Matchstiq™ Z3u

RF Transceiver • Platform

EPIQ SOLUTIONS

GETTING STARTED GUIDE

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CHANGELOG

Revision	Date	Description	Author
0.0.2	2020-08-21	initial draft	Meaghan Z
0.0.3	2020-08-27	first print draft	Barry L
1.0.0	2020-02-04	updated pics and formatting	Barry L

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INTRODUCTION

Congratulations! You are now the owner of Matchstiq Z3u, a small form factor, high performance software defined radio transceiver which provides unprecedented capability and flexibility while maintaining an aggressively low power consumption.

PROPER CARE AND HANDLING

Each Matchstiq Z3u unit is fully tested by Epiq Solutions before shipment, and is guaranteed functional at the time it is received by the customer, and **ONLY AT THAT TIME**. Improper use of Matchstiq Z3u can cause it to become non-functional. In particular, a list of actions that may cause damage to the hardware include the following:

- Handling the unit without proper static precautions (ESD protection) when the housing is removed or opened up

- Connecting a transmitter to the RX port without proper attenuation – refer to Matchstiq Z3u Hardware User's manual [5] for additional information

- Executing custom software and/or an FPGA bitstream that was not developed according to Epiq Solutions' guidelines

AVAILABLE DOCUMENTATION

Documentation for Matchstiq Z3u can be accessed at epiqsolutions.com/docs. After providing a valid email address, an access code will be emailed and grant you immediate access to documentation, so you can get started even before your access to our support forums has been approved.

- The Matchstiq Z3u User's Manual provides a detailed overview and usage details of the Matchstiq Z3u.

- The Sidekiq Software Development Manual provides the details required to enable a software developer to develop software applications utilizing the Sidekiq SDR.

- The Sidekiq API Manual provides an overview and usage details of libsidekiq - Sidekiq Library

- The Sidekiq FPGA Development Manual provides an overview of the FPGA reference design, with the intention of empowering the user to build upon the design to create custom applications.

REFERENCES

1. Matchstiq Z3u Product Page

   https://epiqsolutions.com/rf-transceiver/matchstiq/

2. Epiq Solutions Support Portal

   https://support.epiqsolutions.com/

3. Sidekiq Z3u Hardware User's Manual

   https://epiqsolutions.com/downloads/sidekiq-z3u

4. Epiq Solutions Support Portal Registration

   https://support.epiqsolutions.com/ucp.php?mode=register
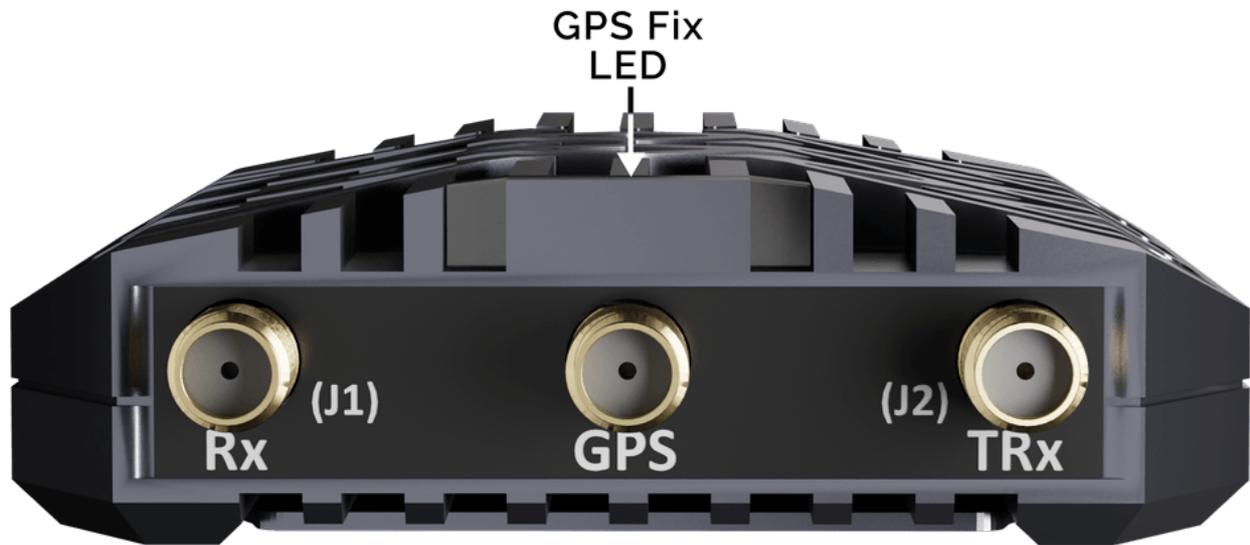
EXTERNAL I/O PORTS

Figure 1: Matchstiq Z3u front I/O ports

The front side of the Matchstiq Z3u has the following I/O ports:

Rx: The Rx interface is a 50 ohm SMA jack connector that provides an antenna input path that can be switched in to the RF receiver in the Matchstiq Z3u, allowing a user-supplied antenna to interface to the RF receiver. This Rx port supports RF input frequencies between 50 MHz and 6 GHz. *The maximum safe RF input level to this port without damage is **+20 dBm**.*

GPS: The GPS interface is a 50 ohm SMA jack connector that provides an antenna input path for the GPS receiver. Both passive and active GPS antennas can be used. The use of this interface is optional and not required. *The maximum safe RF input level to this port without damage is **+10 dBm**.*

TRx: The TRx interface is a 50 ohm SMA jack connector that provides an antenna access path that can be used for either Rx or Tx. *The maximum safe RF input level to this port without damage is **+20 dBm**.*

GPS Fix LED: Provides a visual status indicator that can be controlled via the FPGA. By default, the LED is used to provide an indication if the GPS receiver has a fix.

Figure 2: Matchstiq Z3u rear I/O ports

The rear side of the Matchstiq Z3u has the following I/O ports:

Push Button: This switch input is connected to the PS and is configured as a gpio-keys-polled device with the name of "ext*pb". It is configured to generate the "up key" event (103) when it's state changes. It is connected to a PS pin (PS*MIO70) on the Zynq UltraScale+.

Status LED: Provides a visual status indicator that can be controlled through software. By default, this LED is used to provide a heartbeat indicator after the system has booted Linux and is running, blinking at a rate of ~2 Hz.

REF: The REF interface is a 50 Ohm MMCX jack connector that accepts an external 10 MHz or 40 MHz reference clock signal (software selectable) for the purpose of phase locking the on-board 40 MHz TCVCXO reference clock. This provides the facility to have multiple Matchstiqs share a common external 10 or 40 MHz reference clock. The use of this interface is optional and not required. *Input levels: 0.8 – 1.3 Vpp, 0 dBm max from 50 ohm source for 40 MHz and 0.8 – 3.0 Vpp, +6 dBm max from 50 ohm source for 10 MHz*.

PPS: The PPS interface is a 50 ohm MMCX jack connector that can be used to either provide a reference 1PPS input to the system or to output the 1PPS from the on board GPS receiver and is software selectable. The use of this interface is optional and not required. *A maximum recommended signal level of 3.3V can be applied to this input port.*

uSD: The microSD slot can be used for removable storage via a microSD card. Cards up to 32GB are supported.

USB3: The USB-C interface can be used to both power the Matchstiq Z3u and communicate via a network interface to the radio from a host device (such as a laptop or Android device). It supports a

USB3.0 superspeed interface.

7-17VDC: The DC power input (7 to 17 VDC) barrel jack input can be used as an alternative to the USB3 interface to power the Matchstiq Z3u.

uUSB: The microUSB interface (CP2102 USB-UART) provides access to the Linux serial console. The default serial console runs at a rate of 115.2 kbsps baud, with 8 data bits, 1 stop bit, no parity bits, and no flow control.

SETUP

After you have removed and verified that all the package contents are present as outlined in the Matchstiq Z3u Package Contents, setup the system as follows:

The Matchstiq Z3u can be powered up via either the USB3 interface or the 7-17VDC input. The Matchstiq Z3u can be used by either running Sidekiq applications on a host system and running in a standalone system running Sidekiq applications directly on the Z3u.

In the case of interfacing with the Matchstiq Z3u via a host system, a USB-C cable connecting to a USB3.0 capable host should be used to both power the Matchstiq Z3u as well as communicate to the host. Host systems supported are: Linux, Windows, MacOS, or an Android device.

In the case of applications running standalone directly on the Matchstiq Z3u, the unit can be powered with the power adapter provided and does not require a host device.

When power is applied to the Matchstiq Z3u, the unit will power on and the status LED will turn on a solid green. After several seconds, once the system is fully booted up, the Status LED will begin blinking.

INTERFACING TO MATCHSTIQ Z3U OVER USB

Once the Machstiq Z3u is powered up and the Linux kernel has booted, the device appears as a USB Ethernet gadget network device with a default IP address of `192.168.0.15`. The host has a default IP address of `192.168.0.20` assigned.

DEFAULT LOGIN

USER IMAGE

The default username and password for the user image is `sidekiq`. The `sidekiq` user is configured with sudo access. The user image is a full Ubuntu Linux distribution residing on the eMMC of the device. When the user image is booted, the Status LED turns on twice rapidly and then remains off for a longer period.

RECOVERY IMAGE

If there are any problems encountered when booting the Ubuntu distribution, a reboot of the system will result in the recovery image being booted. The default root username for the recovery image is `root`, and the default password is `root`. Additionally, the Z3u default IP address is `192.168.0.15`. When the recovery image is booted, the Status LED turns off twice and then remains on for a longer period (inverted from the user image).

The user should be able to ping the Matchstiq Z3u unit from a terminal shell on the host PC using the following command entered in to the terminal shell:

```
$ ping 192.168.0.15
PING 192.168.2.140(192.168.0.15) 56(84) bytes of data.
64 bytes from 192.168.0.15: icmp_req=1 ttl=64 time=0.323 ms
64 bytes from 192.168.0.15: icmp_req=2 ttl=64 time=0.390 ms
64 bytes from 192.168.0.15: icmp_req=3 ttl=64 time=0.225 ms
64 bytes from 192.168.0.15: icmp_req=4 ttl=64 time=0.405 ms
64 bytes from 192.168.0.15: icmp_req=5 ttl=64 time=0.343 ms
--- 192.168.2.140 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms
rtt min/avg/max/mdev = 0.225/0.337/0.405/0.064 ms
```

With a successful ping session complete, network connectivity between the Matchstiq Z3u and the host PC has been confirmed. From here, the user can proceed to establish a secure shell (SSH) connection to the Matchstiq Z3u unit from the host Linux PC.

The default login credentials are:

- username: **sidekiq**
- password: **sidekiq**

```
$ ssh sidekiq@192.168.0.15
Last login: Wed Aug 26 14:16:37 2020 from 192.168.0.20
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
sidekiq@z3u:~$
```

INCLUDED APPLICATIONS

Several applications are included with the Matchstiq Z3u in order to help you test and verify your setup, such as our standard libsidekiq command-line test applications.

LIBSIDEKIQ TEST APPLICATIONS

Test applications are located in /home/sidekiq/sidekiq_image_current/test_apps

```
$ cd /home/sidekiq/sidekiq_image_current/test_apps/
```

A user can display libsidekiq and fpga version information with the **version_test** application by executing the command: *./version_test* The application should return results that look something like the following:

```
sidekiq@z3u:~$ ~/sidekiq_image_current/test_apps/version_test
1 card(s) found: 0 in use, 1 available!
Card IDs currently used      :
Card IDs currently available: 0
Info: initializing 1 card(s)...
SKIQ[3396]: <INFO> libsidekiq v4.13.255-z3u-dev-20200826 (g1ff8b75f9)
version_test[3396]: <INFO> Sidekiq card 0 is serial number=9X0J, Z3U (rev B) (part ES032201-B0-
00)
version_test[3396]: <WARNING> FPGA capabilities indicate no support for reading/writing flash
for card 0
version_test[3396]: <INFO> Sidekiq card 0 FPGA v3.14.0, (date 20081217, FIFO size unknown)
version_test[3396]: <INFO> Sidekiq card 0 is configured for an internal reference clock
version_test[3396]: <INFO> Loading calibration data for Sidekiq Z3U, card 0
***********************************************************
* libsidekiq v4.13.255-z3u-dev-20200826
***********************************************************
***********************************************************
* Sidekiq Card 0
  Card
    accelerometer present: true
    part type: Z3U
    part info: ES032201-B0-00
    serial: 9X0J
    xport: custom
  FPGA
    version: 3.14.0
    git hash: 0x1eefb308
    build date (yymmddhh): 20081217
    tx fifo size: unknown
  RF
    reference clock: internal
    reference clock frequency: 40000000 Hz
version_test[3396]: <INFO> Unlocking card 0
```

RAW I/Q CAPTURE

A user can perform an RF capture of I/Q samples using the default configuration by executing the *rx_samples* application as follows:

```
sidekiq@z3u:~$ ~/sidekiq_image_current/test_apps/rx_samples -c 0 --handle=A1 -r 7e6 -b 5.6e6 -f
1e9 -d /tmp/out
Info: using Rx handle A1
Info: initializing card 0...
SKIQ[3435]: <INFO> libsidekiq v4.13.255-z3u-dev-20200826 (g1ff8b75f9)
rx_samples[3435]: <INFO> Sidekiq card 0 is serial number=9X0J, Z3U (rev B) (part ES032201-B0-
00)
rx_samples[3435]: <INFO> libiio v0.19 (tag a74f874)
rx_samples[3435]: <WARNING> FPGA capabilities indicate no support for reading/writing flash for
card 0
rx_samples[3435]: <INFO> Sidekiq card 0 FPGA v3.14.0, (date 20081217, FIFO size unknown)
rx_samples[3435]: <INFO> Sidekiq card 0 is configured for an internal reference clock
rx_samples[3435]: <INFO> Loading calibration data for Sidekiq Z3U, card 0
rx_samples[3435]: <INFO> card 0: number of tx channels supported 1, number of rx channels
supported 2
rx_samples[3435]: <INFO> RF IC version 5.2.255
rx_samples[3435]: <INFO> Default warp voltage not currently stored (user) (card=0)
rx_samples[3435]: <INFO> Default warp voltage not currently stored (factory) (card=0)
rx_samples[3435]: <INFO> No stored default warp voltage is available for card 0, using the
library default
Info: initialized card 0
Info: opened file /tmp/out.a1 for output
Info: tcvcxo warp voltage left at factory setting
Info: packed mode disabled
Info: tunable RX LO frequency range = 47000000Hz to 6000000000Hz
Info: RX calibration mask configured as 0x0
Info: configured Rx LO freq to 1000000000 Hz
Info: configured auto gain mode
Info: actual sample rate is 7000000.000000, actual bandwidth is 5600000
Info: acquiring 100000 words at 1018 words per block
Info: num blocks to acquire is 99
Info: configured for I/Q data mode
Info: starting 1 Rx interface(s)
Info: stopping 1 Rx interface(s)
Info: done receiving, start write to file for hdl 0
Info: Done without errors!
rx_samples[3435]: <INFO> Unlocking card 0
sidekiq@z3u:~$
```

This command will save I/Q samples to a file named /tmp/out.a1 using values for 7 Msps sample rate, 5.6 MHz channel bandwidth, 1 GHz tune frequency. The data is stored in the file as 16-bit I/Q pairs with 'I' samples stored in the upper 16-bits of each word, and 'Q' samples stored in the lower 16-bits of each word. Additional available options are described by executing *./rx_samples -h*

INTERFACING TO MATCHSTIQ Z3U OVER SERIAL CONSOLE

Access to the Linux serial console via the microUSB connector requires the user to connect a microUSB cable between the Matchstiq Z3u and a host PC USB 2.0 port running a serial terminal emulator program such as minicom, PuTTY, or screen. The microUSB interface of the Z3u will enumerate as a USB serial port (typically at `/dev/ttyUSB0` or similar on the host Linux system). The default Linux serial console on Matchstiq Z3u runs at a baud rate of 115.2 kbps, with 8 data bits, one stop bit, and no parity bits.

```
Ubuntu 18.04.4 LTS z3u ttyPS0
z3u login: sidekiq
Password:
Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 4.14.0-xilinx-v2018.3 aarch64)
 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.
To restore this content, you can run the 'unminimize' command.
The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
sidekiq@z3u:~$
```

USING THE MATCHSTIQ Z3U PLATFORM DEVELOPMENT KIT

For details on interfacing with the Matchstiq Z3u Platform Development Kit, please refer to the Matchstiq Z3u Hardware Manual, available Epiq's support forum: https://epiqsolutions.com/support.