RZ10 Lux Integrated Processor

RZ10 Overview

The RZ10 platform includes light driving/sensing capabilities for lock-in amplification fiber photometry setups. The RZ10x model has twice as many light driving/sensing ports for running multiple subjects or to add optogenetic stimulation, and includes fiber optic connections for integrated multi-channel neurophysiology.

The RZ10 Lux Integrated Processor has a single 400 MHz Sharc digital signal processor (DSP). It includes one bank of integrated Lux light drivers and photosensors. The RZ10x model (shown above) has three DSPs and two Lux banks standard. Both models are expandable to up to four DSPs.

Each Lux bank has 3 output drivers and 2 inputs. Each output port can have either a Lux LED, an M8 connector to drive an external LED, or a BNC connector to control a voltage signal. Each input port can have either a Lux PS1 photosensor, Lux PM1 power meter, or BNC connector to measure a voltage input. The components are interchangeable by the user.

The RZ10 includes one additional analog input channel. The RZ10x includes two additional analog input channels. The RZ10x fiber optic input port can acquire up to 32 channels of neurophysiological signals from a PZ amplifier at up to ~50kHz for real-time processing synchronized to your fiber photometry data and/or optogenetic stimulation.

The RZ10 and RZ10x both feature 24-bits of digital I/O (four bits are accessible on the front panel BNC connectors) and a legacy fiber optic port to acquire neurophysiological signals from a Medusa4Z, RA8GA, or RA16PA preamplifier.

This manual provides hardware information for the RZ10. For a full application guide specific to fiber photometry using the RZ10, see the Fiber Photometry User Guide.

Power and Communication

The RZ10's integrated Optibit optical interface connects to a PO5e card in the host PC. The connectors on the back panel are color coded for correct wiring. The RZ10's integrated power supply is shipped from the factory configured for the desired voltage setting (110 V or 220V). If you need to change the voltage setting, please contact TDT support at +1.386.462.9622 or email support@tdt.com.

Software Control

The RZ10/RZ10x is intended for use with TDT's Synapse software only.

RZ10 Features

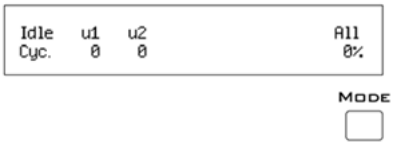
DSP Status Displays

The RZ10 include status lights and a display screen to report the status of the individual processors.

Status Lights

Four LEDs report the status of the multiprocessor's individual DSPs and will be lit solid green when the corresponding DSP is installed and running. If the cycle usage on a DSP exceed 99% of its capacity, the corresponding LED will flash red (~1 Hz).

Front Panel Display Screen



The front panel display screen shows two lines of information about the system status. The top line reports the system mode, Run!, Idle, or Reset. Run! means a circuit is loaded and running. Reset means the system is booting up. The second line reports the user's choice of status indicators for each DSP followed by an aggregate value, selected with the Mode pushbutton. Press and release the button to change the display or push and hold the button for one second then release to automatically cycle through each of the display options.

Note: When burning new microcode after a TDT driver update, or if the firmware on the RZ10 is blank, the display screen will report a cycle usage of 99% and the processor status lights will flash red.

Status Indicators	Description
Cyc:	processing cycle usage
Bus%:	percentage of internal device's data bus capacity used
I/O%:	percentage of data transfer capacity used

PZ Preamplifier Port

The RZ10x acquires digitized signals from any PZ preamplifier (PZ2-PZ5) over a fiber optic cable through the port labeled 'PZ Amp' on the front panel. This port can input up to 32 channels at a maximum sampling rate of ~50 kHz.

Onboard Analog Inputs

The RZ10 has an extra channel of 16-bit PCM A/D input, accessible through the BNC marked 'ADC4'. The RZ10x has an additional channel marked 'ADC8'. See the *Synapse Manual* for information on enabling analog inputs.

Fiber Optic Preamplifier Port

The RZ10 acquires digitized neurophysiological signals from a Medusa preamplifier over a fiber optic cable. It samples up to 16 channels at a maximum sampling rate of ~25 kHz.

The fiber optic ports can be used with any of the Medusa preamplifiers including the Medusa4Z, RA16PA, RA4PA, or RA8GA. The port is limited to ~25 kHz, however if the processor is running ~50 kHz sampling rate the Medusa data is oversampled to 2x or ~50 kHz.

Digital I/O

24 bits of programmable digital I/O is divided into three bytes (A, B, and C) as described in the chart below. All digital I/O lines are accessed via the 25-pin connector on the front of the RZ10 and bits 0 - 3 of byte C are available through BNC connectors on the front panel labeled C0-C3. See "RZ10 Technical Specifications" on page 1-33, for the DB25 pinout and BNC channel mapping.

Digital I/O	Description	DB25	BNCs	Notes
Byte A	bits 0 - 7	Yes	No	byte addressable
Byte B	bits 0 - 7	Yes	No	byte addressable
Byte C	bits 0 - 7	Yes	Yes*	bit addressable
*Note: Byte C Bits 0 - 3 are available via front panel BNCs				

See the *Synapse Manual* for information on enabling digital I/O and configuring data direction.

The RZ10 digital I/O ports have different voltage outputs and logic thresholds depending on the type. Below is a table depicting the different voltage outputs and thresholds for both type.

Digital I/O Type	Voltage Output		Voltage Input	
	logic high	logic low	logic high	logic low
byte addressable	5 V	0 V	≥ 2.5 V	0 - 2.45 V
bit addressable	3.3 V	0 V	≥ 1.5 V	0 - 1.4 V

LED Indicators

The RZ10 has 16 LED indicators for the analog and digital I/O. These indicators are located directly below the display screen and DSP status LEDs. The following tables describe the meaning of the status LEDs.

Digital I/O

These LEDs indicate the state of the 8 bit-addressable I/O of byte C.

Light Pattern	Description
Dim Green	Bit is configured for output and is currently a logical low (0)
Solid Green	Bit is configured for output and is currently a logical high (1)
Dim Red	Bit is configured for input and is currently a logical low (0)
Solid Red	Bit is configured for input and is currently a logical high (1) default

Analog I/O

These LEDs indicate state of the first bank of Lux I/O only.

Light Pattern	Description
Off	Analog I/O channel signal voltage is less than +/- 100 mV
Dim Green	Analog I/O channel signal voltage is less than +/- 5 V
Solid Green	Analog I/O channel signal voltage is between +/- 5 V to +/- 9 V
Solid Red	Analog I/O channel clip warning (voltage greater than +/- 9 V)

Note: ADC channel 3 and DAC channel 4 are used internally while the RZ10 is actively running, so the ADC3 and DAC4 LEDs will flash ~1Hz during normal operation.

UDP Ethernet Interface (Optional)

The RZ UDP Ethernet interface can transfer data to or from a networked computer for fast integration with external software. RZ devices equipped with a UDP interface contain an additional port located on the back panel. See "RZ-UDP Communications Interface" on page 1-51, for more information.

Onboard Lux I/O

The RZ10 has one bank of integrated Lux components. Each Lux bank has three built-in current driver outputs for driving integrated LEDs directly, or external LEDs connected to an M8 cable. Each Lux bank also has two input slots for photosensors and/or power meters.

The RZ10x includes a second full bank for Lux components.

The Lux components are held in place with two nylon screws. They are interchangeable, so you can swap LED colors at any time, upgrade from an external photosensor to a PS1 integrated sensor, or interface with an external device with a BNC connector. In the case of lost Lux screws, do not replace them with metal screws. Please contact TDT support for replacement screw options.

Important!: Make sure the RZ10 is powered off before changing the Lux components.

Each Lux LED pod is colored with the closest visible color to the wavelength of light it emits. The Lux LEDs can occupy the left three slots of each Lux bank. The 465nm Lux LED is shown at left.

The PS1 photosensor measures the fluorescence response from the subject. It can occupy the right two slots of each Lux bank.

The PM1 Power Meter measures the LED power received by the subject. It has built-in fluorescing material so it can also mimic a subject response for full end-to-end system testing. The PM1 can only occupy the slot on the far right of each Lux bank.

The M8 connector is the default placeholder for the left three slots if LEDs aren't installed. It is used to drive an external LED. This can be a Lux LED in an external heat sink, or a third-party LED.

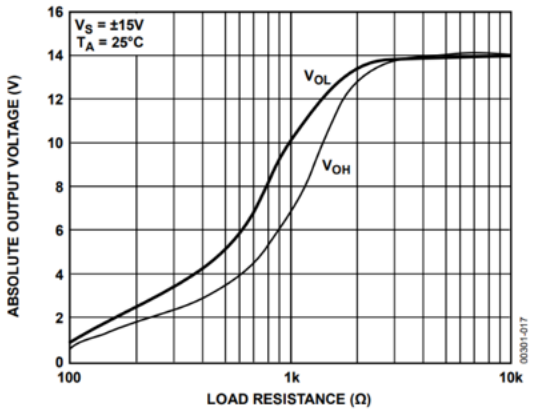
The BNC connector can be swapped into any location on the Lux bank to connect to third party devices. It is the default placeholder for the right two slots if PS1/PM1s aren't installed.

The Lux LEDs, PS1, and PM1 have an FC connector with a small key that must be aligned to the fiber optic cable. This key is in the 10 o'clock position on all TDT optical Lux components.

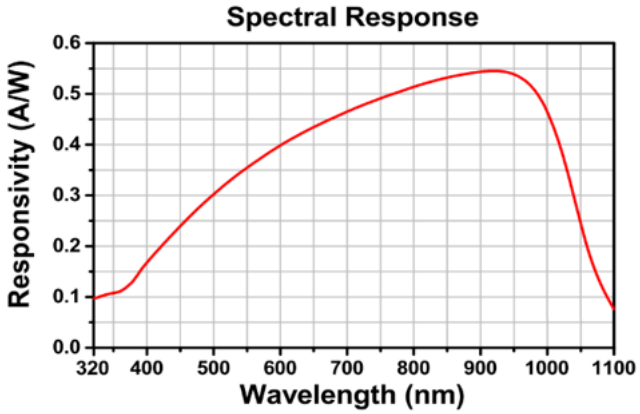
See the *Synapse Manual* for information on controlling the Lux drivers and reading the sensors.

Lux Technical Specifications

LEDs	
Available Wavelengths	385 nm, 405 nm, 415 nm, 450 nm, 465 nm, 500 nm, 530 nm, 560 nm, 590 nm, 615 nm, 635 nm, 850 nm, 940 nm, 5K
Current Range	2 mA - 1000 mA
PS1	
Bandwidth	DC - 700 Hz
Wavelength Range	320 nm - 1100 nm
Gain	10^{10}
PM1	
Bandwidth	DC - 3000 Hz
Wavelength Range	320 nm - 1100 nm
Gain	6.5×10^{4}
BNC Output Pod	RZ10: up to 3 channels, 16-bit PCM RZ10x: up to 6 channels, 16-bit PCM
Sample Rate	Up to 48828.125 Hz
Frequency Response	DC - 0.44*Fs (Fs = sample rate)
Voltage Out	+/- 10.0 Volts, 6 mA max load
S/N (typical)	82 dB (20 Hz - 20 kHz at 9.9 V)
Output Impedance	See below
BNC Input Pod	RZ10: up to 2 channels, 16-bit PCM RZ10x: up to 4 channels, 16-bit PCM
Sample Rate	Up to 48828.125 Hz
Frequency Response	DC - 7.5 kHz (2nd order, 12 dB per octave)
Voltage In	+/- 10.0 Volts
S/N (typical)	82 dB (20 Hz - 20 kHz at 9.9 V)
Input Impedance	10 kOhms (impedance of input connection will appear to be ~400 Ohm higher)



Lux BNC Pod Output Impedance



PS1 and PM1 Responsivity

RZ10 Technical Specifications

Note: Specifications for amplifier A/D converters are found under the preamplifier's technical specifications.

DSP	Up to four standard DSPs and/or quad-core (QZDSP) DSP: 400 MHz DSPs, 2.4 GFLOPS peak per DSP QZDSP: four 400 MHz DSPs, 2.4 GFLOPS per core
Memory	64 MB SDRAM per standard DSP 256 MB DDR2 RAM per QZDSP core
A/D	RZ10: 1 channel, 16-bit PCM RZ10x: 2 channels, 16-bit PCM
Sample Rate	Up to 48828.125 Hz
Frequency Response	DC - 7.5 kHz (2nd order, 12 dB per octave)
Voltage In	+/- 10.0 Volts
S/N (typical)	82 dB (20 Hz - 20 kHz at 9.9 V)
Input Impedance	10 kOhms

Fiber Optic Ports	
PZ Amp	RZ10x: One input for PZ5, PZ2, PZ3 or PZ4, up to 32 channels
Legacy Amp	16-channel input, up to 24414.0625 Hz
Digital I/O	8 programmable bits: 3.3 V, 25 mA max load 2 programmable bytes (16 bits): 5.0 V, 35 mA max load

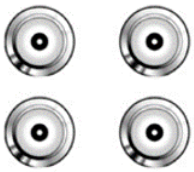
BNC Channel Mapping

Please note channel numbering is printed on the face of the device to minimize mis-wiring.

Maps To:

Ch 4 Analog In

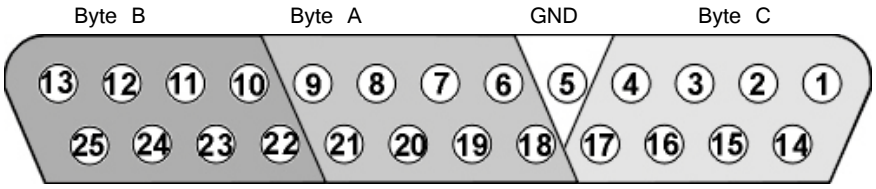
Ch 8 Analog In (RZ10x only)



Maps To:

Port C Bits 0-3 Digital I/O

DB25 Digital I/O Pinout



Pin	Name	Description		Pin	Name	Description
1	C0	Byte C Bit Addressable Digital I/O Bits 0, 2, 4, and 6		14	C1	Byte C Bit Addressable Digital I/O Bits 1, 3, 5, and 7
2	C2			15	C3	
3	C4			16	C5	
4	C6			17	C7	
5	GND	Digital I/O Ground		18	A0	Byte A Word Addressable Digital I/O Bits 0, 2, 4 and 6
6	A1	Byte A Word Addressable Digital I/O Bits 1, 3, 5 and 7		19	A2	
7	A3			20	A4	
8	A5			21	A6	
9	A7			22	B0	Byte B Word Addressable Digital I/O Bits 0, 2, 4 and 6
10	B1	Byte B Word Addressable Digital I/O Bits 1, 3, 5 and 7		23	B2	
11	B3			24	B4	
12	B5			25	B6	
13	B7					