142-1050 MHz	-126 dBm	
Si4460	➔	+13 dBm	Major Bands 142-1050 MHz	-126 dBm	Lowest

EZRadioPRO TX and RX

➤ Unidirectional Link Solutions New!



- Si406x and Si4362 introduced in December 2012
- RF performance similar to Si446x
- Ultra-low standby current for battery powered applications
- Ideal for long range applications

		TX	Frequency	RX
Si4063	➔	+20 dBm	Major Bands 142-1050 MHz	NA
Si4060	➔	+13 dBm	Major Bands 142-1050 MHz	NA
Si4362	➔	NA	Major Bands 142-1050 MHz	-126 dBm

EZRadioPRO Applications

Narrow-band, long range



Applications:

- Strict regulatory rules
 - Narrow-band
- Non-standard frequencies
- Longest range

Electronic shelf labels



Applications:

- Price tags
- Industrial shelf displays
- Portable display (Ads)

Metering



Applications:

- Gas/water/electric
- In-home display
- Energy management

Alarm systems



Applications:

- Fire/Smoke detectors
- Social alarm systems (medical or warning systems)

Silicon Labs—Winning Solution

➤ Range

- Best link budget and selectivity
- +20 dBm TX, -126 dBm RX
- <http://www.youtube.com/watch?v=2UI6A97dIU>



Range

➤ Performance

- High data rate, 1 Mbps
- Advanced packet handling
- Flexible options



Performance

Feature	Silicon Labs Winning Solution	Competitors (Typ.)
Extended output power	Up to +20 dBm	Up to +13 dBm
High sensitivity	-126 dBm	-116 dBm
Industry leading link budget	146 dB	129 dB
Antenna diversity	Increased indoor range	Difficult to implement
Frequency coverage	Multiple bands 119-1050 MHz	Limited bands 315, 433, 868 & 915 MHz

Silicon Labs—Winning Solution

➤ Battery Life

- 50 nA standby current
- Lowest TX and RX current
- Fast wakeup times



Battery Life

➤ Cost

- Advanced features to reduce system cost
 - +20 dBm TX, packet handling
- 30% lower BOM count compared to typical competition
- Smallest package in class (4 mm x 4 mm)



Cost

Feature	Silicon Labs Winning Solution	Competitors (Typ.)
Lower system cost	Superior TX power using low cost components	Requires external PA/LNA for similar performance
Low power consumption	18 mA at +10 dBm 85 mA at +20 dBm	30 mA at +10 dBm
Low sleep mode current	50 nA	200 nA
Offload host MCU	FIFO, packet handler	Limited

Exceptional Narrow-band Performance

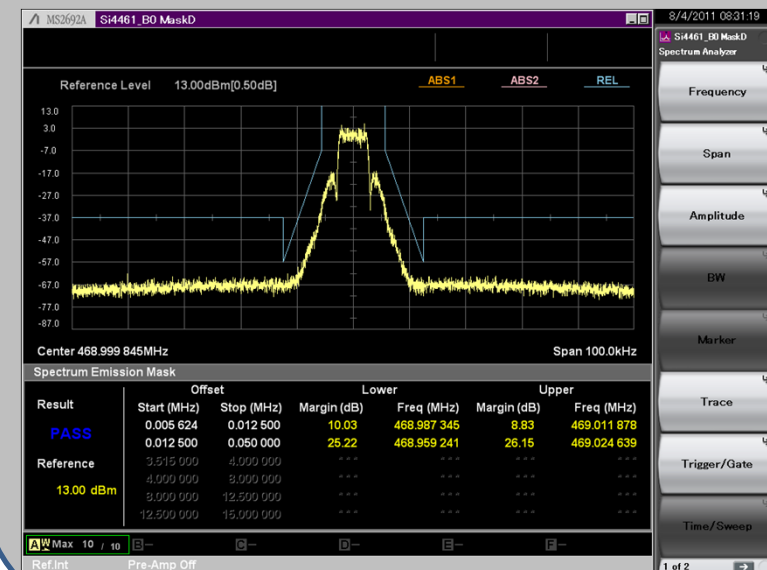
- **Complies with the most stringent narrow-band standards**
 - FCC Part 90 Mask D, ETSI Class-I, ARIB T96/T67, many more....
- **Exceptional phase noise and spurious emission**
- **58 dB adjacent channel rejection**
- **Extended freq coverage for all available narrow bands**
 - 154 MHz (US – MURS), 169 MHz (ETSI/M-BUS)

ETSI Class-I Compliance

Parameter	Class 1 Spec	Silicon Labs Result
Sensitivity (dBm)	-107 dBm	-116 dBm
Adj Channel @ 25 kHz (dB)	54 dB	58 dB
Blocking at 2 MHz (dB)	84 dB	95 dB
Blocking at 10 MHz (dB)	84 dB	91.5 dB
Image Selectivity (dB)	60 dB	66.5 dB

*SAW used for blocking

FCC Part 90 Mask D



Most Advanced Modem Features

➤ Optimized demodulators for different scenarios

Modulation Mode	Design Benefit
Synchronous	Highest performance when conventional preamble is used
Asynchronous	Supports any packet structure while featuring lower jitter. No MCU deglitching or retiming required. Off loads MCU and simplifies design for customer
OOK	Robust performance to counteract burst noise and flutter

➤ Automatic frequency correction (AFC)

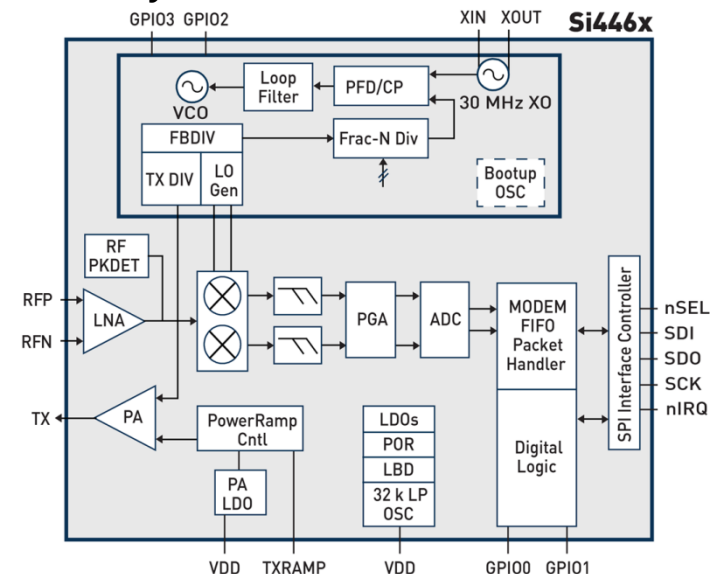
- Provides for excellent sensitivity over a broader range of crystal offsets
- Allows use of lower cost crystal without the loss of sensitivity

➤ Image rejection calibration

- 100% autonomous image calibration
- 55 dB image rejection with calibration

➤ RX architecture options

- Fixed-IF (468 kHz)
- Unique zero-IF & scaled-IF options → can eliminate the image entirely (zero-IF) or move the image to a different frequency (scaled-IF)



Flexibility to Optimize

- **High performance/low current modes**
 - 13.7 mA high performance RX
 - 10.7 mA low current RX
- **Frequency accuracy**
 - 28 Hz frequency resolution
- **Flexible crystal range – 25 to 32 MHz**
- **Automatic frequency hopping and hop table**
 - 64 entry hop table
 - Determine hop based on RSSI, preamble or sync detection
- **Fast RSSI options**
 - Single-bit or 4-bit average
 - Multiple latch options
- **Low duty cycle mode – autonomous RX to sleep mode**
- **Packet handling**
- **Output power step size - <0.25 dB**



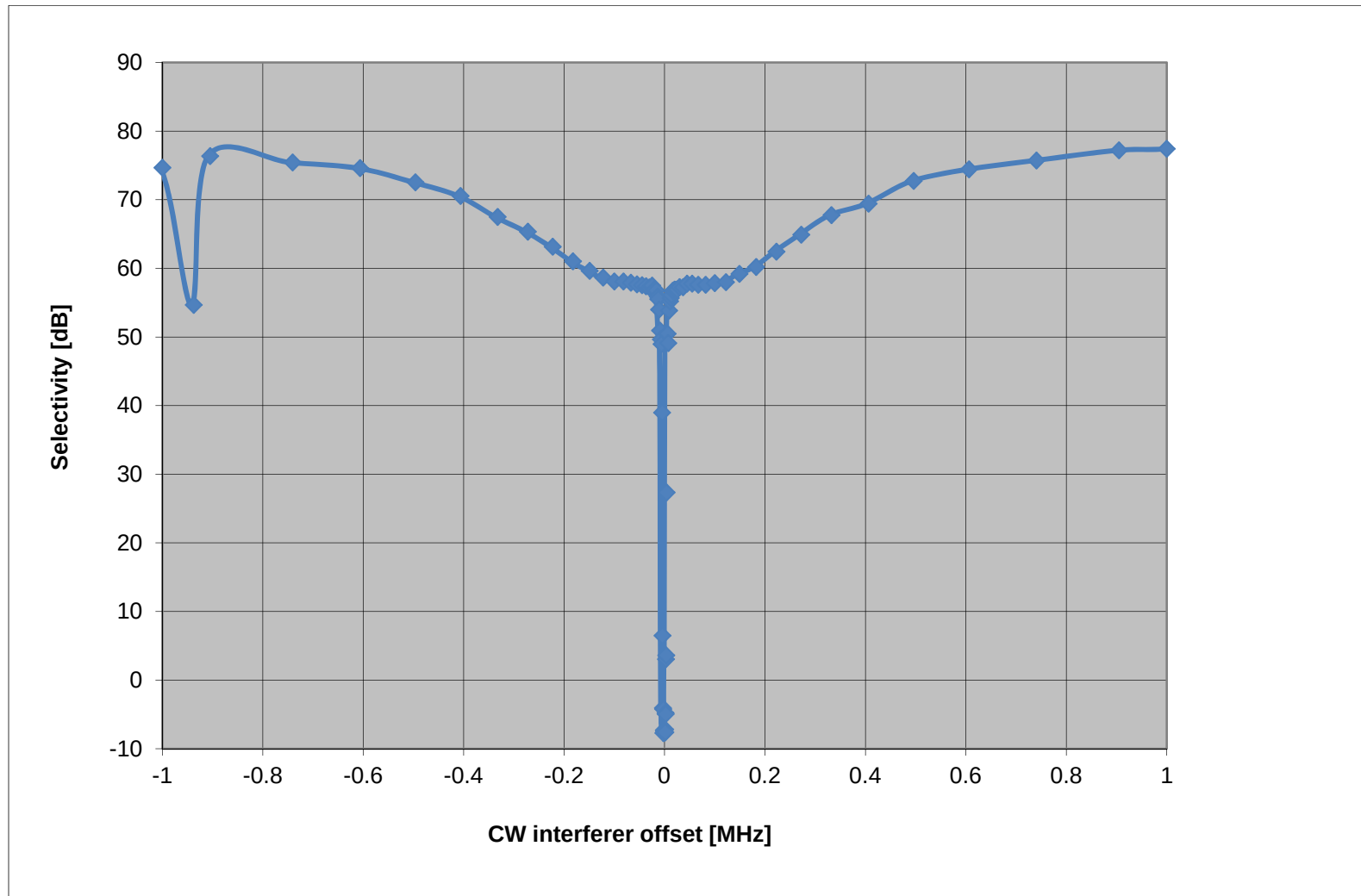
Measurement Results—Sensitivity

- **Sensitivity and output power determine range**

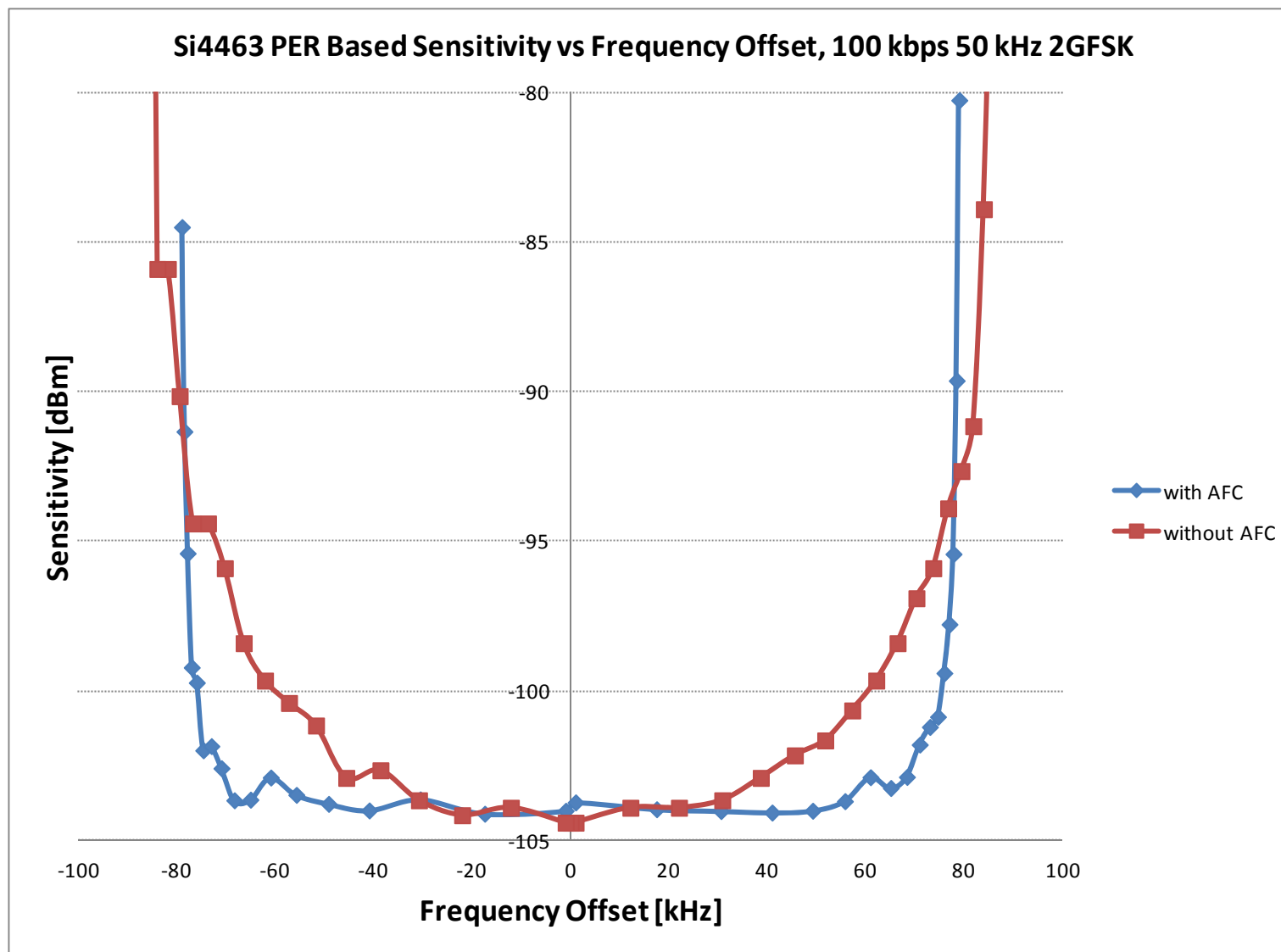
Setting	Sensitivity
500 bps	-126.0 dBm
1.2 kbps	-124.0 dBm
2.4 kbps	-120.1 dBm
4.8 kbps	-118.0 dBm
9.6 kbps	-115.2 dBm
40 kbps	-110.0 dBm
100 kbps	-105.4 dBm
200 kbps	-102.1 dBm
400 kbps	-97.9 dBm
500 kbps	-97.3 dBm

Selectivity and Blocking

➤ 2.4 kbps, 915 MHz selectivity and image rejection



Measurement Results—Sensitivity vs. Frequency



Transceiver Competitive Matrix

Feature	Specification	Si446x	Comp A	Comp B	Comp C	Notes
Transmit	Power Max dBm	20	16	16	20	
	Current mA	85	--	--	125	20 dBm
	Current mA	18	34	38	23	10 dBm
	Power steps dB	0.2	0.4	0.4	1	dB
Receive	Sensitivity dBm	-124	-122	-122	-123	1.2 kbps
	Current mA	13.7	22	26	N/A	
Standby	Current nA	50	300	300	100	
Data rate	Max kbps	1000	200	200	300	
Blocking and Selectivity	Selectivity dB	58	58	58	50	12.5 kHz channel
	Blocking dB	84	84	84	87	8 MHz offset
	Image Rej dB	55	54	58	48	
Size	Package mm	4x4	5x5	5x5	5x5	

RX and TX competitive matrix

	Feature	Specification	Si4362	Comp A	Comp B	Notes
Receiver	Receive	Sensitivity dBm	-124	-112	-120	1.2 kbps
		Current mA	13.7	15	16	
	Standby	Current nA	50	200	100	
	Data rate	Max kbps	1000	600	300	
	Blocking and Selectivity	Selectivity dB 12.5 kHz offset	58	--	42	CC113L = 37 dB @ 100 kHz
		Blocking dB	84	72	87	8 MHz offset
		Image Rej dB	55	31	48	
	Frequency	Major bands	142-1050	300-928	290-1020	MHz
	XTAL	Range MHz	25-32	26-27	26-32	
	Size	Package mm	4x4	4x4	5x5	

	Feature	Specification	Si406x	Comp A	Comp B	Notes
Transmitter	Transmit	Power Max dBm	20	16	17	Si4063
		Current mA	18	34	33	10 dBm (Si4060)
		Current mA	85	--	95	Si4063 @ 20 dBm SX1230 @ 17 dBm
		Power steps	0.2	0.4	1.0	dB
	Standby	Current nA	50	300	500	
	Data rate	Max kbps	1000	200	600	
	XTAL	Freq MHz	25-32	32-33.6	26-32	
	Size	Package mm	4x4	5x5	4x4	

Feature Matrix—Si443x vs. Si446x

	Feature	Si443x	Si446x
Modulation	(G)FSK, OOK, ASK	Y	Y
	4(G)FSK	N	Y
	Max Data Rate	256 kbps	1 Mbps
	Standby current	450 nA	50 nA
Transmit	TX current 10 dBm	25 mA	18 mA
	Max TX power	20 dBm	20 dBm
	TX power step size	3 dB	0.1 dB
Receive	RX current	18.5 mA	10.7/13.7 mA
	Sensitivity	-121 dBm [1.2 kbps]	-124 dBm [1.2 kbps]
	Channel BW (min/max)	2.6 – 620 kHz	1.1 – 850 kHz
	Selectivity (12.5 kHz channel)	31 dB	58 dB
	Blocking (8 MHz offset)	63 dB	84 dB
	Image rejection	30 dB	55 dB
	AFC	Y	Y
	Antenna Diversity	Y	Y
Regulatory	802.15.4g PH	N	Y
	Narrow-band support	N	Y
	ETSI Class1	N	Y [with cheap external SAW]
	FCC Part 90 Mask D	N	Y

EZRadio® and EZRadioPRO® Comparison

	Customer Needs	EZRadio	PRO
Performance	Low cost	✓	
	Small size	✓	
	-116 dBm Sensitivity	✓	✓
	-126 dBm Sensitivity		✓
	+13 dBm max output power	✓	✓
	+20 dBm max output power		✓
	Wideband (RXBW >40 kHz)	✓	✓
	Narrow-band (RXBW <40 kHz)		✓
	Data rates up to 500 kbps	✓	✓
Compliance	Data rates 500 kbps to 1 Mbps		✓
	FCC Part 15.247, 15.240, 15.231	✓	✓
	FCC Part 90		✓
	ETSI EN 300-220 Cat 1		✓
	ETSI EN 300-220 Cat 2	✓	✓
	ARIB RCR STD30	✓	✓
	ARIB T108, T96, T67		✓
	China Regulatory	✓	✓

EZRadio
Broad-base
General Use

EZRadioPRO
Metering &
Narrow-band

Frequency Coverage

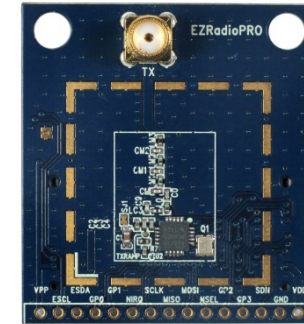
- Recommended devices based on frequency coverage
- See Si446x data sheet electrical specifications for details

Customer Need/Spec	Si4x6x (PRO)
119 – 142 MHz	Si4464
142 – 175 MHz (AMER 154, EU 169)	Si4463/61/60
177 – 283 MHz	Si4464
283 – 350 MHz (AMER 315, China 315)	Si4463/61/60
353 – 419 MHz	Si4464
420 – 525 MHz (EU 433, China 470)	Si4463/61/60
526 – 639 MHz	Si4464
705 – 849 MHz	Si4464
850 – 960 MHz (EU 868, AMER 915 ,Japan 920)	Si4463/61/60
960 – 1050 MHz	Si4463/61/60

Si4x6x Development Tools

➤ Development platform

- Kits based on F930 motherboards
 - Contains everything required to set up a wireless link
- New RF Pico boards
 - Several frequency and power options
- New WDS release



➤ Available collateral

- <https://www.silabs.com/products/wireless/EZRadioPRO/Pages/default.aspx>
- Data sheets
- Firmware release notes
- API guide
- WDS user guide
- Example projects in WDS
- Reference designs for all major bands
- Layout guidelines
- Packet handler application note
- TX and RX matching application note

Development Kits	
4060-868-PDK	Unidirectional +10 dBm link
4063-915-PDK	Unidirectional +20 dBm link
4438-490-PDK	Bidirectional +20 dBm link for China only
4461-868-PDK	Bidirectional +14 dBm link
4463-915-PDK	Bidirectional +20 dBm link

Wireless Development Suite (WDS)

- Intuitive GUI to configure the radio
- Multiple projects to start with
- Customization options for specific application needs
- Supports
 - All EZRadio and EZRadioPRO devices
 - Lab evaluation [RF tests]
 - Software development
 - Launches IDE with code and header file
 - Range tests (PER demo)
 - API Batch File generation
 - Simulation mode (no HW required)

The screenshot displays the 'Radio Configuration Application' window, which is divided into three main sections: '1. Select project', '2. Configure project', and '3. Deploy project'.

1. Select project

Name	Batch	Conf	Down	Gen
Empty framework	-	-	-	+
Unmodulated carrier	-	-	-	+
PN9	-	-	-	+
Standard packet TX	-	-	-	+
Standard packet RX	-	-	-	+

Description: This empty framework of an EZRadioPRO sample project can be used as a template for code development.

2. Configure project

Frequency and power | RF parameters | Packet | Interrupts | GPIO and FRR

Frequency

Center frequency: 915,00000 MHz Channel spacing: 250 kHz
Channel number: 0

Crystal

Crystal Frequency: 30,000 MHz Crystal tolerance TX: 20,0 ppm
Crystal Cap. bank: 0x52 ? Crystal tolerance RX: 20,0 ppm
☐ Use external TCXO/Ref Source

Power amplifier (PA)

PA mode: ClassE/Square W PA bias: 0xC0
Ramp HV cascode: 29 =6.6µs PA power level: 0x20
☐ Enable ramp control of External PA
Regulator voltage: 0x0 =1V
Ramping time: 0x0 =0.63µs

3. Deploy project

Save batch ? Configure&evaluate ? Download project ? Generate source ?

Device: Si4460 Simulation Chip Revision: B1 Status: Idle

Partnerships and Joint Reference Designs



- SKY65313 – Custom +1 W 915 MHz FEM
 - Single-stage PA, PA bypass, LNA and Match
 - Market – NA Electric meter
- SKY65367 – Custom +1 W 169 MHz FEM
 - Single-stage PA, PA bypass, LNA and Match
 - Market – EU water/gas



- RF6569 – +1 W 915 MHz FEM
 - Single-stage PA, switch and match
 - Market – NA Electric meter



- Low cost discrete solutions – PA + switch
 - 169 MHz, 434 MHz, 470-510 MHz and 915 MHz
 - Market – WW metering



- 915 MHz SAW
 - Market – NA Electric meter
- 169/868 MHz SAW
 - Market – EU
 - ETSI Class-I Operation



S I L I C O N L A B S

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