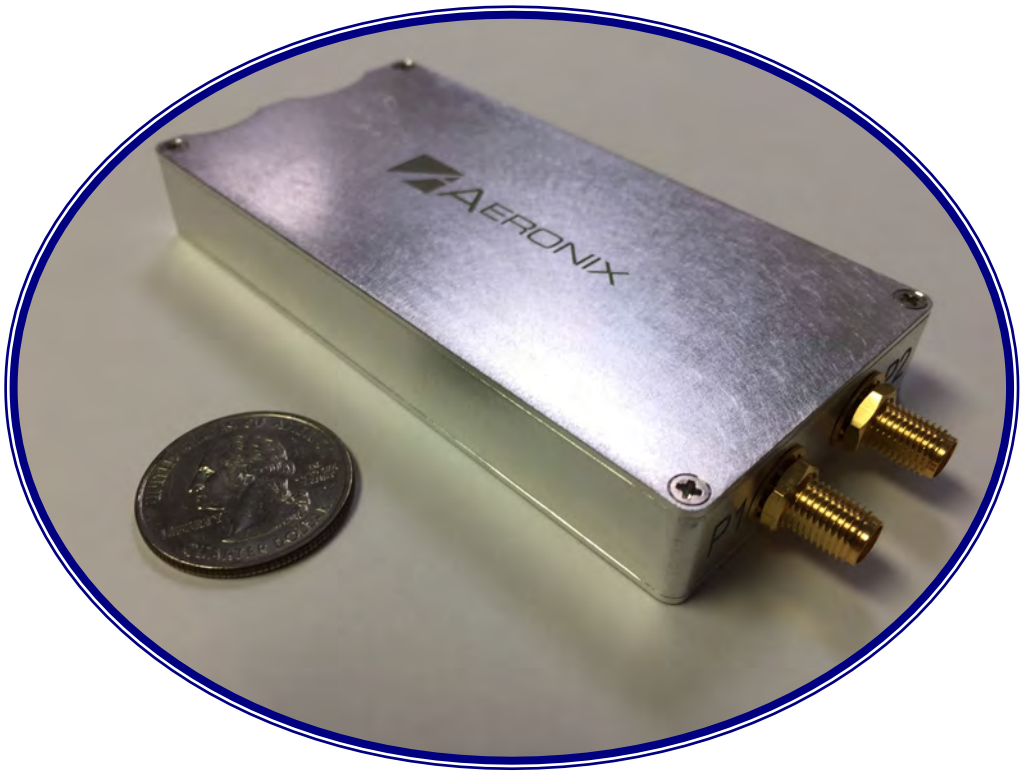
EDL Nano White Paper:

State of the Art High Performance Low SWaP Software Defined Data Links



AERONIX

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The advantages of Software Defined Radios is well established both in the industrial world and in military applications. The paradigm of data links amplifies the same issues found in larger radios that lead to the numerous benefits of software programmability and the ability to adapt radio characteristics for any situation. This leads to only one conclusion, ***Software Defined Data Links***. In this paper we will discuss the merits of software defined data links and in particular one of the most advanced products and concepts on the market the ***Aeronix EDL-Nano***.

When considering low SWaP, high performance data links the 1000's of applications that have been shown for larger software defined radios become 1,000,000's. A small set of factors to be considered in adaptability of Software Defined Data Links are the following:

- Environmental (Land, water, air, speed, terrain, thermal …)
- Waveform/Function (Interoperability for major waveforms WiFi/LTE/ WiMax/ waveform 'X', Doppler,…)
- Applications (data rate, QoS, long ranges, large node quantities)
- Processing Architecture (Interconnects, processors, FPGAs, Cascade processing, Parallel processing, DSP …)
- Interference (environmental, unintentional, intentional …)
- Security (Encryption/Decryption, Change to Sovereign algorithms, COMSEC, TRANSEC …)
- Cyber Security (rapidly changing network threats)

The combinations of these factors is immense and no existing ASIC based or fixed radio can respond to all these moving parts. By adding one additional term the solution set increases by one to two orders of magnitude—Internet of Things IOT. As an example we know that WiFi and LTE (plus many other waveforms) that are typically based on fixed radios have security vulnerabilities, fixed radios can not be adapted while Software Defined Data Links are easily adapted to current threats and threats of the future.

Interference, jamming, water effects, land effects, Doppler, Sovereign security, cyber environment, etc… the list is long and each has many possibilities. It is not reasonable to expect fixed radios to work with all these variables. A **Software Defined Data Link** allows for each individual scenario to be addressed and allow the Software **Defined Data Link** to perform as desired in the scenario.

The **EDL Nano** is a **Software Defined Data Link** that incorporates quad core processors, the latest generation FPGA, and state of the art RF front end. With this hardware the EDL Nano can adapt to any scenario, Aeronix had proven this with applications and testing in Marine, Air, and Ground based environments with different:

- Data rates
- RF band widths
- Security
- Ranges
- Waveforms
- Pieces of waveforms
- Interference mitigation

Of course with all solutions one of the most important factors is **Cost**. Initial purchase costs of **Software Defined Data Link** costs can be slightly higher than unadaptable data links, however over the life of the system the cost of a Software Defined system is much smaller than fixed assets. It has been shown that the ability of Software Defined systems enables a application in the face of constantly changing environments and threats to adapt the application which requires no new purchases of hardware. On fixed systems, the only option is to purchase new hardware which has significant cost, additionally new hardware has logistical, training, and maintenance costs as everything has been changed.

In summary the total **Cost** of **Software Defoined Data Links** is much smaller than that of fixed radios.

Specifications

Networking	
Waveform	Tactical 802.16 High Multipath: Modulations Supported: BPSK, QPSK, QAM16, QAM64, 8PSK, 16PSK Long Range Mode: GMSK Spread 4, Spread 16
Network: Point to Multipoint	Point-to-Multipoint with multiple subscribers MESH software upgrade available 1Q2017
Network::Point-to-Point	High performance mode with reduced overhead. User configured mode via GUI.
Uplink / Down Link Ratio	Ratio is user configurable via GUI slide bar. Max = 80%, Min = 20% of aggregate throughout.
Network Routing	Routing configuration via automatic setup modes and user configuration
IP Support	IPv4 and IPv6
Operating System	Linux general purpose processor operating system
User Data Rate (Mbps)	Maximum user data rate of 37.8 Mbps in a 14 MHz channel

Management Features	
Remote Management	Radios can be configured remotely over the network via USER login via GUI or via SNMPv3
User Interface	Web Based GUI USB OTG 2.0 Ethernet SNMPv3
Software Selectable BS /SS	Radios can be configured via GUI selection as either a base-station or subscriber-station.

Security	
Encryption	AES128 Cover - International Commercial AES256 Domestic Covers management information and data. Configured on/off via user GUI.
Pedigree	U.S. design and manufacture
FIPS 140-2	Future

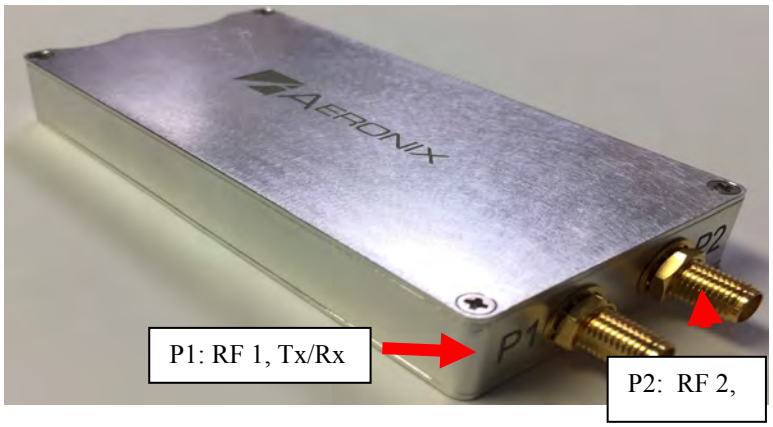
Connector Interfaces	
High Speed I/O Network I/O	Ethernet x 2, USB
DC Power	8v to 18v
Low Speed I/O	RS232 x 2
Tx/Rx I/O	Supports external switching amplifiers if more power is desired.
Video I/O	CSI-2 Digital Video Input
RF I/O	Double RF SMA antenna interfaces

Physical Characteristics	
Size	2"W x 4L" x 0.5H" (4 cubic inch volume)
Weight	~ 3.4oz
Power	Typical 6 Watts, Max 8 Watts

Environmental	
Temp	-40 to 60C, cold plate
Shock	50g
Chassis	Unsealed
Cooling	Conduction

Radio Specifications	
RF Freq.	1.8 –2.5 GHz
Channels Supported	(User Configured via GUI)
Channel BW	3.5. 7.0 14.0 MHz (HW supports 57 MHZ)
Channel Tuning Steps	Configured in 1 MHz steps via GUI
RF Output Power	OFDM: 1W Average at BPSK (2W preamble); GMSK 4W Average,; HP mode **
Noise Figure	~3 dB

Interfaces

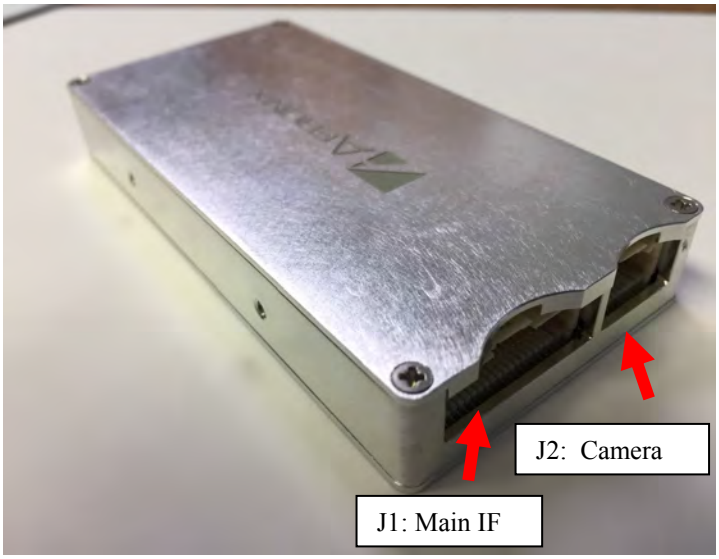


RF Hardware Interface

Con-nector	Description	EDL Con-nector	Mating Connect-or
P1	Tx/Rx1: Female SMA connector connects to the desired antenna	Male SMA	Female SMA
P2	Rx2: Female SMA connector connects to the desired antenna	Male SMA	Female SMA

J1: Main IF Pin Definitions

Pin	Description
1	8-18 VDC
2	Ground
3	8-18 VDC
4	Ground
5	8-18 VDC
6	Ground
7	Platform RS-232 Rx
8	USB OTG VBUS
9	Platform RS-232 Tx
10	USB OTG DP
11	Ext GPIO 0
12	USB OTG DN
13	Ext GPIO 1
14	Ground
15	Ext GPIO 2
16	Console RS-232 Tx
17	Ext GPIO 3
18	Console RS-232 Rx
19	Green LED
20	Ground
21	Red LED
22	Ground
23	RX TX Enable
24	Ground
25	TAMPER
26	Ground
27	VBUS 5V
28	USB Host DN
29	Ground
30	USB Host DP
31	Ether2 Tx+
32	Ether1 Tx+
33	Ether2 Tx-
34	Ether1 Tx-
35	Ground
36	Ground
37	Ether2 Rx+
38	Ether1 Rx+
39	Ether2 Rx-
40	Ether1 Rx-

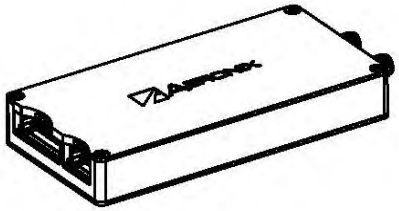


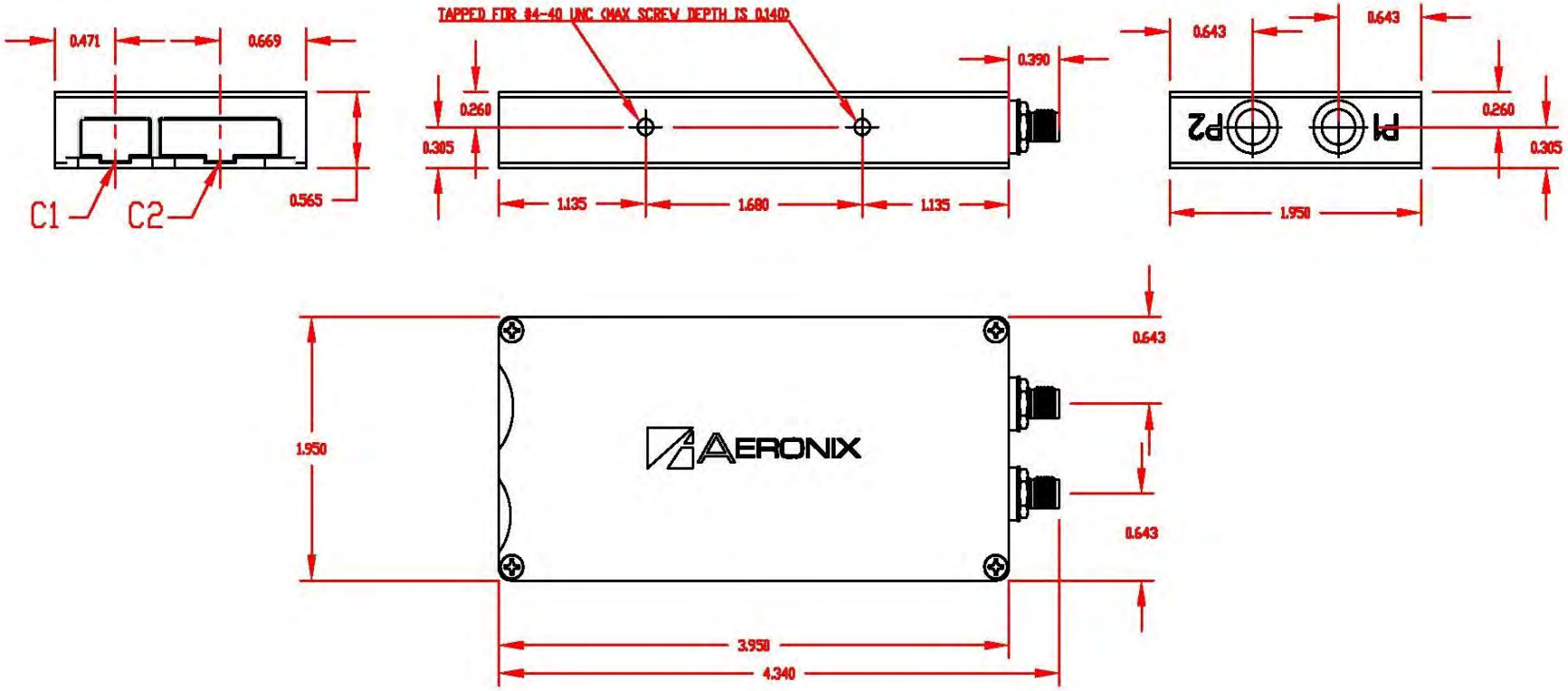
J2: Camera IF Pin Definitions

Pin	Description
1	3 VDC
2	Ground
3	CAM SDA
4	CAM CLK
5	CAM SCL
6	CSI D3P
7	CAM EN
8	CSI D3M
9	CAM RST#
10	Ground
11	CSI D0P
12	CSI D2P
13	CSI D0M
14	CSI D2M
15	Ground
16	Ground
17	CSI D1P
18	CSI CLKDP
19	CSI D1M
20	CSI CLKDM

NOTES:

1. P1 AND P2 ARE SMA CONNECTORS.
2. MATING CONNECTOR FOR C1 IS MOLEX 501189-2010 WITH MOLEX CRIMPS 501193-3000.
3. MATING CONNECTOR FOR C2 IS MOLEX 501189-4010 WITH MOLEX CRIMPS 501193-3000.
4. MOUNTING SCREWS SHOULD NOT PENETRATE THE NANO MORE THAN 0.140 INCHES.
5. SEE USERS MANUAL AE301628-001 FOR C1 AND C2 PINOUTS.



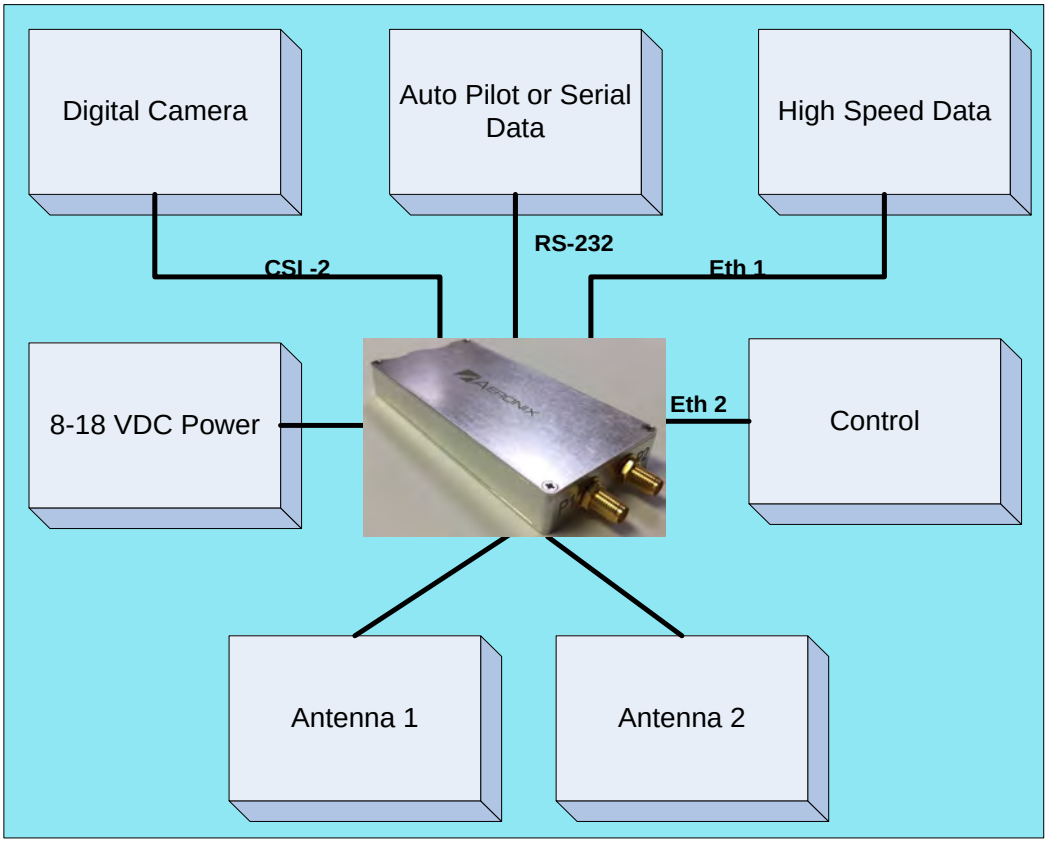


Performance

Example Ranges @ 1.9 GHz		
BPSK 1/2@ 3.5MHz	Antennas = 3 dB	14 km
BPSK 1/2 @ 7MHz	3	8 km
BPSK 1/2 @ 7MHz	6	12 km
QPSK 1/2 @ 7 MHz	6	11 km
QPSK 3/4 @ 7 MHz	9	10 km
QPSK 3/4 @ 7 MHz	12	15 km
QAM16 3/4 @7MHz	12	10 km
QAM16 3/4 @7MHz	14	13 km
QPSK 1/2 @3.5MHz	20	48 km
GMSK FEC 1/2	6	24 km
GMSK FEC 3/4	20	121 km

Demonstrated User Data Rates	
BPSK 1/2@ 3.5MHz	1.0 Mbps
BPSK 1/2 @ 7MHz	2.0 Mbps
QPSK 1/2 @ 3.5 MHz	2.1 Mbps
QPSK 1/2 @ 7 MHz	3.9 Mbps
QPSK 3/4 @ 7 MHz	5.8 Mbps
QAM16 3/4 @3.5 MHz	6.5 Mbps
QAM16 3/4 @7MHz	11.8 Mbps
QAM64 2/3 @7MHz	17.6 Mbps
QAM64 3/4 @14 MHz	37.9 Mbps
GMSK FEC 1/2	3.6 Mbps
GMSK FEC 3/4	5.4 Mbps

Application



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