TI-RSLK MAX

Texas Instruments Robotics System Learning Kit

Texas Instruments

Introduction: TI-RSLK to TI-RSLK MAX change document

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1. Fundamental differences

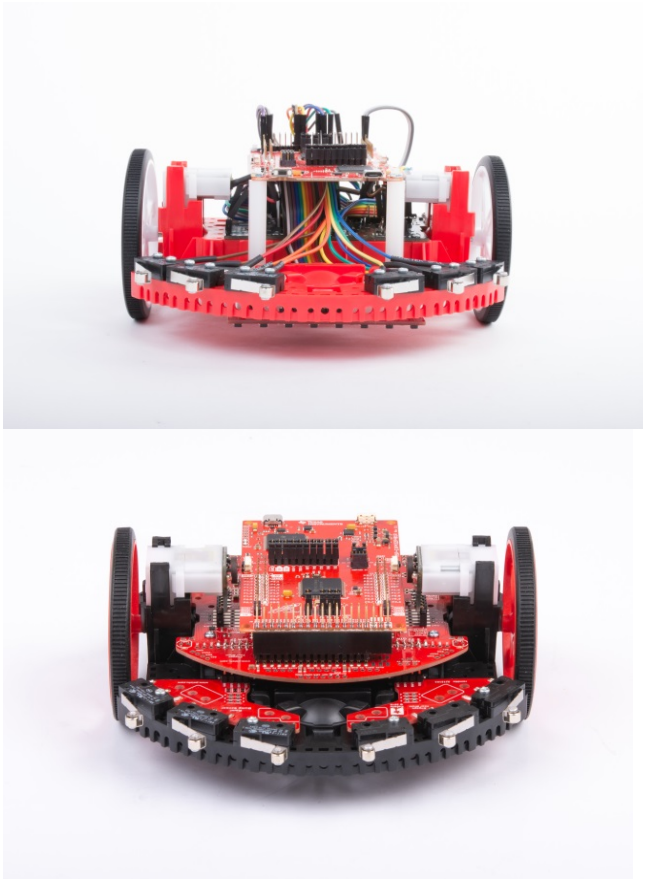

Figure 1: TI-RSLK (Basic) v/s TI-RSLK MAX

1.1. Curriculum focus

There is a fundamental shift in focus from the TI-RSLK to the TI-RSLK MAX, trading some of the **bottom-up** "build the robot as you go" curriculum for the speed and reliability of using pre-soldered circuit boards. In the classic version or TI-RSLK, each module builds on top of the previous module, such that the robot is not completed until module 12 is completed. Although there is a suggested choice for TI SimpleLink™ MSP432 pins and resources, TI-RSLK is very open-ended, such that multiple design choices are possible. For example, although six bump switches on the front are suggested for TI-RSLK, one could have had more or less bump switches, and one could have placed the switches anywhere on the robot. The goal of the TI-RSLK curriculum is to study each of the components (hardware and software), module by module and aggregate the knowledge to finally interface with the robot; then create, build and compete in challenges or solve a maze. This is a natural progression to discover the robot's abilities from a **component-level perspective.**
In the new TI-RSLK MAX version of the curriculum, we "build the robot first" in a more **top-down** curriculum. You also get to test the robot's functionality with test code that is made available to you. The goal is to have something moving and running as early as module 5. With the construction out of the way, you can use modules 6-20 to learn how the system works. Because you have a completed robot at the beginning of the curriculum, it is now more natural to discover the robot's abilities from a **system-level perspective.** You also now have more time for additional coding lessons, deeper learning and extended exercises using the additional material provided in the lab documents. Refer the TI-RSLK MAX user guide for more details.

1.2. Using TI-RSLK for competitions and challenges

Because the sensors and actuators on both platforms are essentially the same, both robots can solve identical challenges.
However, because of the ease of assembly, the new TI-RSLK MAX provides the opportunity for short-time (weekend) and segmented robot challenges. In comparison, the final competition challenge that is provided with the TI-RSLK is more suitable for curriculum where you build the robot component by component in a bottom up fashion, and then use it to solve a master challenge.

1.3. TI-RSLK kits

The TI-RSLK kit comes in two options: basic and advanced. Conversely, there is **a single TI-RSLK MAX** kit with the following features:

- The tachometer is included in the base kit of the TI-RSLK MAX. This, enables you to add more concepts to your courseware such as closed

loop control systems, speed control, sensing and feedback without having to buy additional encoders.

- The overall assembly has also been simplified and does not require additional items or any tools besides a screwdriver.
- The SimpleLink MSP432P401R LaunchPad™ Development Kit comes **pre-soldered with the headers (J5)** needed to connect to the TI-RSLK Max robot chassis.
- The motor driver and power distribution board that was part of TI-RSLK has now been replaced with a more versatile TI-RSLK chassis board which provides power to your robot system. It has connectors that easily allow the LaunchPad and other sensors to plug-in, without soldering.
- The TI-RSLK chassis board offers multiple headers and capability to add accessory options, providing the flexibility to add more components based on your class focus.
- Examples of optional components that are part of the curriculum, but are not part of TI-RSLK MAX kit includes: LCD and OLED displays (for debug and display of the robots movements), pre-assembled Sharp IR distance sensor kit, audio circuits with microphone and speaker to enable robot-to-robot communication and voice command and TI SimpleLink Bluetooth® low energy CC2650 Module BoosterPack™ Plug-in Module and SimpleLink Wi-Fi® CC3100 wireless network processor BoosterPack plug-in module. Batteries ***are not included*** in the TI-RSLK MAX kit to keep the cost low and to enable the use of high capacity rechargeable NiMH batteries with chargers specifically for their local use or country.

1.4. Wi-Fi

In the TI-RSLK MAX, we have switched from CC3120 to the CC3100, which allows Wi-Fi to operate with the robot and use the same software framework as the other labs. TI-RSLK Wi-Fi required TI-RTOS and couldn't be used at the same time as the robot hardware. Programming the TI-RSLK MAX is identical to the other labs, and the Wi-Fi module allows robot data to be streamed onto the cloud. This could be very interesting if you want to add internet of things (IoT) capability to the robot or teach students about cloud computing.

1.5. Modules

We have also added some new challenges and extended several modules such as Module 5, Module 11, Module 15 and Module 20.

2. Similarities and improvements

2.1. Motors and drivers

Both robots use the DC motors with differential drive steering. Both robots use two TI DRV8838s to drive the motors and essentially have the same motor commands (each motor can be powered with 15000 different duty cycles in either direction. The software for both robots uses two pulse width modulation (PWM) outputs (to adjust power) and four general purpose input output (GPIO) outputs (for direction and sleep).

2.2. Tachometer

Both robots use a tachometer/encoder to measure direction and speed of each motor. The TI-RSLK MAX uses a new encoder/tachometer that contains the Hall Effect sensor (TI DRV5013) on the sensor board. The tachometer is already attached to the motor assembly of the TI-RSLK MAX.

2.3. IR line sensor (8 channel QTRX Sensor Array)

Although the line sensor has been updated in the TI-RSLK MAX, the basic operation is essentially the same. The distance between sensors is the same, and the software controller is very similar. However, the new updated sensor has two IR outputs even and odd, while TI-RSLK has one IR output. Both have 8 inputs and take about 1ms to convert. The new sensor array is customized for the TI-RSLK MAX and has extended male headers **already soldered in**, so it is ready to plug directly into the chassis board. No additional wiring required.

TI-RSLK https://www.pololu.com/product/961
TI-RSLK MAX https://www.pololu.com/product/3672
The line sensor on the TI-RSLK MAX is easier to connect than the TI-RSLK.

2.4. Solderless breadboard

Both robots support a small solderless breadboard for flexibility and expansion. The solderless breadboard on the TI-RSLK MAX is easier to connect than the TI-RSLK.

2.5. Educational objectives

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Except for Labs 5, 11, 15, and 20, the educational objectives for the two curricula remain unchanged.

2.6. Additional expansion

Both robots support interfacing components that are not specifically explained in detail within the curriculum. Examples of expansion possibilities include: Lidar or optical sensing using OPT3101 (2020), other distance sensors and Pololu's servo robot arm.

3. Improvements (simpler, faster)

3.1 Construction

TI-RSLK MAX is much easier and faster to build than TI-RSLK. Compare the build times in the table below:

RSLK Base Robot with	TI-RSLK	TI-RSLK MAX
Line sensor, bump, tach, motor	2.5 hours	15 minutes
Plus 3 IR sensors	3 hours	45 minutes

TI-RSLK build times will be slower if one is new to soldering. Building TI-RSLK also requires you to drill (holes for solderless breadboard), cut/strip (wires for cables), solder (wires onto motor power distribution board and J5 MSP432 LaunchPad) and shrink (heat shrink connections). The three Sharp IR sensors on the TI-RSLK MAX require 12 solder connections, otherwise the TI-RSLK MAX essentially snaps together. The pre-constructed components in TI-RSLK MAX should result a more reliable robot.

3.2. Power reliability

Having to connect and disconnect the +5V line from MSP432 to +VREG on motor power distribution board for TI-RSLK could create unsafe and potentially unreliable situation. On the TI-RSLK MAX, the MSP432 Launchpad comes with the 5V jumper permanently removed, using the robot in three modes (just battery, just USB and both battery and USB) is easy and safe.

3.3. LCD, I2C and servo interfacing

The TI-RSLK MAX chassis board has headers for three different display panels, three analog ports, five I2C ports, and three servo ports for interfacing with future components like the OPT time of flight sensor. It uses the same input/output pins on the MSP432 as the TI-RSLK, so the same LCDs, I2C, analog, and servo devices can be connected to a TI-RSLK robot, but will require headers on the board to make it easier to wire up. Please refer to TI-RSLK MAX construction guide document and construction videos.

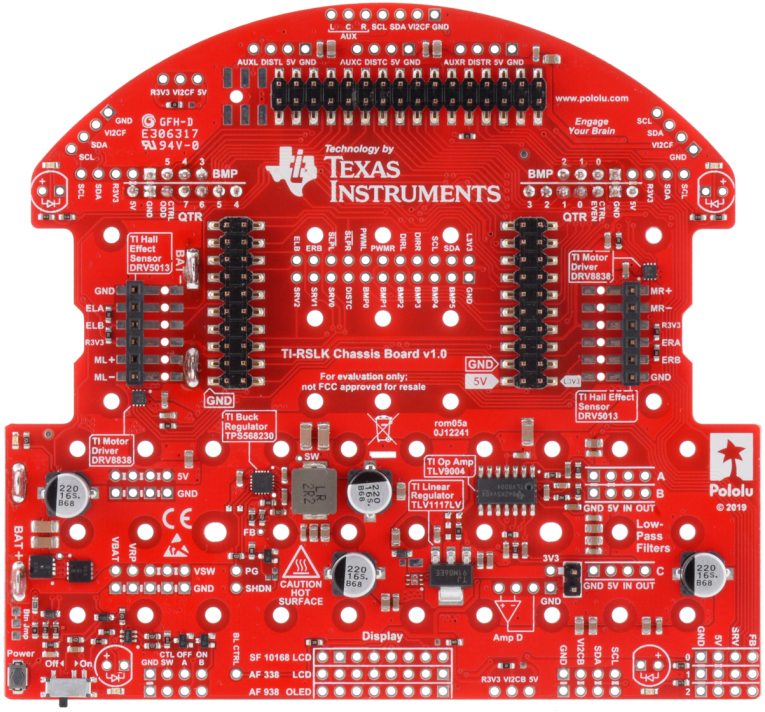

Figure 2: TI-RSLK Chassis board for the TI-RSLK MAX robot

3.4. Analog signal processing

There are three analog LPF for IR distance sensors built into chassis board. There is also one op amp that could be used for other purposes.

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4. New features in TI-RSLK MAX not possible with TI-RSLK

4.1. More current

The regulator on TI-RSLK MAX sources 8A at 5V, as compared to 3A at 5V for TI-RSLK. This extra will allow you to drive multiple servo motors.
However total current load should not exceed 5A to ensure the temperature of the board stays within the temperature requirements.

4.2. More display options

Lab 11 added OLED and UART as options in addition to the LCD. The TI-RSLK MAX robot has 4 LEDs, one in each corner.

4.3. More data acquisition options

Lab 15 added audio input/output as an alternative to the Sharp IR distance sensors. The audio lab allows the robot to play music or allows one robot to send commands to the other via sound. If you can sing with moderately accurate pitch, you can sing commands to your robot.

5. Pin assignment changes (MSP432 pins and resources)

5.1. Moving pins
This means TI-RSLK code will not run on TI-RSLK MAX.

Signal	TI-RSLK	TI-RSLK MAX
Center IR	P4.1	P6.1
Motor DIR_L	P1.7	P5.4
Motor DIR_R	P1.6	P5.5
Tach ERB	P10.5	P5.0
Tach ELB	P9.2	P5.2
Tach ELA	P8.2	P10.5

5.2. Adding new pins
These pins reflect new features like CC3100, LEDs, robot arm and I2C.

Signal	TI-RSLK	TI-RSLK MAX
Arm analog grip	na	P8.2
Arm analog height	na	P8.4
Arm analog tilt	na	P8.3
CC3100 Clk	na	P1.5
CC3100 CTS	na	P5.6
CC3100 NWP log	na	P2.3
CC3100 RTS	na	P6.6
CC3100 SPI CS	na	P3.0
CC3100 SPI MISO	na	P1.7
CC3100 SPI MOSI	na	P1.6
CC3100 WLAN log	na	P5.1
I2C SCL	na	P6.5
I2C SDA	na	P6.4
Reflectance odd	na	P9.2
Servo PWM grip	na	P5.7
Servo PWM height	na	P2.4
Servo PWM tilt	na	P3.5
Front right LED	na	P8.5
Front left LED	na	P8.0
Back right LED	na	P8.7
Back left LED	na	P8.6

The kit consists of the following :

1. Modified SimpleLink MSP432P401R LaunchPad with 2 x19 stackable* female headers and 1x2 female header soldered and ready
2. TI-RSLK kit with Black Romi Chassis and redwheels which includes :
   a. Black Romi Chassis kit with red wheels
   b. TI-RSLK chassis board assembly
   c. 8-Channel QTRX Sensor arrayfor ROMI/TI RSLK MAX
   d. Left Bumper Switch assembly for TI-RSLK MAX
   e. Right Bumper Switch assembly for TI-RSLK MAX
   f. Gearmotor and encoder assembly (2)
   g. 400-point breadboard with special mounting holes and four 1”- long #2-56 M-F aluminium standoffs (with scres and nuts for mounting
3. Cable USB-A to Micro USB-B 0.3M to connect your LaunchPad to PC
4. Male/Femaie Wires (10 pieces)
5. Male/Male wires (10 pieces)
6. Electronic components for lab experiments

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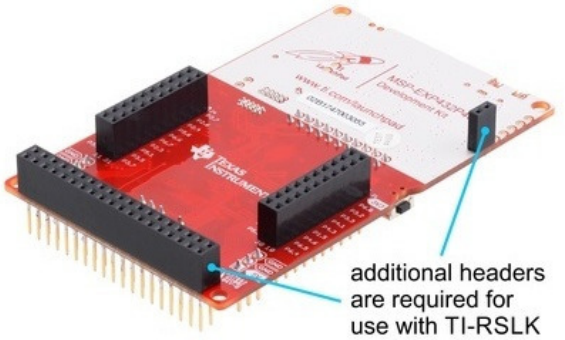
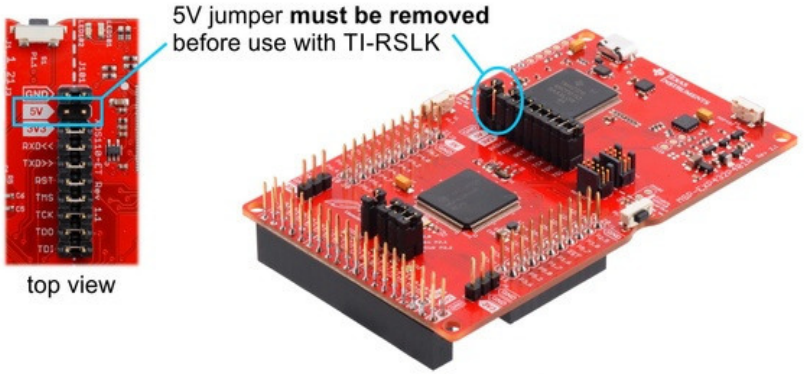
a. LED RED DIFF 5MM ROUND T/H 10mA (1)
b. LED RED DIFF 5MM ROUND T/H 2mA(1)
c. RESISTOR 220 OHM 1/6W 5% AXIAL (1)
d. RESISTOR 470 OHM 1/6W 5% AXIAL(1)
e. RESISTOR 22K OHM 1/6W 5% AXIAL(1)
f. RESISTOR 33K OHM 1/6W 5% AXIAL(1)
g. RESISTOR 10 ohm Wirewound 10W, 5%, Axial
h. CAPACITOR Ceramic, 0.47 µF, 50 V, ± 5%, Radial (2)
i. CAPACITOR Tantalum, 10 uF, 20V, 10%, Radial (3)
j. Tactile push button Switch (3)



WARNING – If you have a LaunchPad that did not come with the TI-RSLK MAX robot kit. Please assemble the MPS432 LaunchPad with a 2 X 19 stackable female header and 1 x2 female header so that it can plug into the TI-RSLK Chassis board for this TI-RSLK MAX robot and the LaunchPad 5V jumper must be removed and disconnected prior to use with TI-RSLK MAX in order to avoid shorting different power rails and potentially damaging the chassis board.



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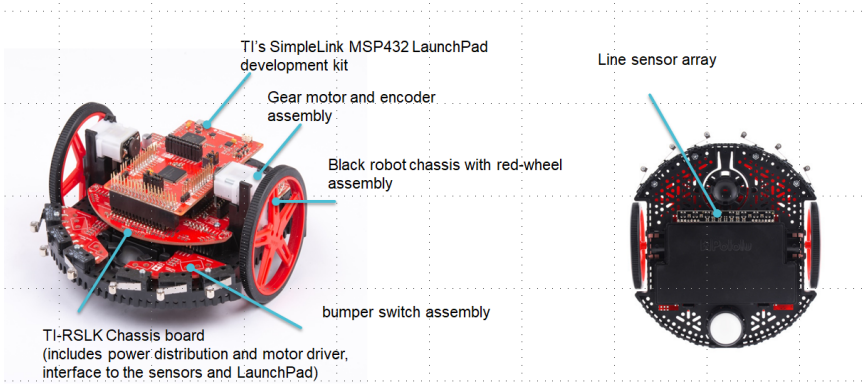
Not included in the kit :

a) Six rechargeable, Nickel Metal Hydride,1300mAH, 1.2V, AA (**required to power the robot)**
b) Black masking tape, maze for line following competition [several modules]
c) TI SimpleLink Bluetooth low energy CC2650 Module BoosterPack Plug-in Module (BOOSTXL-CC2650MA) [module 19]
d) SimpleLink Wi-Fi CC3100 wireless network processor BoosterPack plug-in module (CC3100BOOST) [module 20]
e) Three Sharp GP2Y0A21YKOF analog distance sensors kit (distance sensor kit) [module15]
f) Nokia 5110/3310 monochrome LCD [module 11]
g) Monochrome1.3" 128 x 64 OLED graphic display [module 11]
h) Audio kit for robot to robot communication [module15]
    a. Microphone, TLV9004 on the chassis board or LC2272CP
    b. TPA731(Audio amplifier)
    c. Resistors :1k, 10k, 20k,22k,200k
    d. Capacitors : 100nF ceramic, 220nF ceramic,1uF ceramic,2.2uF tantalum,4.7uF tantalum, SOIC to DIP,8 by 1 male header

In addition to the kit you will need some tools for assembly, in certain portions you may require to solder, please use proper precausttion and follow lab safety rules.



Fuly assembled TI-RSLK MAX robot

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