Device Drive

specification IRIS - SIP
WRF01



October 8, 2015

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1. Introduction

The WRF01 SIP handles all connectivity issues so that your device can simply send JSON on the UART and get reply from your selected cloud solution.

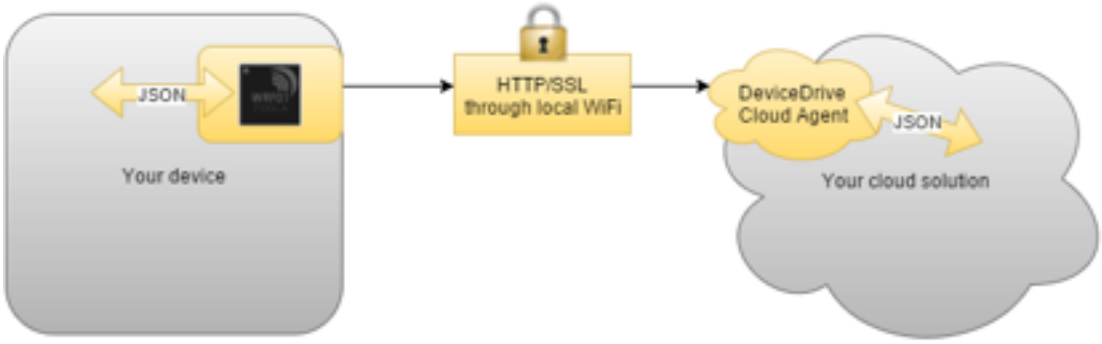


Figure 1: Send JSON through the WRF01 UART and get reply from your cloud solution.

The WRF01 is a part of the DeviceDrive Smart Connectivity Platform (DDCP); a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers.

Wrf01 provides unsurpassed ability to embed Wi-Fi capabilities into devices with the lowest cost, and minimal space requirement.

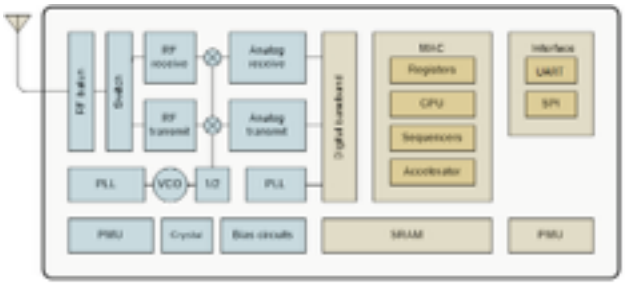


Figure 2: WRF01 Block Diagram

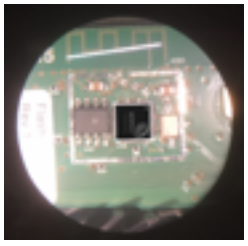


Figure 3: Very small footprint on the PCB. Wrf01, Flash, crystal, antenna and a few minor components.

2. Technology Overview

WRF01 offers a complete and self-contained Wi-Fi networking solution. It completely offloads Wi-Fi networking functionality from the application processor.

WRF01 will boot up the DeviceDrive application directly from an external flash, and dynamically load it into SRAM cache to improve the performance of the system.

When WRF01 is serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller-based design with simple serial connectivity through UART.

The WRF01 is among the most integrated Wi-Fi chips in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules (Figure 2: WRF01 Block Diagram). It requires minimal external circuitry, and the entire solution is designed to occupy minimal PCB area (Figure 3).

WRF01 also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM to serve the Wi-Fi functionalities.

The WRF01 comes with a LinkUp™ SDK for Android for easy Wi-Fi setup using HTTP/SSL. The LinkUp™ software takes care of all the complexity of connecting any device to your selected cloud system (SSID, password, token and product key), in the most safe and easy way.

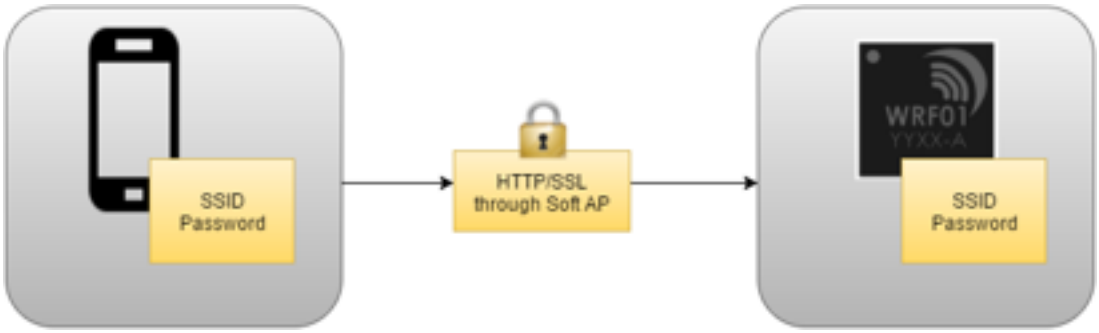


Figure 4: Secure LinkUp of Wrf01 device with mobile app through Soft AP

Please note that you need to order a **product key** from www.devicedrive.com to redirect the data to your selected cloud. The same product key should be applied to all devices of the same type communicating with the same target cloud. You can set the product key from the mobile app or through the serial interface.

3. Features

3.1. Hardware features

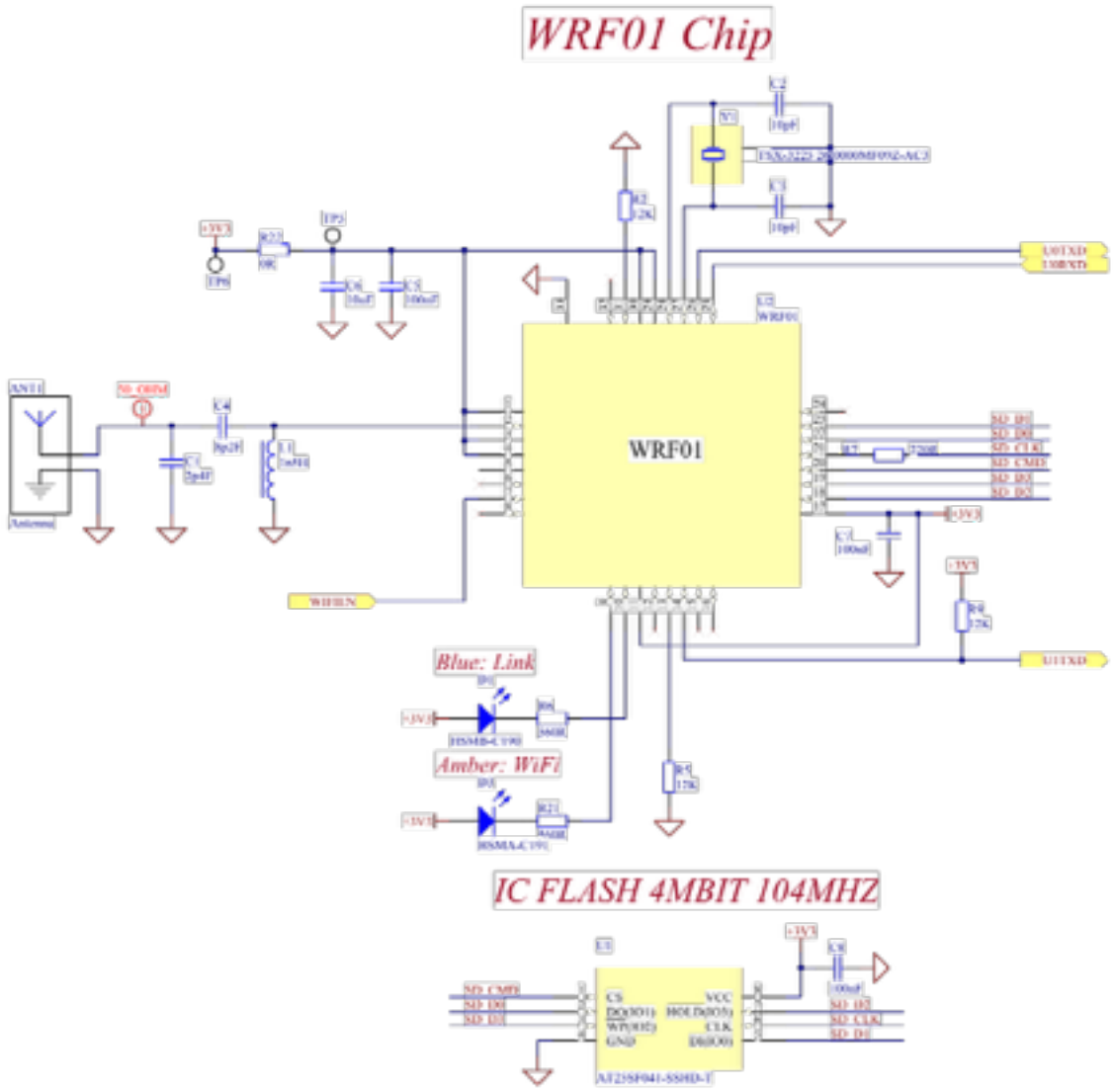
- 802.11 b/g/n protocol
- Wi-Fi LinkUp™ using soft-AP
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- +20.5dBm output power in 802.11b mode
- Supports antenna diversity
- Power down leakage current of < 10uA
- Integrated low power 32-bit MCU
- UART (for commands and cloud transmissions)
- A-MPDU & A-MSDU aggregation & 0.4μs guard interval

3.2. Firmware features

The DeviceDrive firmware is stored in the external SPI Flash module, enabling simple connectivity to your selected cloud solution.

- High level operations:
    - Easy LinkUp™ with Soft AP
    - Automatic connection to Access Point
    - Serial transmission to cloud
    - Setup commands
    - Error handling
    - Diagnostics
- Low level operations:
    - Acknowledgement
    - Fragmentation and defragmentation
    - Transmission retries
    - Error handling
    - Aggregation
    - Frame encapsulation (802.11h/RFC 1042)
    - Automatic beacon monitoring / scanning

4. Application Diagrams



IRIS-WRF01-EVK-ZERO ARDUINO ZERO SHIELD - DEV BOARD

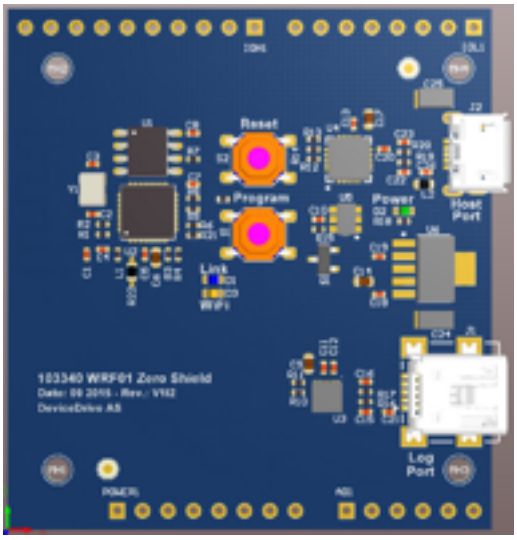
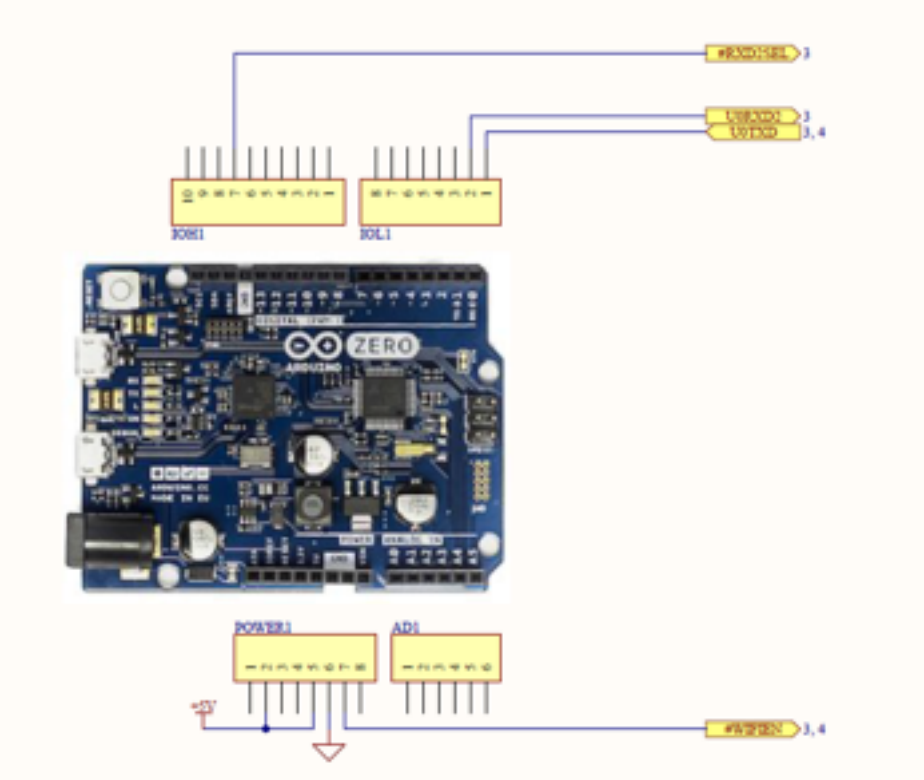


Figure 5

ARDUINO HEADER



5. Technology

WRF01 has been designed for mobile, wearable electronics and Internet of Things (IoT) applications. The aim is to achieve the lowest power consumption possible with a combination of several proprietary techniques and very few components.

By integrating the costliest components such as power management unit, TR switch, RF balun, high power PA capable of delivering +25dBm (peak), WRF01 ensures that the BOM cost is the lowest possible, with ease of integration into any system.

With WRF01, the only external BOM are resistors, capacitors, and crystal. For cellphone compatibility, a SAW filter may be required.

6. WRF01 Applications

Typical applications:

- Smart power plugs
- Home automation
- Mesh network
- Industrial wireless control
- Sensor networks
- Wearable electronics
- Wi-Fi location-aware devices
- Security ID tags
- Wi-Fi position system beacons

7. Specifications

7.1. Current Consumption

The following current consumption is based on 3.3V supply, and 25°C ambient, using internal regulators. Measurements are done at antenna port without SAW filter. All the transmitter's measurements are based on 90% duty cycle, continuous transmit mode.

Mode	Min	Typ	Max	Unit
Transmit 802.11b, CCK 1Mbps, POUT=+19.5dBm		215		mA
Transmit 802.11b, CCK 11Mbps, POUT=+18.5dBm		197		mA
Transmit 802.11g, OFDM 54Mbps, POUT =+16dBm		145		mA
Transmit 802.11n, MCS7, POUT=+14dBm		135		mA
Receive 802.11b, packet length=1024 byte, -80dBm		60		mA
Receive 802.11g, packet length=1024 byte, -70dBm		60		mA
Receive 802.11n, packet length=1024 byte, -65dBm		62		mA
Total shutdown (Chip Enable pin disabled)		0.5		uA

8. Receiver Sensitivity

The following values are measured under room temperature conditions with 3.3V and 1.1V power supplies.

Description	Min	Typical	Max	Unit
Input frequency	2412		2484	MHz
Input impedance		50		Ω
Input reflection			-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
CCK, 1Mbps		-98		dBm
CCK, 11Mbps		-91		dBm
6Mbps (1/2 BPSK)		-93		dBm
54Mbps (3/4 64-QAM)		-75		dBm
HT20, MCS7 (65Mbps, 72.2Mbps)		-71		dBm
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

8. Clock Management

8.1. High Frequency Clock

The high frequency clock on WRF01 is used to drive both transmit and receive mixers. This clock is generated from the internal crystal oscillator and an external crystal. The crystal frequency can range from 26MHz to 52MHz.

While internal calibration of the crystal oscillator ensures that a wide range of crystals can be used, in general, the quality of the crystal is still a factor to consider, to have reasonable phase noise that is required for good performance. When the crystal selected is sub-optimal due to large frequency drifts or poor Q-factor, the maximum throughput and sensitivity of the Wi-Fi system is degraded. Please refer to the application notes on how the frequency offset can be measured.

Parameter	Symbol	Min	Max	Unit
Frequency	FXO	26	52	MHz
Loading capacitance	CL		32	pF
Motional capacitance	CM	2	5	pF
Series resistance	RS	0	65	Ω
Frequency tolerance	ΔFXO	-15	15	ppm
Frequency vs temperature (-25°C ~ 75°C)	ΔFXO,Temp	-15	15	ppm

9. External Reference Requirements

For an externally generated clock, the frequency can range from 26MHz to 52MHz can be used. For good performance of the radio, the following characteristics are expected of the clock:

Parameter	Symbol	Min	Max	Unit
Clock amplitude	V	0.2	1	Vpp
External clock accuracy	Δ	-15	15	ppm
Phase noise @1kHz offset, 40MHz clock			-120	dBc/Hz
Phase noise @10kHz offset, 40MHz clock			-130	dBc/Hz
Phase noise @100kHz offset, 40MHz clock			-138	dBc/Hz

10.Radio

The WRF01 radio consists of the following main blocks:

1. 2.4GHz receiver
2. 2.4GHz transmitter
3. High speed clock generators and crystal oscillator
4. Real time clock
5. Bias and regulators
6. Power management

10.1.Channel Frequencies

The RF transceiver supports the following channels according to the IEEE802.11bgn standards.

Channel No	Frequency (MHz)	Channel No	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	12	2467
6	2437	13	2472
7	2442	14	2484

10.2.Receiver (2.4GHz)

The 2.4GHz receiver down-converts the RF signal to quadrature baseband signals and converts them to the digital domain with two high-resolution high speed ADCs. To adapt to varying signal channel conditions, RF filters, automatic gain control, DC offset cancelation circuits and baseband filters are integrated within WRF01.

10.3.Transmitter (2.4GHz)

The 2.4GHz transmitter up-converts the quadrature baseband signals to 2.4GHz, and drives the antenna with a high-powered CMOS power amplifier. The use of digital calibration further improves the linearity of the power amplifier, enabling a state of art performance of delivering +20.5dBm average power for 802.11b transmission and +16dBm for 802.11n transmission.

Additional calibrations are integrated to cancel any imperfections of the radio, such as:

- carrier leakage,

- I/Q phase matching, and
- baseband nonlinearities

This reduces the amount of time required and test equipment required for production testing.

10.4.Clock Generator

The clock generator generates quadrature 2.4GHz clock signals for the receiver and transmitter. All components of the clock generator are integrated on-chip, including:

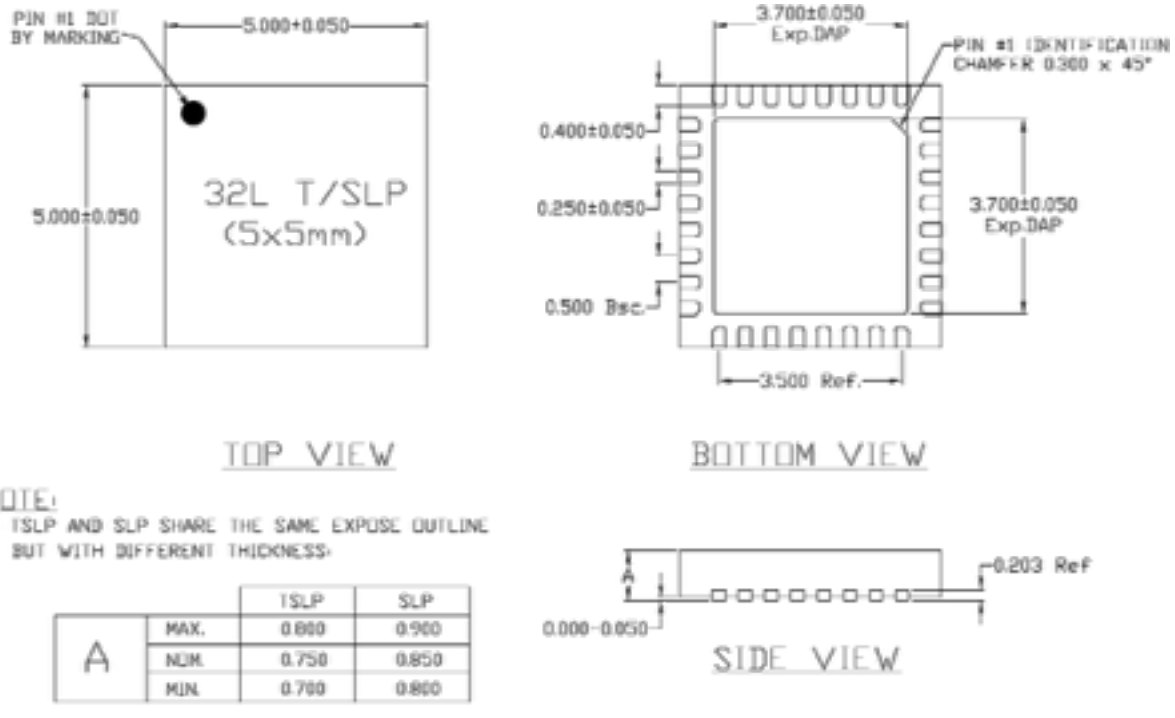
- inductor,
- varactor, and
- loop filter.

The clock generator has built-in calibration and self-test circuits. Quadrature clock phases and phase noise are optimized on-chip with patented calibration algorithms to ensure the best receiver and transmitter performance.

10.Related documents

- WRF01 serial specification
- WRF01 http specification
- WRF01 LinkUp procedure

Appendix 1: QFN32 Package Drawing



		TSLP	SLP
A	MAX.	0.800	0.900
	NOM.	0.750	0.850
	MIN.	0.700	0.800