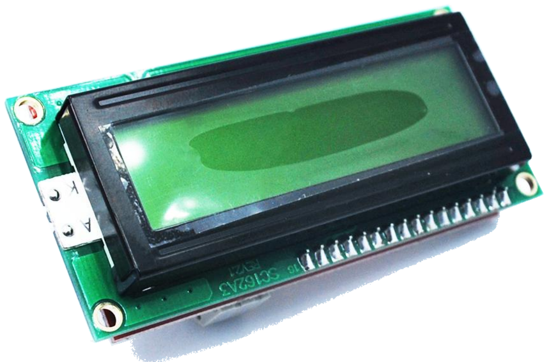
e-Gizmo

Load Cell Display Unit **LDU**

Hardware Manual
Rev. 1r0



Serial LCD II with 2x16 characters LCD display module

(See the HX711 datasheet) for the schematic

HX711 Loadcell amplifier (Weighing sensor breakoutboard)

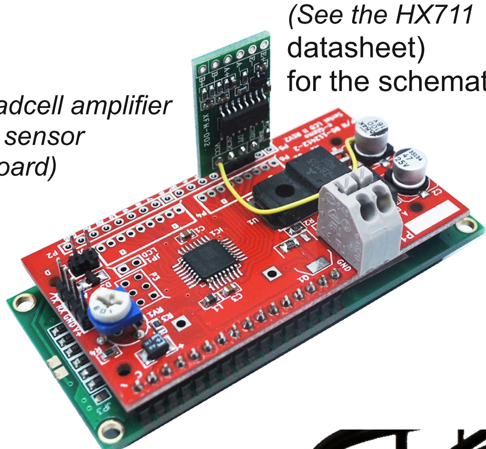


*Figure 1. Loadcells Available 3kg to 400kg (*Optional)*

Summary of Features

- 2 x16 LCD Display

- 24-bit Sigma Delta ADC converter

- 4 + 1 digit precision

- Accepts 3kg to 400kg capacity load cell

- UART control (TTL Level)

- Comparator Function

The LoadCell Display Unit LDU is a general purpose load cell amplifier used mainly in electronic weighing applications. It works with strain gauge type load cells of various load capacities. It uses a 24-bit delta-sigma ADC that gives it a full 4 digit precision at 1 acquisition per second display rate without the use of any expensive input signal conditioning circuit. 5-digit precision (available only through UART port) is possible with long average and slower acquisition rate.

An LDU + load cell system will make a stand alone electronic weighing scale unit. Using the UART connectivity enables you to use all available features, including remote commands that make LDU integration into an automated weighing system easy. UART based control commands allow you to setup the comparators, calibrate the LDU, modify its data acquisition and precision, and collect weighing data.

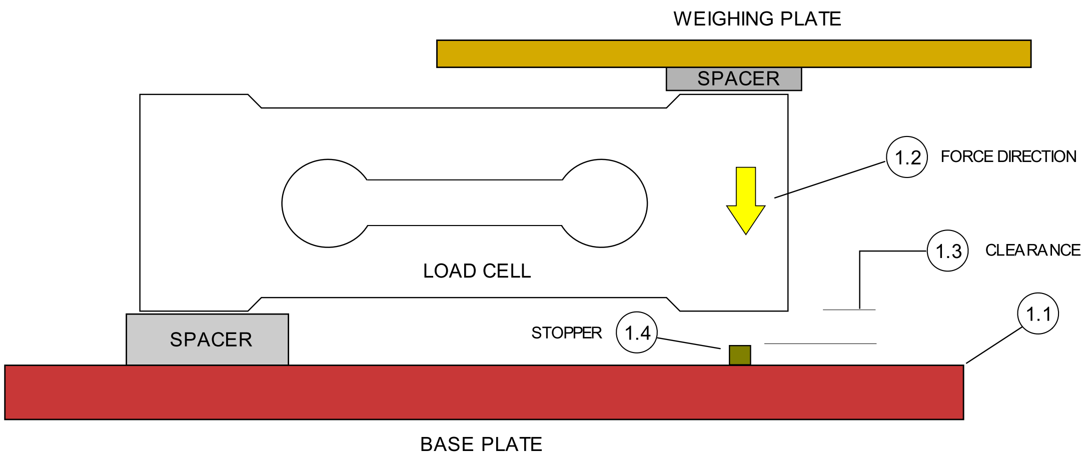


Figure 1.1 Preferred load cell mounting scheme. Side view projection.

1. LOAD CELL INSTALLATION AND USAGE GUIDE

The load cell is a delicate sensor and must always be handled with care.

1.1 The load cell must be mounted securely on a rigid base plate.

1.2 Note and install the load cell so that the direction of weighing force corresponds to the indicated direction.

1.3 Sufficient clearance between the base and bottom of the load cell must be ensured to allow the unimpeded downward deflection of the load cell operating at full load.

1.4 Do not overload the load cell. To prevent damage due to excessive overloading, a hard stop must be installed.

1.5 Make sure the load cell is on a level surface during use.

1.6 Sufficient slack in the load cell wiring must be ensured at all times.

1.7 Do not leave weight on for an extended period of time.

2. PREPARATION FOR USE

The LDU borrowed the PCB of an existing kit - do not be alarmed if you find the markings as that of the Serial LCD II - with an HX711 ADC board already installed. You need to install your load cell sensor and a push button switch as follows:

2.1 Connect a Load Cell as shown in Fig 2.1 and Table 1.1.

2.2 Connect the ZERO/TARE push button switch.

2.3 Power up and test the unit. The LDU should display a zero kg reading. Test the load cell by putting a weight on it. The LDU should display a positive weight, probably incorrect, until you perform the calibration procedure as described next.

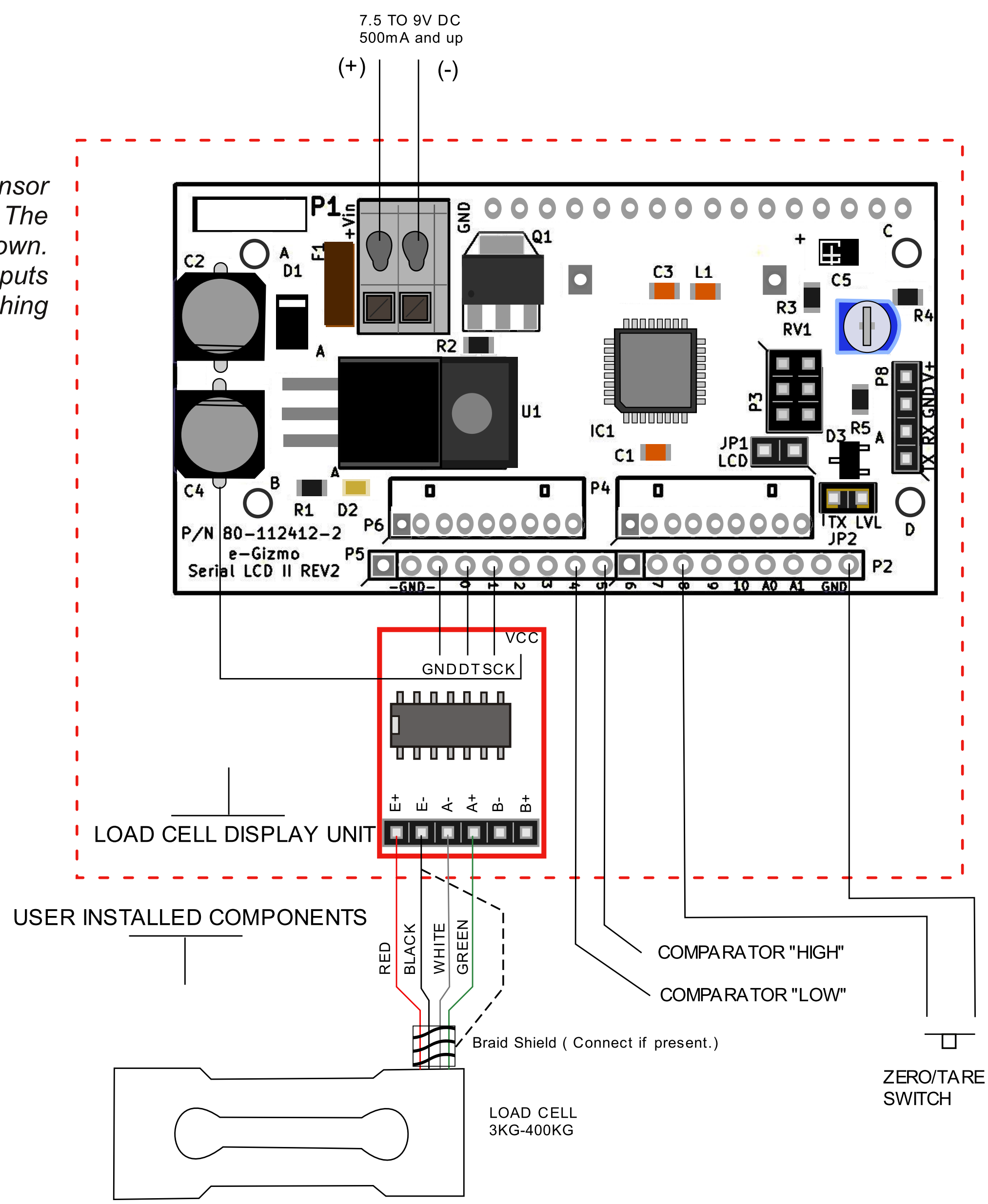
Table 1.1 Load cell to HX711 board Wiring

PIN HX711	WIRE COLOR LOAD CELL	DESCRIPTION
E+	RED	Exciting Voltage (+)
E-	BLACK (& Shield)	Exciting Voltage (-)
A-	WHITE	Input (-)
A+	GREEN	Input (+)

* Connect load cell braid shield to E- whenever applicable.

** Your load cell may have a color coded wiring different from that shown in the table. Check your load cell datasheet for the correct wiring if your load cell would not work with the LDU.

Figure 2.1 Wiring a load cell sensor and TARE switch to the LDU. The comparator outputs are also shown. These 5V TTL compatible outputs can be used for automated weighing applications.



3. CALIBRATION

Equipment Needed:

- A PC running a Terminal program.
- USB to TTL converter kit or equivalent.
- A known test weight (see text)
- An accurate electronic weighing scale if you don't know how much your test weight weigh.

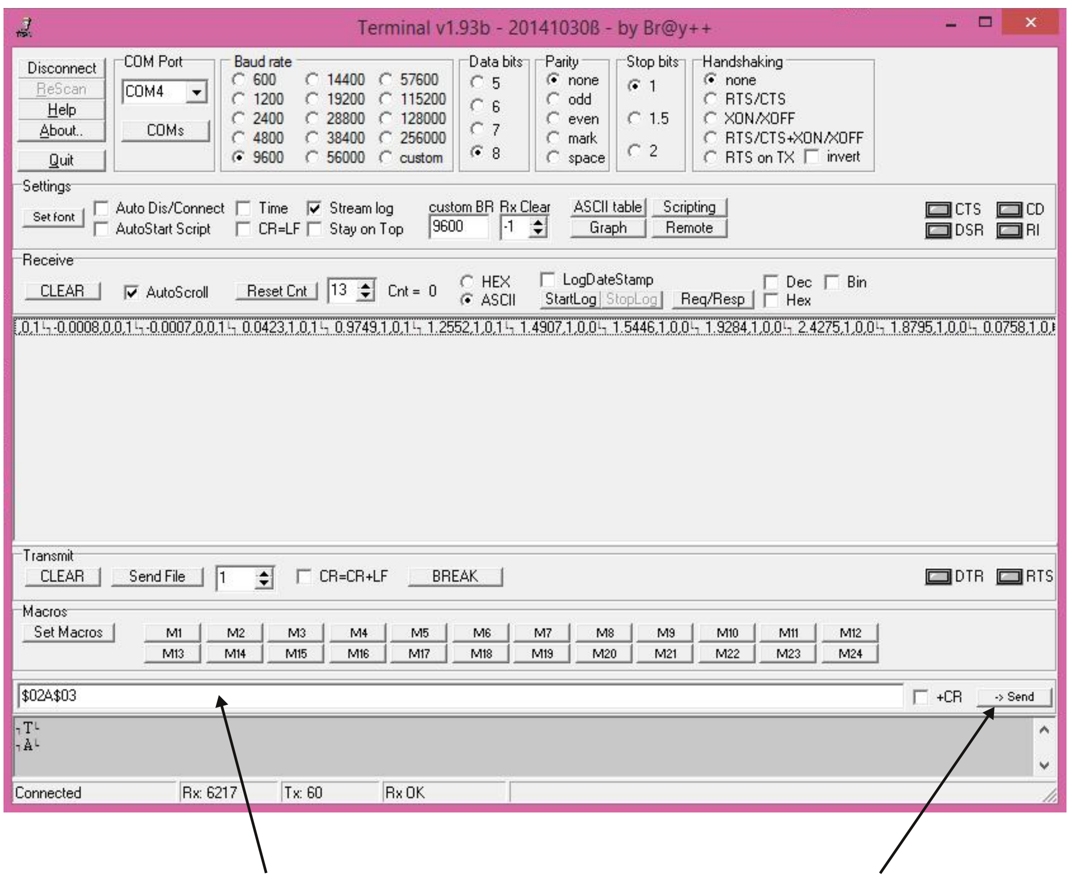
With the LDU weighing system operational, you are now ready to calibrate your unit. Note that if you purchased the LDU together with the load cell at e-Gizmo, *calibration for system up to 40kg will be performed for you in-store free of charge. Note further that we do not have the facility to perform calibration for load cells capacity in excess of 40kg, please understand this cases will be entirely a user responsibility.*

The test weight can be any convenient object with an accurately known weight. The test weight should weigh at least half of the full capacity of the load cell to get the best calibration accuracy. Using a borrowed accurate electronic weighing scale as the reference, measure and record the weight of your test weight.

In this procedure, we will use a popular PC freeware terminal program

Terminal v 1.9b by Br@y++

This terminal program, among others, allows the user to send non-printable ASCII character (i.e. The ETX and STX wrapper) quite easily, hence is particularly suited for manually controlling and calibrating the LDU. You should spend time studying the command set as detailed in section 4 in order to qualify yourself for this task.



COMMAND WINDOW

[SEND] BUTTON

Figure 3.1 A PC running the Br@y terminal window can be used to test and manually control the LDU.

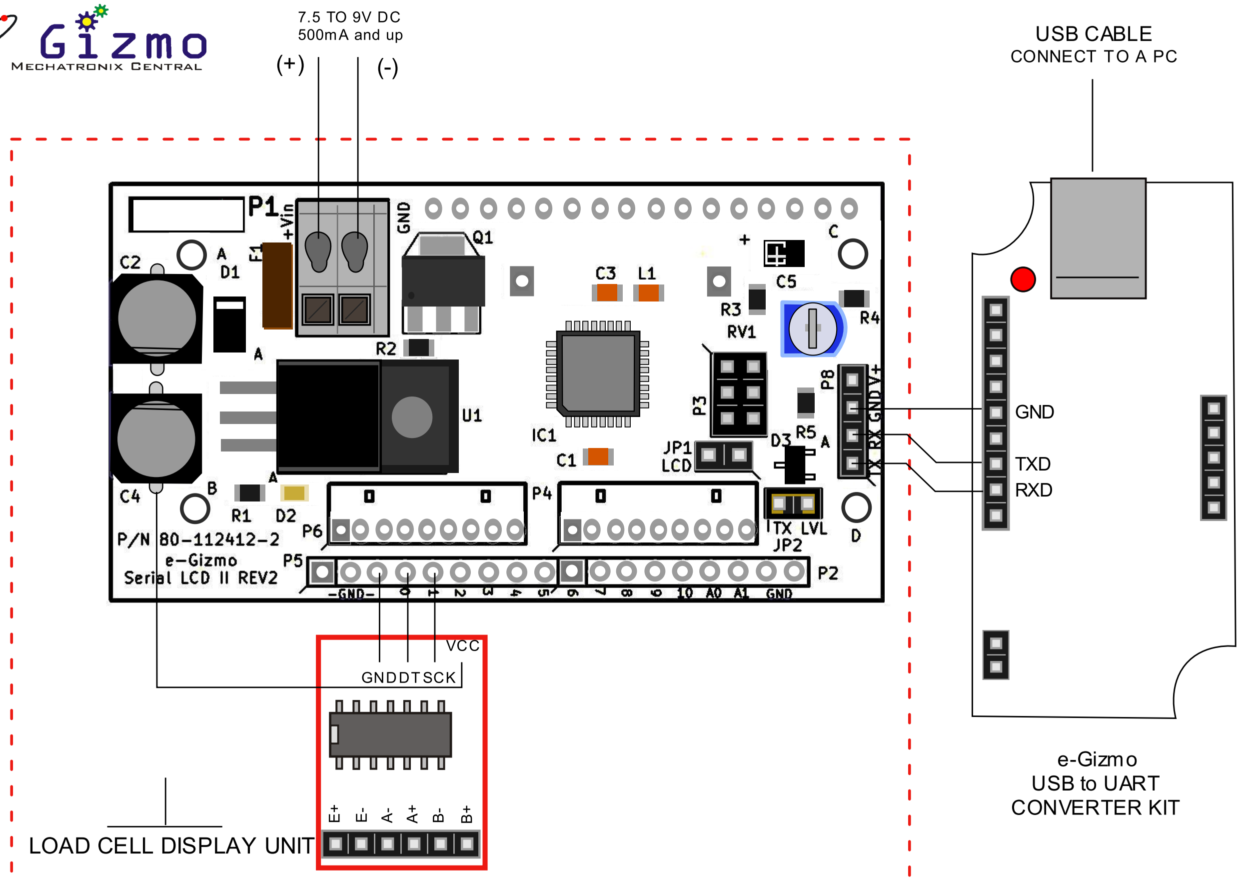


Figure 3.2 A USB to UART converter is required to connect the LDU to a PC. The USB converter will appear as a COM Port to your PC. Determine what COM your PC did assign the USB to UART converter, and enter accordingly as your Br@y terminal COM Port.

3.1 Setup the terminal program by clicking the communications parameters as follows:

Baud Rate - 9600
Data bits - 8
Parity - none
Stop bits - 1
Handshaking - none

The text box with un-greyed background located near the bottom is the command window - this is where you type your commands. The [SEND] button located in far right of the command window, once clicked, will send to the LDU whatever you type in the command window.

3.2 Select the COM Port where your LDU is connected and then click the [Connect] button. If your setup and connections are correct, you should see your screen slowly filled with patterned numbers. Those are the data streams periodically sent by your LDU.

3.3 Type $02**G**$03. This is equivalent to sending the G command wrapped in STX ($02) and ETX ($03), as represented by [STX]**G**[ETX] explained in detail in the communications section. click [SEND] button and watch the terminal window. LDU data sending should stop, and you should see an “OK” response at the end of the displayed data stream.

3.4 You are now ready to setup the decimal point placement of your LDU. You do this by typing (and clicking [SEND]):

$02**P**1$03 - if your loadcell capacity <10kg (Display in x.xxx format)
$02**P**2$03 - if your loadcell capacity <100kg (Display in xx.xx format)
$02**P**3$03 - if your loadcell capacity >10kg (Display in xxx.x format)

3.5 With nothing on the measuring plate of the load cell, type $02**Z**$03 and click [SEND]. You just instructed the LDU to perform a zero reference calibration. The LDU display will indicate this in progress, and then send a second "OK" to your terminal window once completed.

3.6 Put on the test weight very carefully. And then after letting it settle for a few seconds, enter the weight value as described in section x.7 (C calibrate command).

Example 1: if your test weight is 2.725 kg

Type $02**C**2725$03 and then click [SEND]

Example 2: if your test weight is 60.236 kg
Type $02**C**6023$03 and then click [SEND]

Remember, the C command does not like decimal points, and only the four most significant digits should be entered.

Check the LCD display, the LDU should be displaying the correct weight now, give or take a small variation in the least significant digit. Otherwise, repeat steps 3.5 & 3.6 until the correct weight is displayed.

3.7 Finally, you want your LDU to remember your setup and calibration, even after power is removed from the unit.

Type $02**S***$03 and then click [SEND]

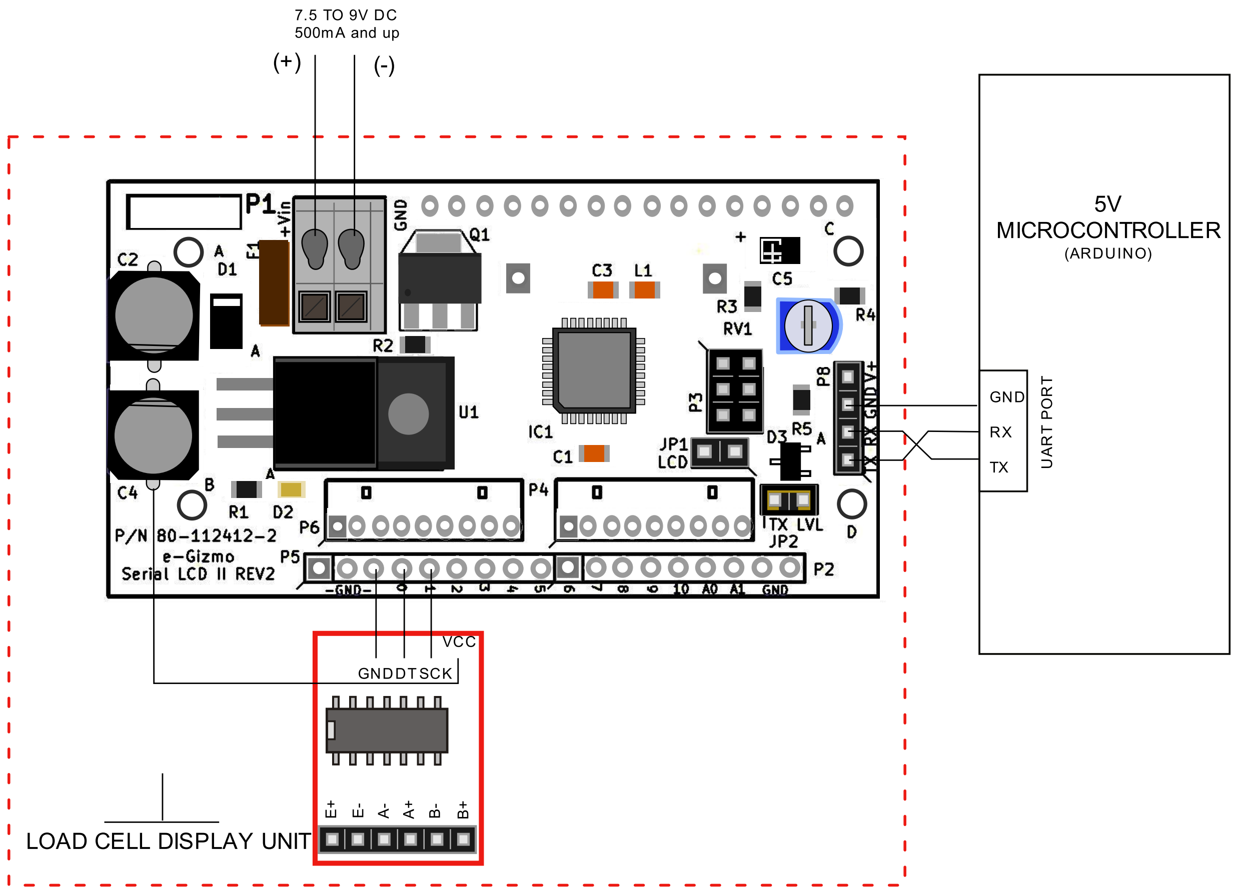


Figure 3.3 The LDU can be controlled by a Microcontroller equipped with a UART board, such as Arduino, ATMEGA and PIC microcontrollers. Note that the LDU TX and RX lines are cross connected to the MCU's TX and RX lines.

4. COMMUNICATIONS MANUAL

Baud Rate:	9600
Data:	8 Bit
Parity:	none
Handshake:	none

Summary of Functions

Z - Tare/Zero reference display
H - Set High trigger for comparator
L - Set Low trigger for comparator
P - Set display decimal point position
R - Sampling Rate and averaging
I - Stable trigger
C - Calibrate to this weight
S* - Save current settings (to NVRAM)
G - Get a measurement. This will also halt continuous auto weighing.
A - Resume auto weighing
T - test

Important:

Communications Format

Every packet of data transmission are wrapped inside an [STX] and [ETX] marker.

[STX] – Start of transmission marker, ASCII value = 0x02
[ETX] – End of transmission marker, ASCII value = 0x03

The first character after the [STX] marker is a single character function specifier. Each transmission may contain just a function specifier only, or may contain a series of data in addition to the function specifier. End of transmission is signaled by the [ETX] marker.

[STX] and [ETX] are data packet markers and should not be transmitted as a literal string. They should be sent in their ASCII representation. The correct way of transmitting the [STX] and [ETX] markers are as shown in the following example:

Example 1: Test

Transmission Format: Format: [STX]T[ETX]

This should be transmitted in their ASCII code representation as shown in the following table:

Symbol	STX	T	ETX
Hex	0x02	0x54	0x03

Visual Basic:

Correct:
```
' correct way to send [STX] & ETX  marker
Serial1.print(chr(2)+"T"+chr(3))
```

Wrong:
```
Serial1.print("[STX]T[ETX]")        'WRONG!
```

Arduino:

Correct:
```
Serial.write(0x02);  //correct way to send [STX]

Serial.print("T");
Serial.write(0x03);     // [ETX] marker
```

Wrong:
```
Serial.print("[STX]T[ETX]");          // WRONG!
```

Alternately, you can use the C/Arduino "\" operator to send the ASCII code of STX and ETX, together with the function and data:

```
Serial.print("\002T\003");      //"\002"=STX,
                                "\003" = ETX
```

Notice that in the example, only the STX and ETX marker need to be manually converted to their ASCII code, for the simple reason that they have no equivalent printable characters. The three line implementation (long format)may make your program longer, but is more human readable. Hence, for clarity, all example codes given are shown in the long format. We leave it up to you if you want to convert and code it in short format.

Receive Packet

After an acquisition is completed, the LDU will dump the results in the UART port in the following ASCII character format:

[STX]w,u,o,c[ETX]

where:
w = weight in kg, 5-digits + decimal point
u = unstable indicator, 0 - stable 1 - unstable
o = overload indicator, 0 - normal 1 - overload condition
c = comparator indicator, 0 - In Range 1- Low 2- High

Example:

[STX]***09.825,1,0,2***[ETX]

w = 09.825 Kg
u = 1 (unstable)
o = 0 (normal)
c = 2 (Weight exceeded comparator HIGH setting)

Important: Weight precision is highly dependent on averaging and range. 4 digit precision can be obtained with 10 or more samples. 5 digit precision requires more than 50 samples. See function (.5) for more details.

Function Description

Important: All settings made through the following functions are temporary and will return to its old saved value once the LDU is power cycled. If you want to keep the current settings as your new instrument saved value, you should perform the Save settings (.8) function.

4.1. **Z** – Zero/Tare

Set the current weight as the zero reference and display it as "0.000". Tare-ing takes about 5 secs to complete.

Caution: Be careful not to exceed the specified maximum of the load cell. For example, If you tare a 30kg load cell with a 10kg load, its maximum capacity is now reduced to 30-10 = 20kg.

Format: [STX]**Z**[ETX]
Reply:[STX]OK[ETX] after tare completion.

4.2. **H** - Set HIGH trigger for comparator

Format:[STX]**H**nnnn[ETX]
Reply: [STX]OK[ETX]

where: nnnn - 4 digit set value, 0-9999
Note: Do not include a decimal point in the entry.

Example:
With the display unit decimal point set for "00.00" display
[STX]H1234[ETX] will set the high trigger to 12.34
[STX]H0123[ETX] will set the high trigger to 01.23

While [STX]**H**123[ETX] will have the same effect as [STX]**H**0123[ETX], it is best to always enter parameters in 4-digit format to minimize unexpected behavior. Entering nonnumeric characters, including decimal point, will give unexpected results, hence, should be avoided.

4.3. **L** - Set LOW trigger for comparator

Format:[STX]**L**nnnn[ETX]
Reply: [STX]OK[ETX]

where: nnnn - 4 digit set value, 0-9999
Note: Do not include a decimal point in the entry. (see 4.2 for more details)

4.4. **P** - Set decimal point position

Decimal point position left to the most significant digit.

Format:[STX]**P**n[ETX]
Reply: [STX]OK[ETX]

where: n - 1 to 3

Example:
For load cell capacity < 10kg.
Send [STX]**P**1[ETX] to fix the decimal point for x.xxx display format.

For load cell capacity < 100kg.
[STX]**P**2[ETX] will fix the decimal point for xx.xx display format.

For load cell capacity > 100kg.
[STX]**P**3[ETX] likewise will result in xxx.x display format.

4.5. **R** - Sampling Rate/Averaging

Averaging is used to cancel the effect of noise that is ever present in a system. Generally, more samples result in better precision but requires longer waiting period to get the results.

Format:[STX]**R**nnn[ETX]
Reply: [STX]OK[ETX]

where nnn = sample size. 1-100

Each sample takes about 0.1s to to complete, hence nnn=10 (default) will require 0.1 x 10 = 1sec to complete. 5-digit precision may be possible with nnn>50.

4.6. **I** - Not Stable indicator

The weighing display unit features a “Not Stable” indicator appearing in LCD display as an asterisk following immediately the "kg" display. The UART data stream also carries this indicator. This indicator appears (value=1 in the data stream), whenever short term variations in the average value taken exceed the specified limit. This can be a useful indicator where there is little room for error is afforded and/or when the load cell display unit is used in automated systems.

Format:[STX]**I**nnn[ETX]
Reply: [STX]OK[ETX]

where nnn = Stable criteria, 5-200

Larger **I** values correspond to a more relaxed criteria and vice versa. This indicator is meaningless whenever the Sampling Rate R is set to 1.

4.7. **C** - Calibrate to “this” weight”

To calibrate the Load Cell display unit, a known test load is put onto the load cell unit, and you let the Load cell Display unit calibrate itself by entering the test load weight through this function.

Format:[STX]**C**nnnn[ETX]
Reply: [STX]OK[ETX]

where nnnn = 4-digit test sample weight
Note: Do not include a decimal point in the entry. (see 4.2 for more details)
See Section 3 "Calibrating your Load Cell Display Unit" for additional details

4.8. **S*** - Save current settings

All new settings entered via the UART functions are temporary in nature and will be lost once the power is cycled. This will allow the users to programmatically tweak the behavior of the LDU without permanently losing the saved settings. If you wish to reconfigure your LDU to power up with this new setting, the Save S* request must be sent.

Format:[STX]**S***[ETX]
Reply: [STX]OK[ETX]

Previously saved settings will be lost and replaced by the new settings.

4.9. **G** - Get a weight measurement.

The LDU will transmit a latest set of weight measurement data and at the same time stop auto weighing and transmission activities, effectively putting the LDU in data on demand mode. Use this command as often as you like to obtain a latest weighing data set.

Format:[STX]**G**[ETX]
Reply: Weight Data Set followed by [STX]OK[ETX]

4.10. **A**- Resume Auto Weighing

This will put back the LDU in the default continuous measurement and data transmission mode.

Format:[STX]**A**[ETX]
Reply: [STX]OK[ETX]

4.11. **T** - Test

Used primarily to test the UART port.

Format:[STX]**T**[ETX]
Reply: [STX]OK[ETX]

5. PCB LAYOUT

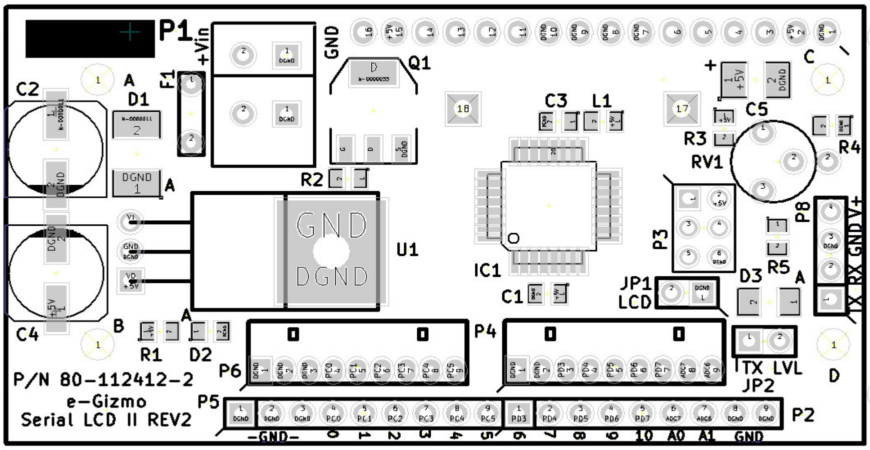


Figure 5.1. Silkscreen Guide

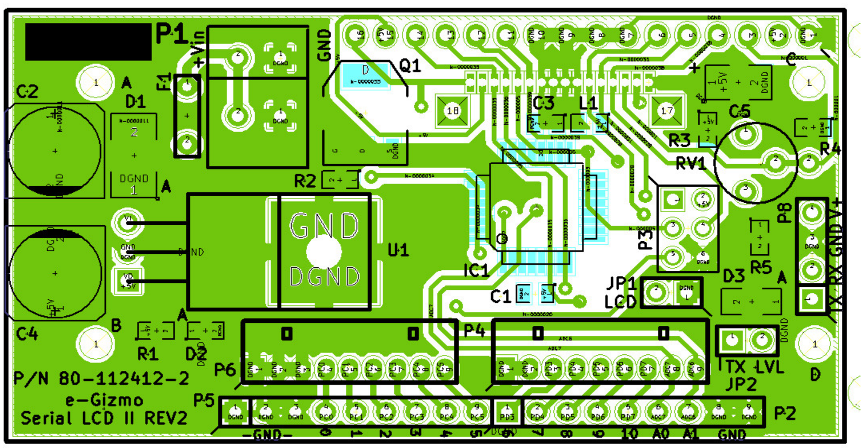


Figure 5.2. Bottom PCB Layer

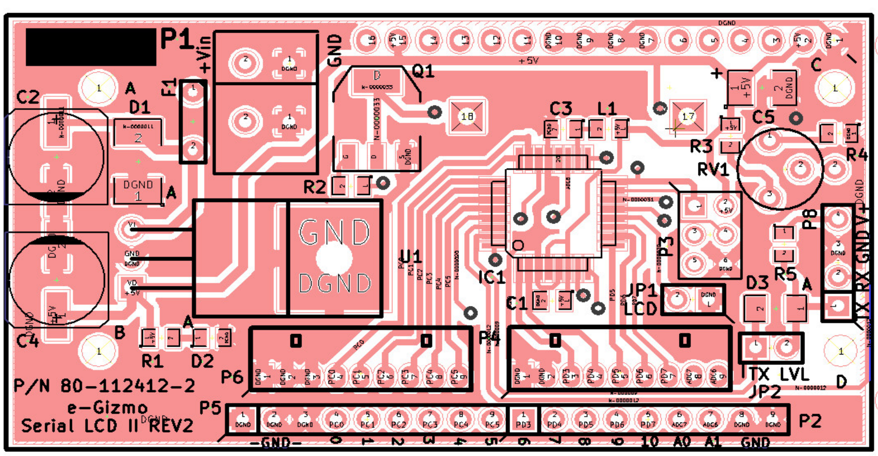


Figure 5.3. Top PCB Layer

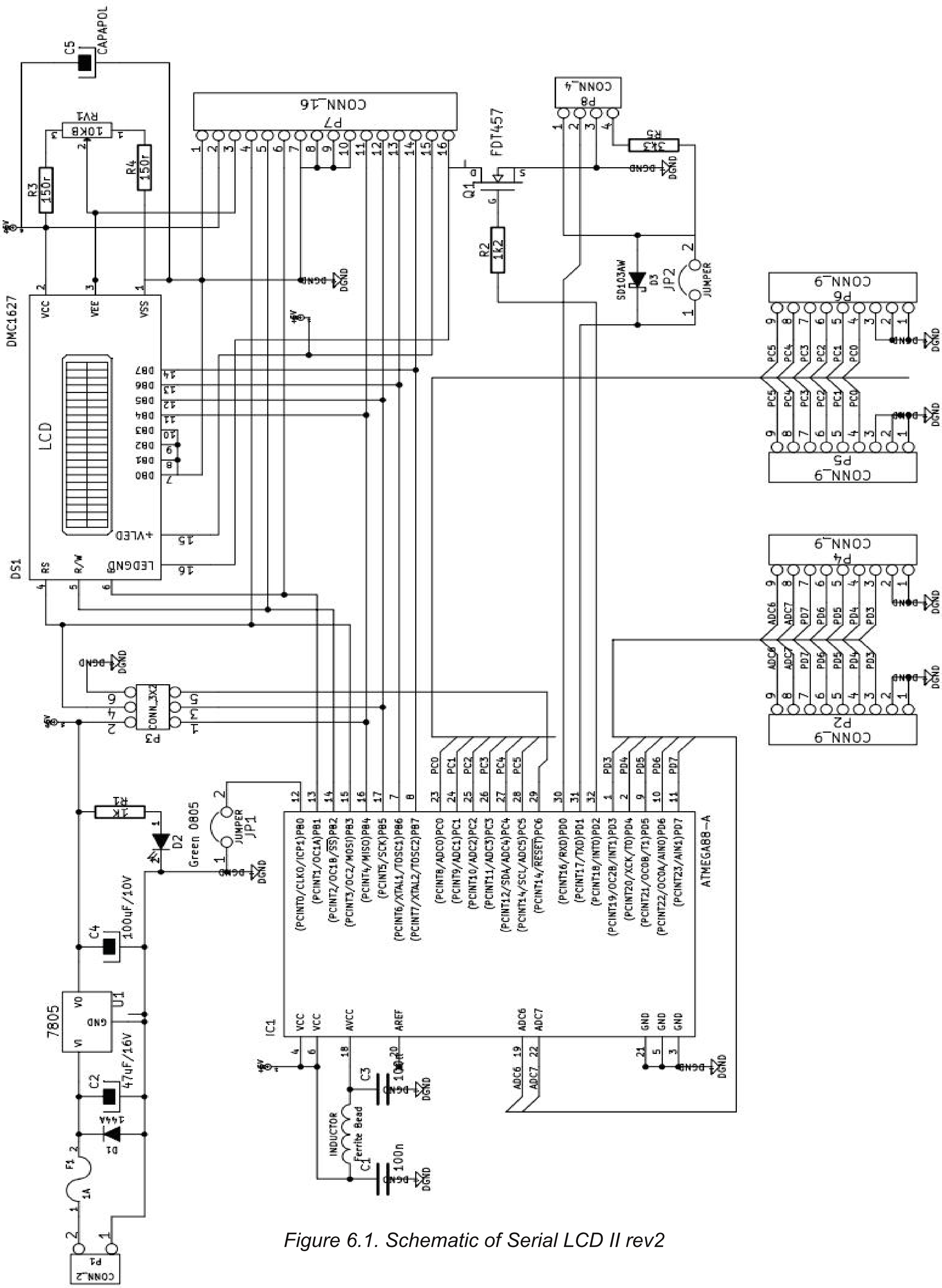


Figure 6.1. Schematic of Serial LCD II rev2

7. SAMPLE DISPLAY APPLICATIONS

Figure 7.1. StartUp Display

Calibration:

if your test weight is 2.725kg,
*$02***C2725***$03*

if your test weight is 60.236kg,
*$02***C6023***$03*

*$02***L1000***$03*

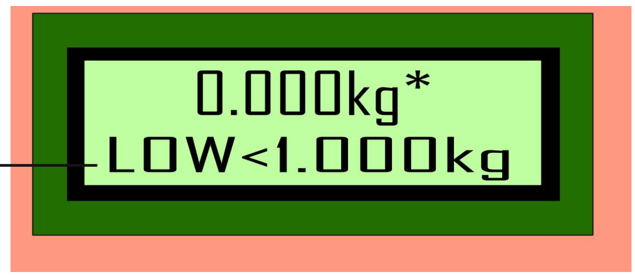
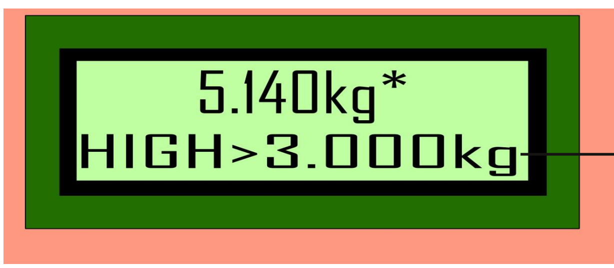


Figure 7.2. SettingUp LOW trigger comparator



*$02***H3000***$03*

Figure 7.3. SettingUp HIGH trigger comparator

*$02***Z***$03*

*$02***S*** *$03*
Save Current settings

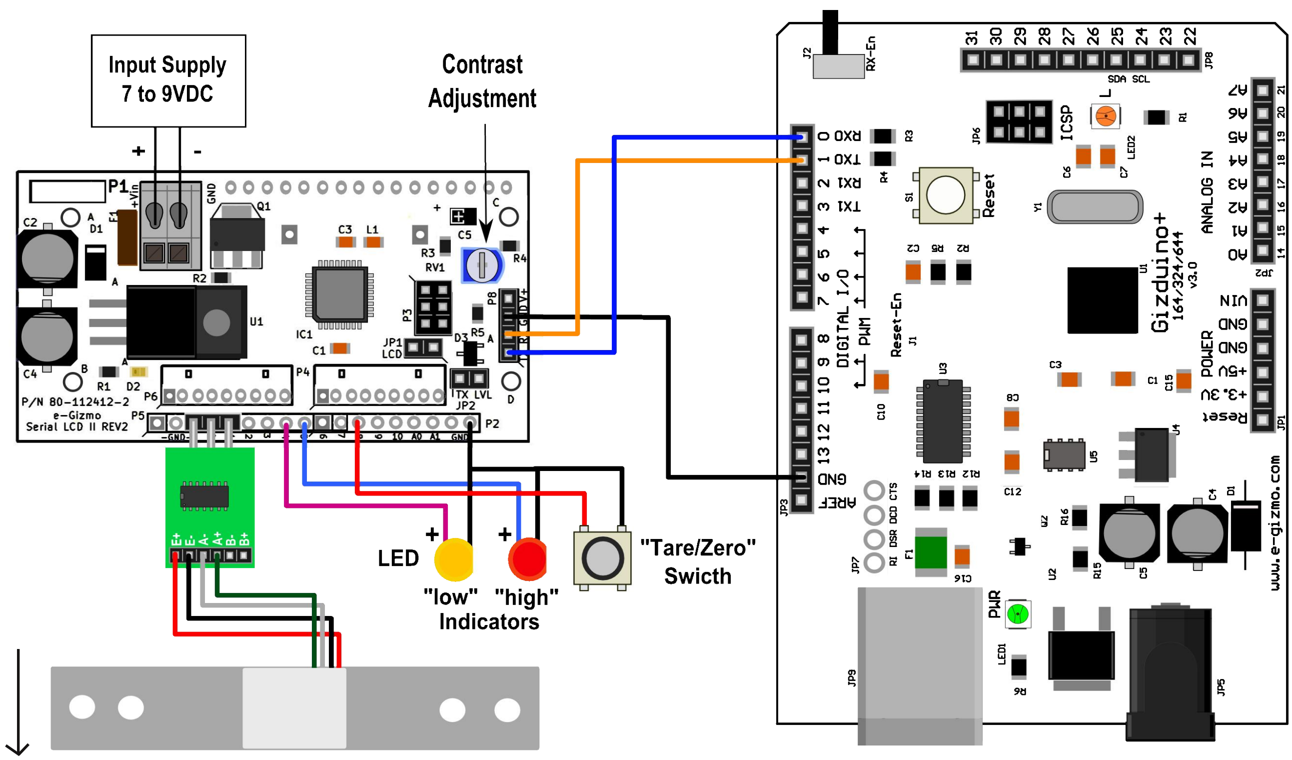
Figure 7.4. Pressing the TARE/ZERO Switch Display.

8. SAMPLE APPLICATIONS WITH GIZDUINO + 644P

Wiring Connections:

Loadcell Display Unit ----> gizDuino +

RX	---->	TX0(pin1)
TX	---->	RX0(pin0)
GND	---->	GND(Ground)
Load cell (ex. 3kg)	***---->***	***Weighing sensor***
Red wire	---->	E+
Black wire	---->	E-
White wire	---->	A-
Green wire	---->	A+



Example LOAD CELL (3kg) connections

GizDuino + w/ATmega644P

Wiring Connections:

Loadcell Display Unit ----> LEDs Indicators

pin4(D4)	---->	"Low" Comparator
pin5(D5)	---->	"High" Comparator
GND	---->	GND(Ground)
Weighing sensor	***---->***	***Loadcell Display Unit***
GND	---->	GND (Ground)
DT	---->	pin0(D0)
SCK	---->	pin1(D1)
VCC	---->	+5VDC

Figure 8.1 Sample Application of Loadcell Display Unit with gizDuino + w/ ATmega644P