The Sick LIDAR Matlab/C++ Toolbox: Enabling RS-422 Communication via USB–COMi–M

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February 27, 2008

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Figure 1: (Left) The USB–COMi–M USB to RS–232/422/485 Industrial Adapter can be used to enable the fastest Sick LMS 2xx data rate of 75Hz. It is a popular alternative (in both industry and academia) to the proprietary Sick adapters, which are nearly an order of magnitude more expensive. (Right) The Sick LMS 2xx Data Terminal Block w/ DB–9 Male Connector.

1 Introduction

1.1 Document Overview

This guide shows how to enable 500Kbps serial communication with a Sick LMS 2xx laser range finder via the USB–COMi–M USB to RS–232/422/485 industrial serial adapter. In contrast to the proprietary Sick RS-422 adapters, this device allows 75Hz performance – the fastest data rate possible – at a cost that is nearly an order of magnitude cheaper.

This guide also provides the RS–232 wiring necessary for communication via the USB–COMi-M.

1.2 Target Audience

This guide assumes no prior knowledge of multimeter usage, soldering, etc. Links to other tutorials are included.

2 Equipment

2.1 Parts

1. DB–9 cable (RadioShack Catalog: 26–117)
2. USB–COMi–M USB to RS–232/422/485 Industrial Adapter (Figure 1) (http://www.usbgear.com/USB-COMi-M.html)
3. Sick LMS 2xx data terminal block (Figure 1 (Right))
4. Male DB–9 connector (i.e. 9–Position Male Solder D-Sub Connector, RadioShack Catalog: 276–1537), which should be with the Sick cable block **OR** Female DB–9 connector (i.e. 9–Position Female Solder D-Sub Connector, RadioShack Catalog:

276–1538) and protective hood (RadioShack Catalog: 276–1513), if your cable is already attached to the cable block.

2.2 Tools

1. Solder (RadioShack Catalog: 64–035)
2. Soldering gun (RadioShack Catalog: 64–2802)
3. Multimeter (RadioShack Catalog: 22–816)
4. Wirestrippers/cutters (RadioShack Catalog: 64–2980)
5. Electrical tape (RadioShack Catalog: 64–2375)
6. Heat shrink tubing (RadioShack Catalog: 278–1611) and heat gun
7. Philip's head screwdriver

3 Sick LMS 2xx Serial Protocols

3.1 RS–232

If you ordered cables with your Sick LMS 2xx unit, the data cable should already be attached to the block and be wired for RS–232. Even if you did not order with cables, there is a sticker on the block giving details about the current wiring, and what lines are respectively for RS–232 and RS–422.

Here is what the sticker indicates for RS-232:

```
Sick sensor   PC / USB-COMi-M
    1 ---\  /---- 1
    2 ----\/--\/- 2
    3 ----/\--/\- 3
    4 ---/  \---- 4
    5 ----------- 5
    6     NC      6
    7     NC      7
    8     NC      8
    9     NC      9
```

Lines 1 and 4 cross, 2 and 3 cross, and 5 is straight through. All other pins should have no connections.

3.2 RS–422

To successfully operate over RS–422, however, you'll need to modify the data cable. In contrast to the above, you'll have this:

```
Sick sensor   PC / USB-COMi-M
    1 ----------- 1
    2 ----------- 2
    3 ----------- 3
    4 ----------- 4
    5 ----------- 5
    6     NC      6
    7 --|         7
    8 --|         8
    9     NC      9
```

Lines 1–5 are straight through, and 7 is wired to 8 on the sensor side.

4 Wiring a RS–422 Serial Cable

The instructions that follow assume that there is no cable attached to the Sick cable block. If the cable is already attached to the block, don't take it apart! By removing the female end of the attached cable and soldering a new female connector on, you can save time. Just cut off the female end of the cable and skip to step 5. Remember that you're now attaching a female DB–9 connector instead of a male DB–9 connector.

1. Unscrew male DB–9 end on the Sick data cable block.
2. Unscrew the cap on the opposite side of the block revealing a gray support cylinder for the cable.
3. Remove the black plug from the gray cable support. The easiest way to do this is to remove the grey support cylinder, then poke the plug out with the screwdriver. Replace the gray cylinder after removing its plug. See Figure 2.

Figure 2: (Left) Remove the gray cylinder from the Sick cable block. (Center) Remove the plug by poking it out with a screw driver. (Right) Reinsert the cylinder back into the Sick data cable block.

4. Cut off the non-female end of the DB9 cable. If you have a female-to-female cable, flip a coin.

5. Strip the outer sheathe. You can either use strippers with measurements or very simple strippers. Always start at a measurement you think will be too large and work your way to a smaller cut. See Figure 3.
6. Strip sheathes from the inner wires.

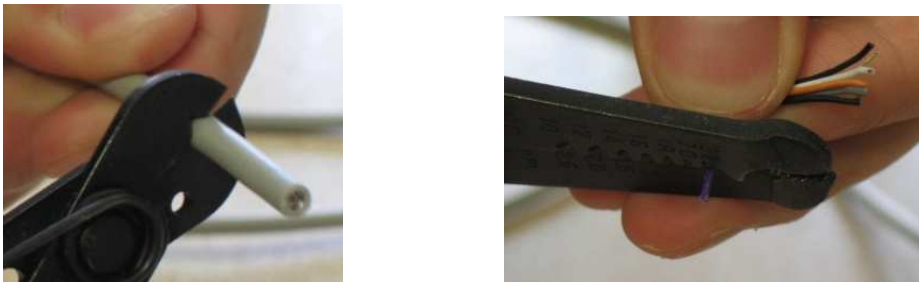


Figure 3: (Left) Strip the outer sheathe from the DB–9 cable. (Right) Now, strip the sheath from each of the inner wires.

7. Identify which wire color matches with which pin. You will only need to identify pins 1–5 as they are the only ones that will be connected.

   Note: Manufacturers may have their own color schemes, but many follow the resistors color scheme - 1-brown, 2-red, 3-orange, etc. The cable used for this tutorial was from Belkin, and has the following setup: 1-brown, 2-black with white stripe, 3-orange, 4-purple, 5-white.

   How to identify the color scheme: Attach a male DB–9 connector to the female DB–9 cable end. Set the multimeter to its continuity–test setting (typically indicated by a symbol that looks like a propagating sound wave). If you do not have such a setting, skip to the next paragraph. Touch the two probes together. The multimeter we used emits a steady beep when there is continuity. Now, wrap or press one of the wires onto either of the probes, and tap the other probe on each of the protruding solder cups of the male DB–9 connector.

   Note: The use of the male connector here is only to make identification easier; it's not a necessary step.

   If there is no continuity setting: Look instead for an ohmmeter setting (typically indicated by a capital omega). If there are multiple such settings (a ranging multimeter), choose one around 200 ohms. If you touch the two probes together, the multimeter should display a number very close to 0, or even just 0. When the probes are apart, it should display 200 ohms, or indicate the value is out of range. Some

out-of-range responses are “OL”, (standing for “open loop”), or ’1.’ It depends on the type of multimeter you have. Now, test for continuity using the method described in the previous paragraph. You won’t get a nice beep, but the ohmmeter will display a value close to 0 (or at least below 200 ohms) when you hit the right pin.
A good tutorial on using a ranging multimeter to measure ohms can be found here: http://www.ladyada.net/library/metertut/resistance.html

Figure 4: Identifying the white wire using the connectivity setting of the multimeter. In this case, a loose male DB–9 adapter was affixed to the female end of the altered cable making it easier to probe and measure the outputs. To measure connectivity (in this case for the the white wire), we hold a single probe (the black probe) to the exposed part of the wire and then test each of the pins on the other end (with the red probe) until the multimeter indicates connectivity.

Figure 4, illustrates the process of mapping the white inner cable to its respective pin number. In this example, the white wire is wrapped around the black probe and the red probe is on pin 5. The multimeter indicates connectivity, so we record pin 5 maps to white.

8. After properly mapping the pins, thread the data cable through the Sick block. Ensure that all the pieces (the cap to the block’s entry point and the block) are in their proper places. Figure 5 (Left) shows what the the cable block should look like after doing this.

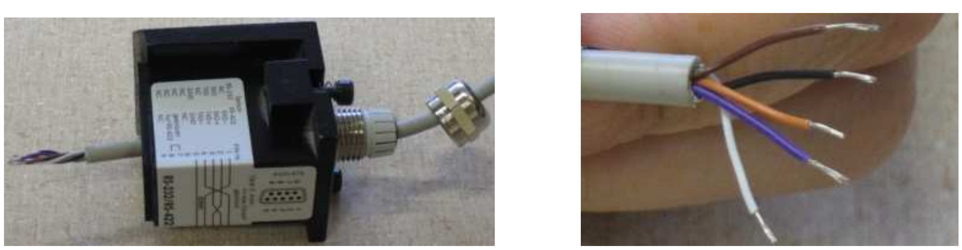
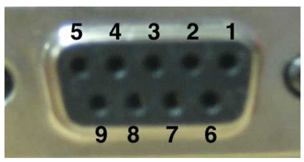


Figure 5: (Left) After properly mapping the inner wires to their respective pins, thread the data cable through the cap and then through the block. (Right) Wires lined up according to the mapping after being threaded, pin 5’s wire is white, pin 1’s wire is brown.

9. Double check that all pieces are in their proper places.
10. Given the wire–to–pin mapping, line up the wires to match the corresponding solder cups on the DB–9 male connector that will be affixed to the data block. Remember, the goal is to have a straight-through connection for pins 1-5. So, the pin labeled '1' on the male end must be connected to the pin labeled '1' on the female end. Remember that the connectors should have the pin number printed next to each pin, and may have the pin number printed next to each solder cup as well. Here is a visual of the pin layouts.

   Note: If you're looking at the soldering cups side, it will be the mirror image of the diagrams appearing in Figure 6!

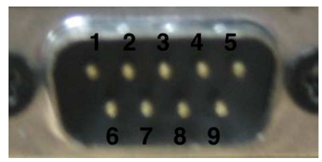
   

   Figure 6: (Left) Female 9–Pin D–Sub Connector (Right) Male 9–Pin D–Sub Connector

   For example, we soldered the brown wire in our cable onto the cup labelled '1', the black–with–white–stripe wire onto the cup labelled '2', etc.
11. Trim the bare wires to fit inside the solder cups. If you're using heat shrink tubing, place a section of tubing on each of the wires and then push the tubing as far away from the exposed wire as possible. You want to avoid heating the tubing with your soldering tip.
12. Solder the exposed wires corresponding to cups 1–5 onto the male DB–9 end.
   For tips on soldering, check here http://www.mediacollege.com/misc/solder/.
   Twisting and then tinning the wires is best. (Note: "Tinning" is essentially "coating with solder." It prevents any bits of wire from sticking out.)
   If you are using heat shrink, wait a little while for the solder and wires to cool. Then, slide the tubing over the exposed wires and soldering cups, and use the heat gun to shrink the tubing around the wiring. Point the heat gun at the heat shrink, turn it on, and move the gun around to evenly heat the tubing up. The wrap will shrink and tighten around the area it's covering.
   Figure 7 (Center) shows what it should look like when completed. Note that the solder is still shiny - dull solder indicates a poor join, possibly caused by removing the heat too quickly.
13. Form a loopback connection by connecting the solder cups for pins 7 and 8. To do this, fill the solder cups for 7 and 8 with solder. Then, preferably with a small or fine solder tip, heat the solder at one pin, feed more solder into the cup, and slowly

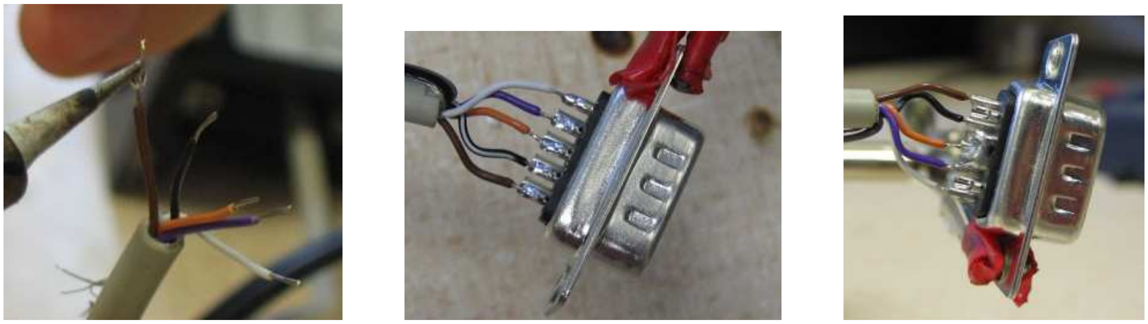


Figure 7: (Left) Tinning the brown wire in our example cable. (Center) Pins 1–5 soldered to the corresponding wires. (Right) Pins 7–8 jumpered for loopback.

> **Safety First!** Heat guns will burn you and possibly melt whatever they're pointed at. Use a low setting, and keep the barrel away from wires, workbench, and self when it's on!

bring the soldering tip to the other cup. The solder should flow to the heat source, and form a bridge between the two cups. It may take a few tries, and you may have to bring the solder along with the tip to the other cup. Just be sure you don't form a bridge between any other pins except for 7 and 8.
You can also simply use some spare wire to form the connection. Strip, trim, and solder it to connect 7 and 8.

> **Note:** A loopback connection must be created, but it doesn't have to be done here. You can also create the loopback inside the USB-COMi-M adapter. However, we recommend that you create the loopback as its shown here so as to avoid having to tamper with the adapter.

14. Trim the extra, non-soldered wires. You may also want to wrap all of the wires in electrical tape, to bundle them up.
15. Screw the male DB–9 end back into the block
16. Screw on the cap of the block's cable entry point. Depending on the diameter of the selected serial cable, you may notice a gap between the cable and the cap. If you plan on using the Sick outdoors, you should plug this gap. Electrical tape is an easy solution to this problem. Simply wrap the cable with electrical tape at that point until the gap is filled.

You should now have a fully–functional RS–422 cable for your Sick LMS 2xx. Check the connections by using the multimeter to verify continuity from pin to pin as well as discontinuity between pins that should not be connected. Once continuity has been checked,

Figure 8: The final assembled data block terminal for the Sick LMS 2xx.

the cable is ready for use. Simply reconnect the cable block to your Sick. Figure 8 shows what the finished block will look like.

5 Using the USB-COMi-M

Figure 9: USB–COMi–M jumper configuration for RS-422 communication.

You can use the USB–COMi–M to adapt the female end of the Sick LMS 2xx RS–422 cable. Doing so will allow the device to stream at any of the following baud rates: 9600bps, 19200bps, 38400bps, or 500Kbps. However, you must first ensure that the USB–COMi–M is jumpered for RS–422 communication. Particularly, you must ensure that each of the pins on the device are set to "ON" as shown in Figure 9.

Note that the jumpers (i.e. DIP switches) are marked on the top of the box as "SW." It's also worth mentioning that if you flip jumper 1 to the "OFF" position, the USB-COMi-M will convert RS–232 signals to USB. However, this requires a separate cable corresponding to the layout given in Section 3.1.

Attention Ubuntu Users: If you are using the USB–COMi–M adapter under Ubuntu Feisty Fawn or newer, be sure to uninstall *brltty* and *brltty–X11* (using synaptic is the easiest way). Otherwise, you will not see a /dev/USBx device. By default, they grab the USB serial device, preventing it from showing up under /dev/. Once uninstalled, reboot your machine and reconnect your USB–COMi–M adapter. You will now see the /dev/ttyUSBx device path associated with your Sick LMS unit.