Matchstiq™ X40

Multi-Channel 6 or 18 GHz SDR Enabling AI & ML in Small Form Factor Applications at the RF Edge

Complete SDR + FPGA + CPU + GPU Transceiver Platform for COMINT, ELINT, EW, DF, Wireless Survey and Test on Small Platforms

The Matchstiq™ X40 is a high-performance SDR and digital signal processing platform optimized for small form factor applications with challenging SWaP-C requirements. It has an unprecedented level of integration, which makes it ideal for applications like UxS payloads. The Matchstiq™ X40 combines an RF frontend capable of accessing up to 18 GHz with multiple digital transceiver channels, a high performance NVIDIA Orin NX 16G GPU/CPU, and an AMD Zynq Ultrascale+ FPGA. Loaded with high performance components, this SDR delivers powerful data processing and AI & ML capabilities at the RF edge.

Matchstiq™ X40 supports phase coherent and independent modes, as well as fast frequency hopping, and comes in two configurations. The high frequency configuration has four receivers and one transmitter — each capable of accessing frequencies from 1 MHz to 18 GHz with instantaneous bandwidth up to 450 MHz with two channels. The low-frequency configuration benefits from reduced power consumption and offers four receivers and two transmitters - all capable of accessing RF frequencies from 1 MHz to 6 GHz with an instantaneous bandwidth of 200 MHz per channel.

Key Features

- Low SWaP Platform with high level of integration and transmit & receive functionality
- Optimized for small UxS payloads and dismounted applications
- Up to 450 MHz instantaneous bandwidth and 18 GHz coverage makes it ideal for detecting and DF'ing radars
- Supports phase coherent and independent operation
- Fast frequency hopping supported on all RF channels
- Integrated AMD Ultrascale+ FPGA and NVIDIA Orin NX for signal processing
- Libsidekiq API for SDR control and application development

Specifications at a Glance

Category	Output	F_{Min}	F_{Max}	LO Tuning	Timing Inputs	CPU Enabled	GPU Enabled
Platform	Digital	1 MHz	6/ 18 GHz	Indep. Pairs & Coherent	10 MHz, PPS, GPS	Yes	Yes

Max Rx Channels	Max Tx Channels	IBW_{Max}	$SFDR_{Typ.}$	Weight	Typ. Power Consumption	Interfaces	ADC bits/ DAC bits
4	2/ 1	450 MHz	75 dB	2.6 lb. 1.2 kg	50/ 65 W	Ethernet etc.	16/ 14

Specifications

Model:	6 GHz	18 GHz
Environmental Specifications		
Temperature (operating)	-40 to +70 °C, cold plate surface temperature under typical operating conditions	
Temperature (Storage)	-40 to +85 °C	
Size	9.75 x 4.25 x 1.45 inches 248 x 108 x 37 mm	
Weight	2.6 lb. 1.2 kg	
Power (Typ.)	40 - 70 W	60 - 90 W
Digital Specifications		
FPGA[1]	AMD Zynq Ultrascale+ XCZU7EG or AMD Zynq Ultrascale+ XCZU11EG	
CPU/ GPU	Jetson Orin NX 16 GB Ampere GPU + Arm Cortex-A78AE CPU + 16 GB LPDDR5	
NVMe SSD	1 TB (Jetson module operating system and user storage space)	
eMMC	128 GB (ZynqMP operating system and user storage space)	
User I/O	USB-A 3.2 to Jetson module USB-A 3.0 to ZynqMP microUSB Linux serial console (Orin NX and ZynqMP) 1 GbE to Orin NX System LEDs	
GPIO I/O	User accessible GPIO, user accessible SPI	
Other		
Export Classification	5A991.b	
CE-Marked	No	

Model:	6 GHz	18 GHz
RF Specifications		
All		
Connector Types	SMA Female	
Frequency Range	1 MHz to 6 GHz	1 MHz to 18 GHz
Channel Bandwidth	Up to 200 or 450 MHz depending upon mode	
Tuning Operation	See table on next page.	
Receivers		
Channels	4	
Noise Figure (Typ.)	<12 dB	
IIP3 (Typ.)	+12 dBm	+5 dBm
Spurious Free Dynamic Range (Typ.)	75 dB	
A/D Bits	16	
Transmitters		
Channels	2	1
Typical Output Power	0 dBm	0 dBm
D/A Bits	14	
Clocking		
Reference	10 MHz	
PPS Input	Yes	
GPS Input	Yes	

1 An AMD document summarizing differences between Zynq models may be found here. The ZU11 has almost twice the block RAM and is better equipped in many dimensions..

Data subject to change without notice.

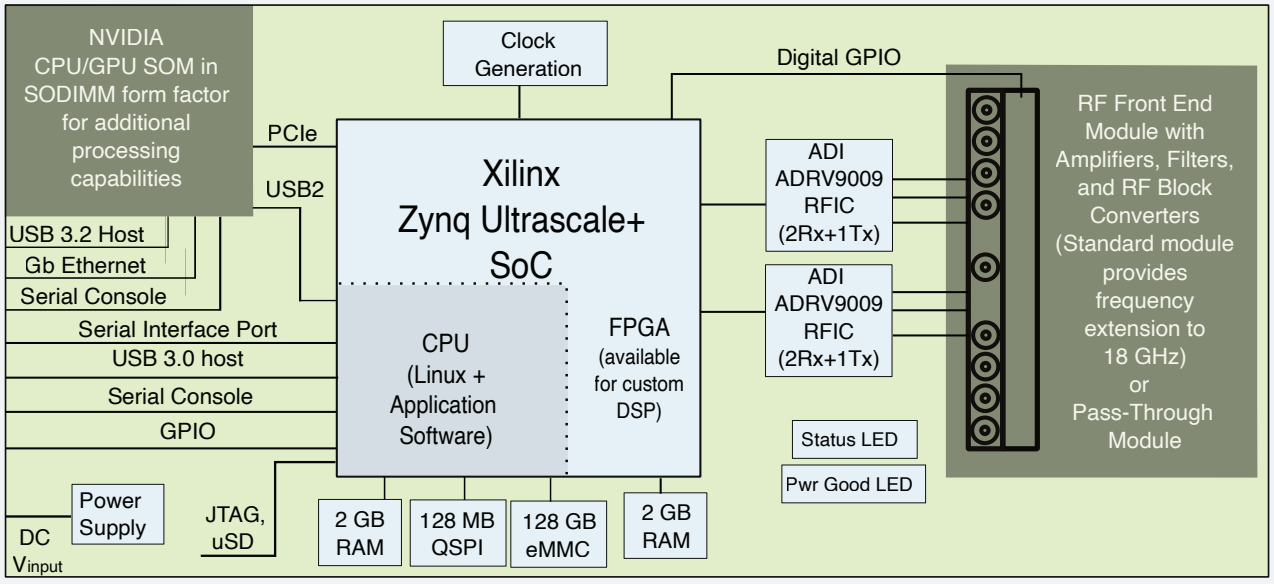
Tuning Modes

The table below outlines the tuning flexibility of the X40 and the instantaneous bandwidth available per channel.

Configuration	Description	Channel Pair A	Channel Pair B	Max Bandwidth Per Rx Channel
6 GHz Model, 4 Rx, 2 Tx				
2R 2T Coherent Mode	• 2 Rx and 2 Tx channels • All channels coherent across all frequencies	• RX2 & Tx1 enabled • LO_A = FreqA	• RX2 & TX1 enabled • LO_B = FreqA	200MHz
		• ORX1 & Tx1 enabled • LO_A = FreqA	• ORX1 & TX1 enabled • LO_B = FreqA	450MHz
Two 1R 1T Pairs	• 2 Rx and 2 Tx channels • Each coherent 1R 1T pair tunes independently	• RX2 & Tx1 enabled • LO_A = FreqA	• RX2 & TX1 enabled • LO_B = FreqB	200MHz
		• ORX1 & Tx1 enabled • LO_A = FreqA	• ORX1 & TX1 enabled • LO_B = FreqB	450MHz
4R 2T Coherent Mode	• 4 Rx and 2 Tx channels • All channels coherent across all frequencies	• RX1, RX2 & Tx1 enabled • LO_A = FreqA	• RX1, RX2 & TX1 enabled • LO_B = FreqA	200MHz
Two 2R 1T Pairs	• 4 Rx and 2 Tx channels • Each coherent 2R 1T pair tunes independently	• RX1, RX2 & Tx1 enabled • LO_A = FreqA	• RX1, RX2 & TX1 enabled • LO_B = FreqB	200MHz
18 GHz Model, 4 Rx, 1 Tx				
2R 1T Coherent Wide Band Mode	• 2 Rx & 1 Tx channels • All channels coherent across all frequencies	• ORX1, TX1 enabled • LO_A = FreqA	• ORX1 enabled • LO_B = FreqA	450MHz
2R 1T Independent Wide Band Mode	• 2 Rx & 1 Tx channels • 1R 1T pair & 1Rx channel tune independently	• ORX1, TX1 enabled • ≤6GHz LO_A = FreqA • >6GHz LO_A can be independent per channel	• ORX1 enabled • LO_B = FreqB	450MHz
4R 1T Coherent Mode	• 4 Rx & 1 Tx channels • All channels coherent across all frequencies	• RX1, RX2, TX1 enabled • LO_A = FreqA	• RX1, RX2 enabled • LO_B = FreqA	200MHz
4R 1T Independent Mode	• 4 Rx & 1 Tx channels • 2R 1T pair & 2Rx pair tune independently	• RX1, RX2, TX1 enabled • ≤6GHz LO_A = FreqA • >6GHz LO_A can be independent per channel	• RX1, RX2 enabled • ≤6GHz LO_B = FreqB • >6GHz LO_B can be independent per channel	200MHz

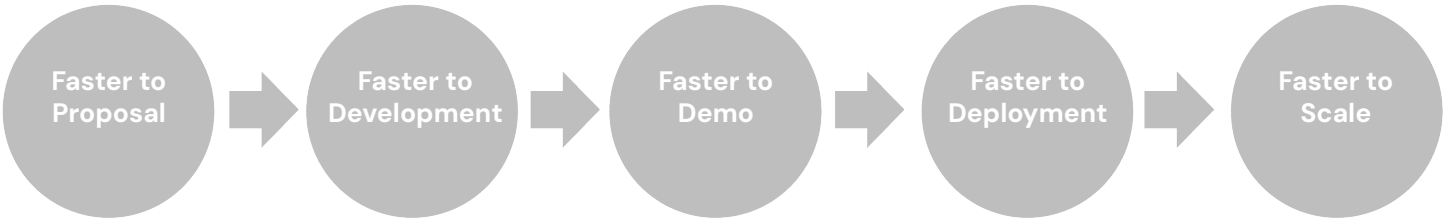
Note: ORX1 refers to the 'observation port' within the RFICs used in the X40 which become enabled during 450 MHz bandwidth operation. Contact factory for more details.

X40 Block Diagram



Epiq COTS Value Proposition

Epiq has always followed a COTS model for the products we offer, even before it was fashionable. Customers find it pays off at every stage of their project life cycle.

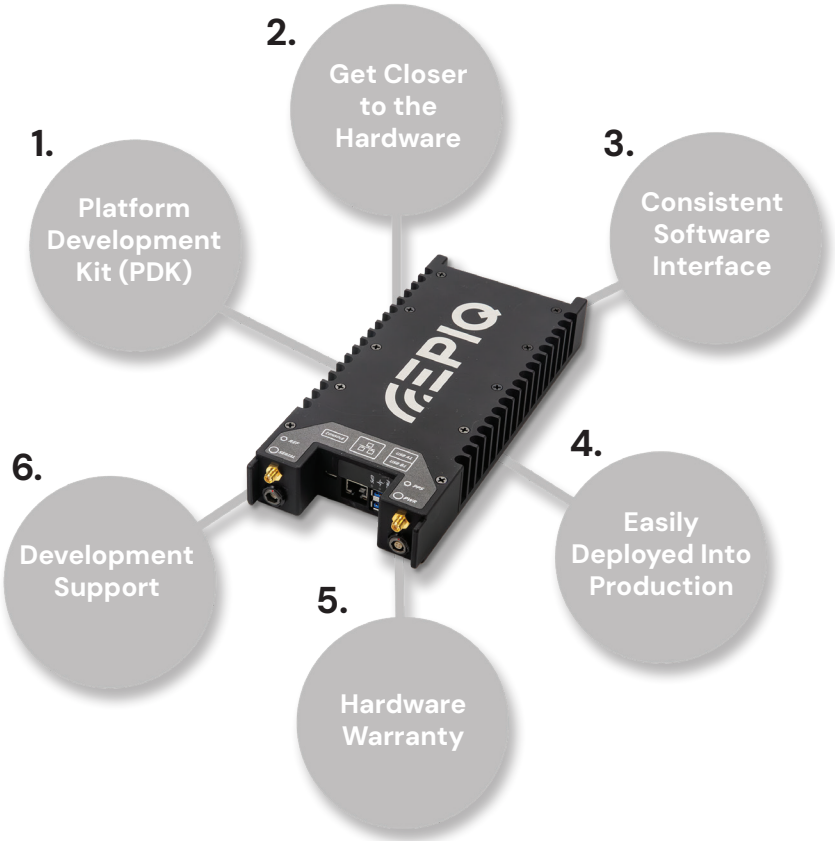


Epiq's GPU-Enabled Platforms

We offer two different platforms and a number of options within those platforms to tailor them to your needs. The G20/ G40 products are smaller and lighter than the X-series, and typically draw less power. They are easily capable of running AI/ML-enabled applications. The primary trade-offs are that they max out at 6 GHz, and 50 MHz IBW where the X40 goes higher in both, and the X40 has more FPGA and processing power. A unique feature of the G-series is that the G20 has one of the transceiver cards swapped out for an on-board SSD.

More information on the G-series and a more detailed comparison between platforms can be found here.

Developing with the X40



We're told we're one of the easier companies to do business with, and that starts with the development experience which is designed to get you up and running fast.

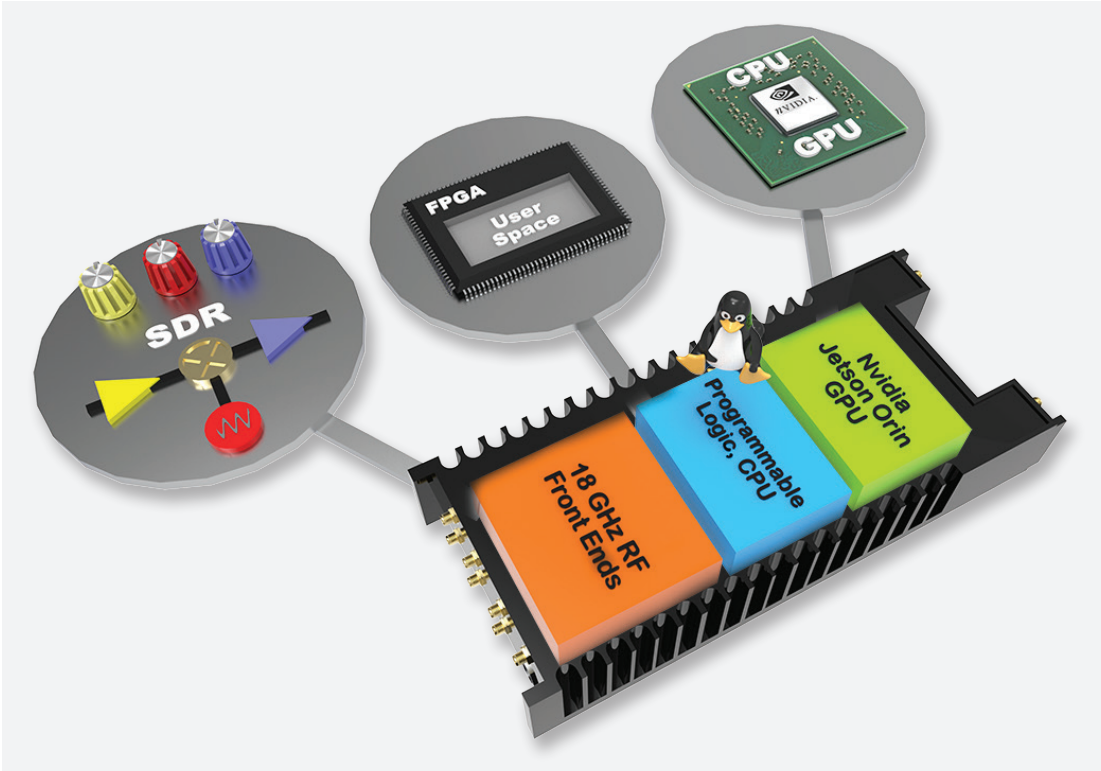
1. It starts with the Platform Development Kit, or **PDK**, which contains a full development setup, including an uneclosed X40 to allow JTAG access, cables and accessories, software and support. More details are given later.

2. The X40 has been designed to give the utmost flexibility for designers needing to develop quickly, and possibly uniquely, allows you to **get closer to the hardware** if desired. This ranges from using a consistent set of commands to control the device, all the way through to developing software on the CPUs and GPU, to controlling the RF hardware, to implementing custom FPGA code for the lowest latency processing.

3. A **consistent software interface** is provided by Libsidekiq. Many SDRs are a combination of radio frequency (RF) components, one or more radio frequency integrated circuits (RFICs), and a variety of logic devices. This means controlling them requires expertise in very different domains. A typical RFIC will have more than 1,000 individual hardware registers that are often interdependent, so changing one affects several others, and they will be different in another RFIC.

   Learning all of this and keeping up with it requires a consistent investment in time and money, which is why we developed **Libsidekiq** so that you don't have to.

   Libsidekiq provides a layer of abstraction so that consistent commands may be applied independent of the radio model being controlled, and development effort leveraged between projects. It also comes with a reference design for the FPGA in use, which is coded with RF data pass-throughs out of the box, but may be



customized by the user for time-sensitive applications.

Libsidekiq is compatible with a wide range of Epiq SDRs including the X40 and G20/40. Code developed on one platform can be ported to others with the minimum of effort. Compatibility is shown in the panel on the right. It also comes with test examples to make starting development easier.

4. The PDK provides tools for the development of software for the target product. Once developed, it can **easily be deployed into production** on an unlimited number of production devices.

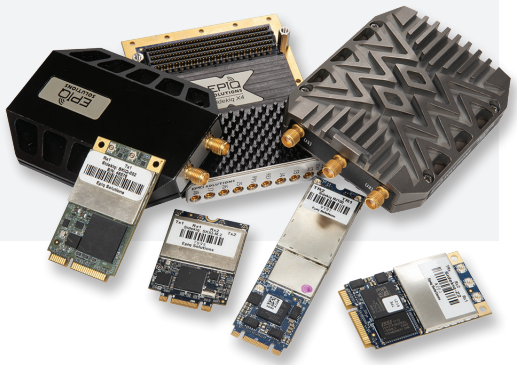
5. **Hardware warranty** is provided for 12 months from the date of delivery.

6. **Development support** is a big deal and something we have always taken very seriously. We don't subscribe to the model where support is abdicated to users helping each other. Instead, for verified purchasers of our products, we provide access to a private support forum. This gives access to our extensive collection of product literature including hardware, software and firmware development manuals. We won't write your code for you, but in our forum questions that you ask will be addressed in a timely fashion, often by the engineers who designed the products you bought.

Libsidekiq Compatibility

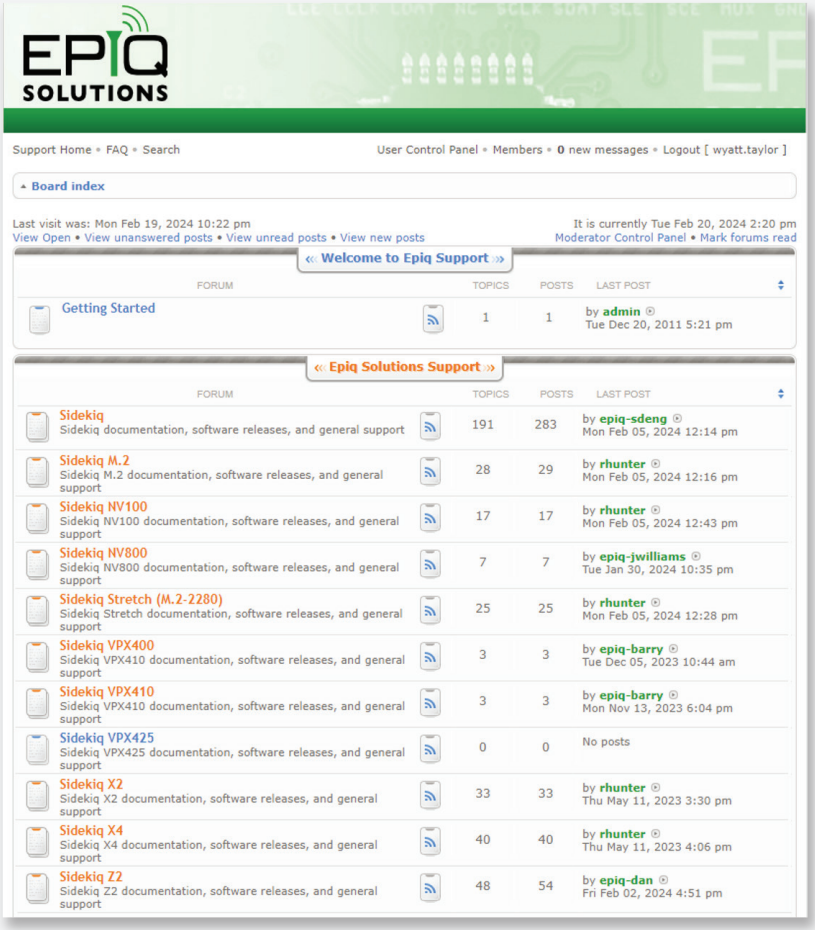
Epiq SDRs Supported by Libsidekiq:
- X40
- G20
- G40
- Z2
- Z3u
- M2
- MiniPCIe
- NV100
- NVM2
- Stretch
- VPX400
- X4

SDRs *Not* Supported by Libsidekiq:
- Tuners e.g. VPX410
- VITA 49 streaming devices such as NV800, NDR Products



We also understand that projects are dynamic, and team members change, which is why questions that have been asked and answered for your project are archived forever; new people don't have to reinvent the wheel each time there's a change.

Forum access and software updates are included for 3 users for 12 months after purchase, and are optionally extendable.



Support Forum Statistics 2023-24
- ~6,300 Total Posts by 259 Customers
- ~5,800 Total Responses by 35 Epiq Team Members
- Average of ~25 Forum Posts Per Working Day

Customer Quote

"Your staff who is manning the forums are 100% amazing. They have been very helpful and more responsive than every other support forum I've encountered."

Capabilities

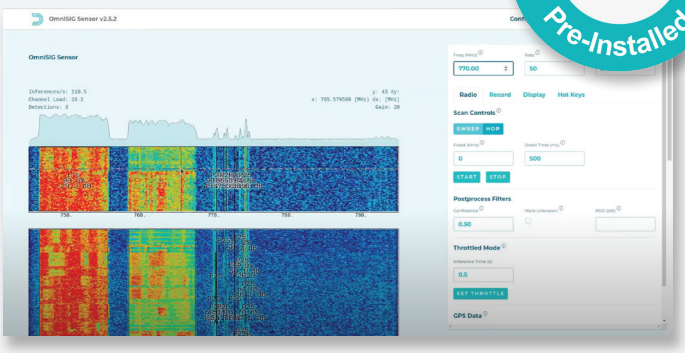
The following partner applications have been tested with the X40, providing signal classification, direction finding and a wealth of other capabilities out of the box. A trial license of DeepSig's OmniSIG comes pre-installed on models of the X40.

DEEPSIG OmniSIG

Trial License X40 Pre-Installed

Next Generation RF Awareness

OmniSIG is a machine-learning (ML) software application that provides RF situational awareness to a wide range of radio systems. DeepSig's custom neural network provides real-time identification, classification, and localization of known and unknown RF signals, enables automated alerting and reaction, and open-standards based descriptions of signal activity.

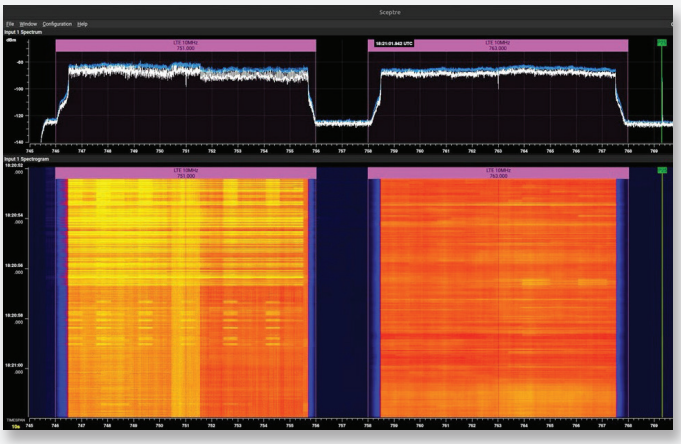


3dB LABS SCEPTRE

Reveal The Unknown

Quickly identify and locate anomalous signals across multiple domains.

Sceptre provides state of the art signal processing software built for real-time and offline spectrum and temporal analysis. Sceptre enables advanced signal discovery through remote spectrum operations, precision geolocation and multi-discipline analysis.



NVIDIA Jetson Orin NX

Jetson Software

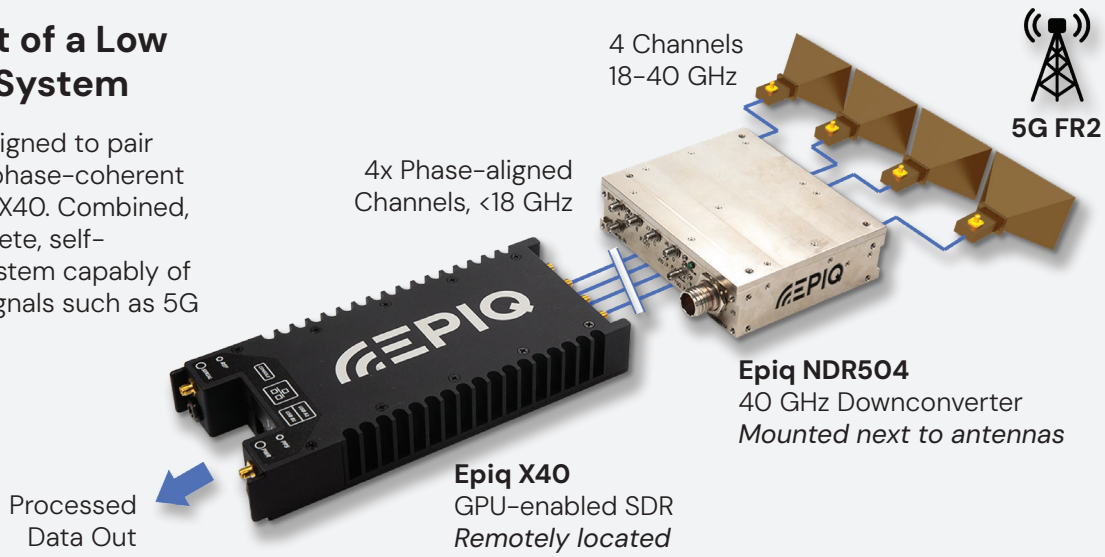
The Jetson software stack begins with NVIDIA JetPack™ SDK, which provides Jetson Linux, developer tools, and CUDA-X accelerated libraries and other NVIDIA technologies.

JetPack enables end-to-end acceleration for your AI applications, with NVIDIA TensorRT and cuDNN for accelerated AI inferencing, CUDA for accelerated general computing, VPI for accelerated computer vision and image processing, Jetson Linux API's for accelerated multimedia, and libArgus and V4l2 for accelerated camera processing.

Deployment Examples

Example 1: Part of a Low SWaP 40 GHz System

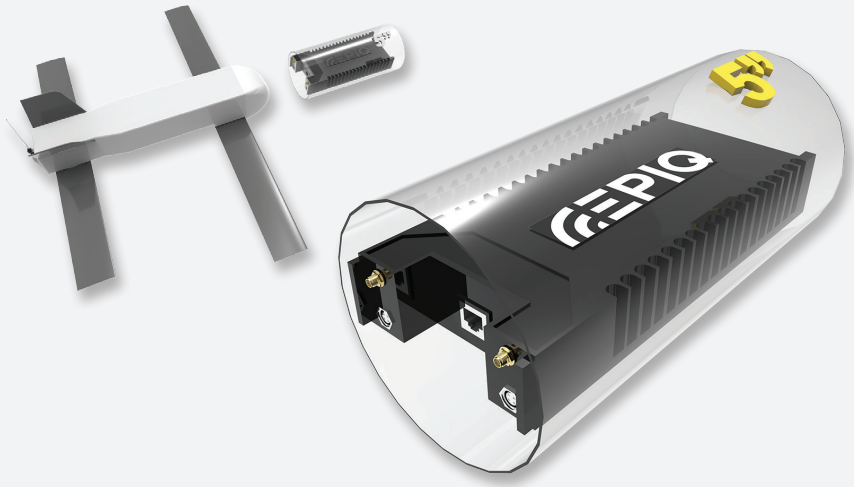
The NDR504 was designed to pair with a four-channel, phase-coherent platform such as the X40. Combined, they provide a complete, self-contained 40 GHz system capably of sensing and DF for signals such as 5G FR2.



Example 2: UAS Payload

The X40 was developed as a maritime RF payload, and is equally suited to deployment as a battery powered RF platform for airborne use. At 2.6 lb. and 50-65 W power consumption, it has ample on-board processing, RF coverage to 18 GHz, wide instantaneous bandwidth to 450 MHz per channel, fast frequency hopping and transmit capability.

Ideal for detecting and DF'ing radars from small platforms. Smaller payload dimensions can also be accommodated with unenclosed board set.



Example 3: Man-Portable DF System

Similar to the G20 and G40 GPU-enabled SDR platforms from Epiq shown here, the X40 comfortably straps to a small tripod-mounted broadband DF antenna, and easily hosts AI/ML-enabled capabilities such as DeepSig's OmniSIG to form a complete system.

(Computer is providing display only, processing is performed on the SDR platform)

The Epiq Family of Products

The X40 is part of our Platforms group of products that contain an accessible CPU which can run Linux or other operating systems and allow them to operate without a host. It goes further by also offering an NVIDIA Orin which gives even more compute capacity as well as an on-board GPU, an attribute shared with the G20 and G40 platforms.

The tables below show some examples of the Epiq portfolio, with the full range available in the comparison table here.

Product	**Matchstiq X40 (6 GHz)**	**Matchstiq X40 (18 GHz)**	**Matchstiq G20**	**Matchstiq G40**
				
Description	GPU-equipped SDR		GPU-equipped SDR with SSD	SWaP-optimized GPU-equipped SDR
Output	Digital			
Max Channels Rx/ Tx	4/ 2	4/ 1	2/ 2	4/ 4
Frequency Range	1 MHz - 6 GHz	1 MHz - 18 GHz	10 MHz - 6 GHz	
IBW Max	450 MHz		50 MHz	
SFDR Typ.	75 dB			
CPU?	Yes			
GPU?	Yes			
Typ. Power Consumption	50 W	65 W	25 W	30 W
Interface e.g.	Ethernet & USB			

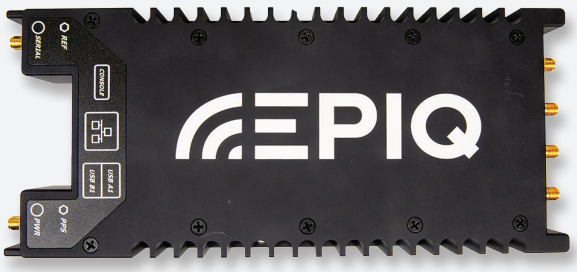
Maximum number of Rx, Tx channels, often not simultaneously. SFDR = Spurious Free Dynamic Range. IBW = Instantaneous Bandwidth. Interface example, often others present also.

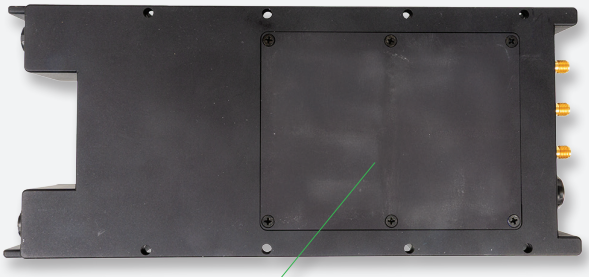
Product	Sidekiq Z2	Matchstiq Z3u	Sidekiq NV100	Sidekiq NV800
				
Description	Tiny 6 GHz SDR with CPU	Small, packaged 6 GHz SDR with CPU	Small 6 GHz SDR with RF pre-selection	8-Channel 6 GHz VITA 49 streaming SDR
Output	Digital			
Max Channels Rx/ Tx	1/ 1	2/ 1	2/ 2	8/ 1
Frequency Range	45 MHz - 6 GHz		10 MHz - 6 GHz	
IBW Max	50 MHz			
SFDR Typ.	60 dB		75 dB	
CPU?	Yes		-	
GPU?	-			
Typ. Power Consumption	2.5 W	4.5 W	5 W	25 W
Interface e.g.	USB	USB	PCIe	Eth., VITA 49 Streaming

Product	NDR325	NDR585	NDR374	NDR358
				
Description	Mod Payload High Performance SDR	High Performance 3U VPX 18 GHz Tuner	High Performance 8 GHz SDR Rackmount	High Performance 6 GHz SDR Rackmount
Output	Digital	RF	Digital	
Max Channels Rx/ Tx	4/ 0	4/ 0	4/ 0	8/ 0
Frequency Range	20 MHz - 6 GHz	20 MHz - 18 GHz	2 MHz - 6 GHz	20 MHz - 6 GHz
IBW Max	500 MHz		125 MHz	80 MHz
SFDR Typ.	90 dB			
CPU?	Yes	-		
GPU?	-			
Typ. Power Consumption	67 W	48 W	145 W	145 W
Interface e.g.	MAIM	Ethernet (Control)	Ethernet, VITA 49 Streaming	

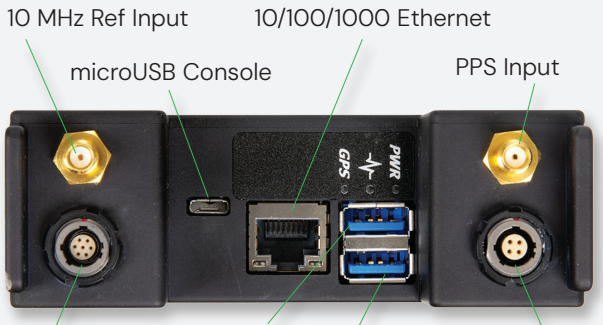
Physical Views

The photos below show the housed X40. Contact us for other options.

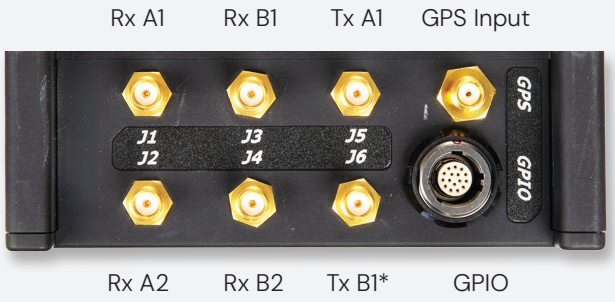




Thermal pads applied in this area



(RF Connectors are all SMA)



* J6 present but not connected on 18 GHz units

Optional Accessories

Note that X40 units are shipped with no accessories unless ordered in addition.

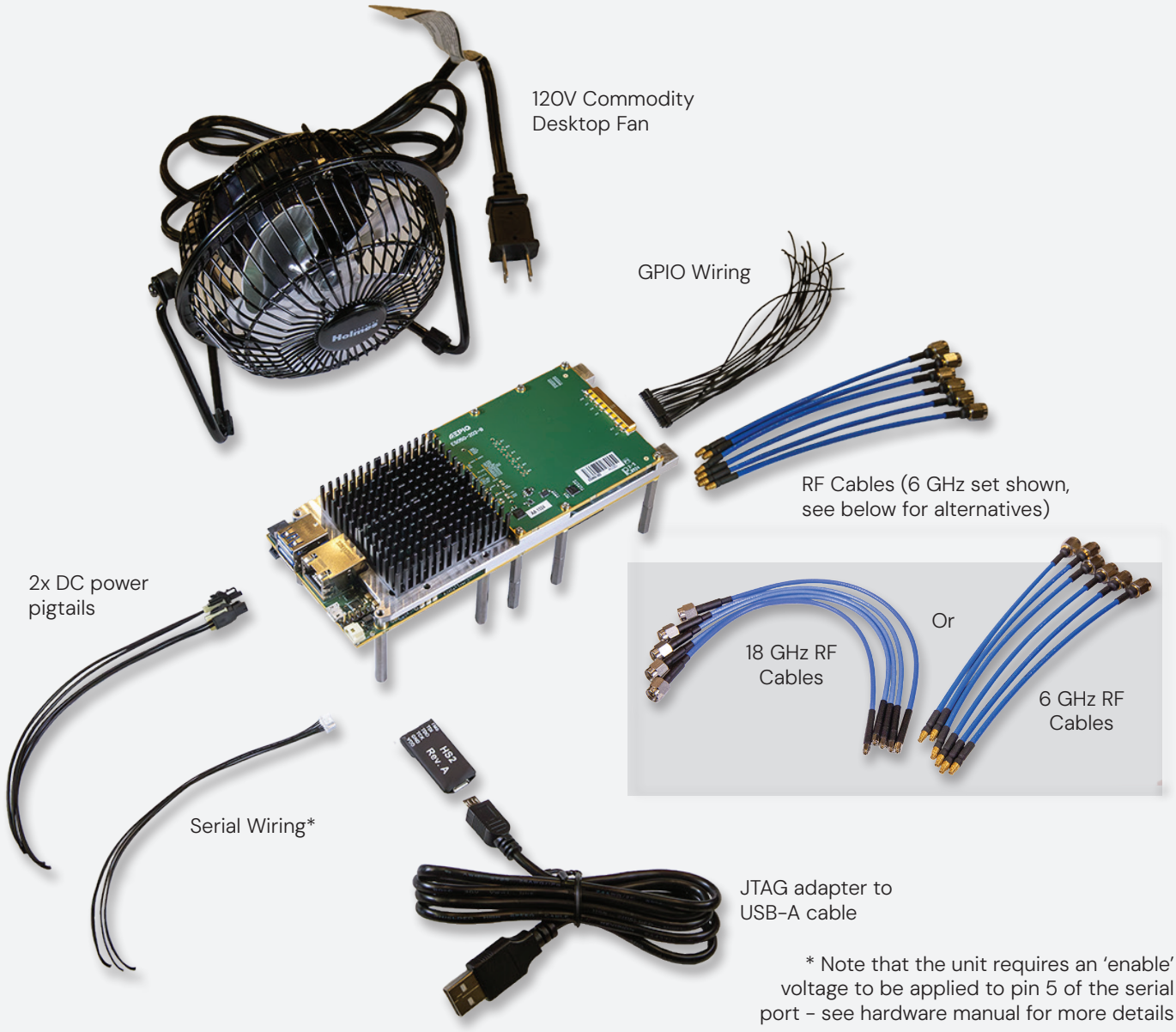
PDK Kit

The X40 platform development kit (PDK) is available in the following configurations:

- 6 GHz ZU7
- 6 GHz ZU11
- 18 GHz ZU7
- 18 GHz ZU11

Each kit is supplied with the items shown on below, including all cables, a desktop fan and an un-housed X40 allowing full JTAG access. Depending upon the frequency range, either 6 or 5 RF cables with suitable interfacing connectors are supplied (the 18 GHz unit has only one transmitter output).

The PDK also comes with a one-year hardware warranty, the Libsidekiq development environment including programming examples, and private support forum access for one year for up to 3 users (extendable).

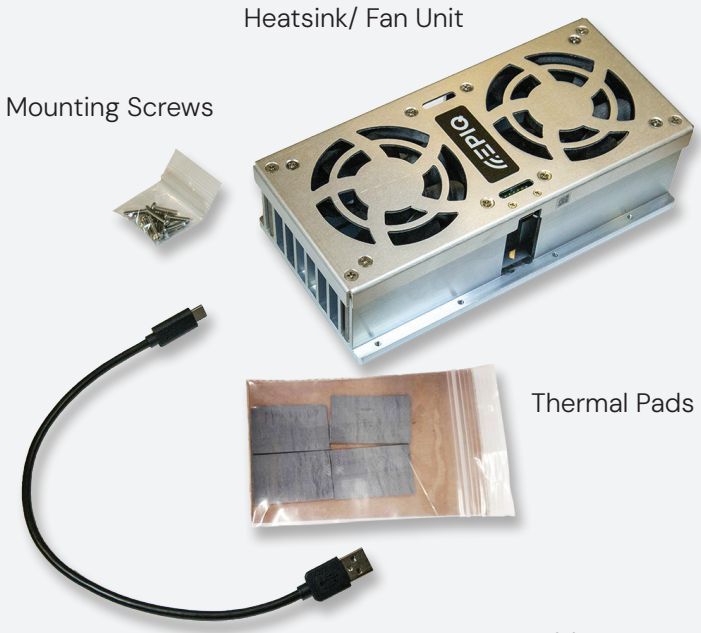


* Note that the unit requires an 'enable' voltage to be applied to pin 5 of the serial port - see hardware manual for more details

Heatsink and Fan Unit Kit

The X40 units have very low SWaP, with high power density. They therefore require careful management of heat, with attachment to a cold plate recommended when deployed. To make development easier, a fan kit is available as shown below. Note that air entry is required through the top of the fan unit, such that placing the fan unit on a bench underneath the X40 will not provide sufficient airflow and therefore cooling.

Cooling unit shown installed (X40 not included in kit); fan may be powered from an X40 USB socket if desired.



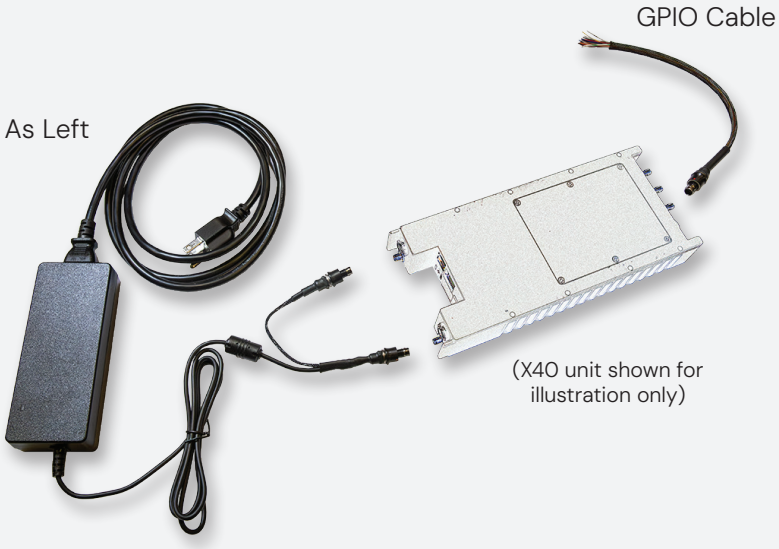
USB-C to USB-A cable, ~6" (15cm) in length

Power Brick Kit

DC power connector with 'enable' flying lead to serial connector

US 120V power cable, with a Universal power brick capable of 120/ 240V 50/ 60 Hz operation

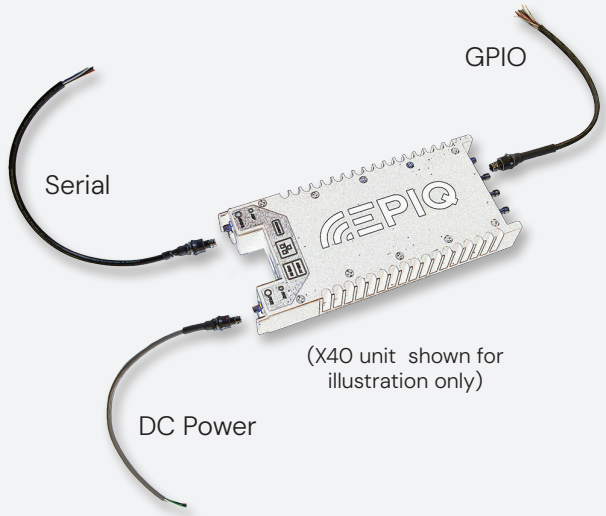
Power Brick & GPIO Kit

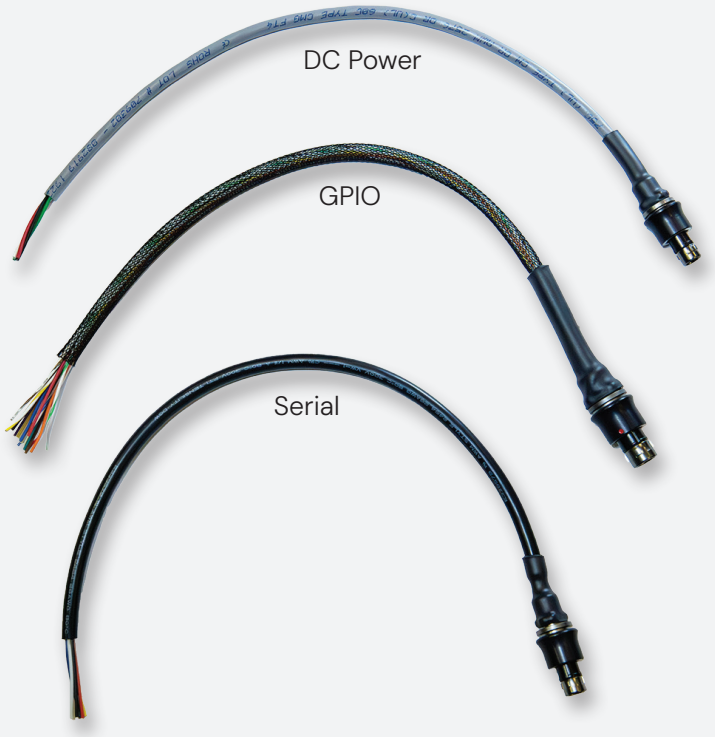


(X40 unit shown for illustration only)

Mating Cable Integration Kit

This kit contains the three non-RF cables required for the housed X40 suitable for integration into a wiring harness or battery. These include one each of the power cable, serial cable and GPIO cable, each approximately 12" (30 cm) in length.





Specifications subject to change without notice.

Epiq Solutions exports its products strictly in accordance with all US Export Control laws and regulations which shall apply to any purchase or order.

ABOUT EPIQ

Epiq Solutions develops high performance tools for engineering teams and government-focused organizations requiring situational awareness and detailed insight into their RF environments in order to identify and act against wireless threats.

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