Operating manual of display

TSDZ2 open source firmware v20.1C.6-update-1
modified version of 20 beta 1 (C)
adapted to the stock displays, VLCD5 - VLCD6 - XH18

Before using the display and the bike, carefully read the manual and the parameter configurator guide.
Consult the laws of your country relating to road traffic with pedal assisted bikes.

The basic operation of the displays remain the same with the Open Source Firmware (OSF).
The following descriptions will never refer to the name of the key used but to the function called, this is because on the various displays, the functions can be called by different buttons.

In particular, we will use:	"lights"	- VLCD5 and XH18, (on/off) power button. - VLCD6, (-) button 2 seconds.
	"walk assist"	- VLCD5, (-) button 3 seconds. - VLCD6, (+) button 2 seconds. - XH18, throttle "Down" 5 seconds.
	"change of level"	- VLCD5 and VLCD6, (+) or (-) button. - XH18, throttle "Up" or "Down".

The lights button is always active to turn the lights on and off if pressed once.
The additional functions can be recalled with a combination of the lights button, pressed twice consecutively (on/off) and the selected level.

There are two ways of using the display, data display and parameter setting.
The function to view the data is "Auto display data" (default enabled), the one to set parameters is "Set parameters" (default disabled). They can be enabled or disabled at the same time.
The default values can be changed in the configurator, or on the display by saving the configuration in eeprom.

DATA DISPLAY

In this mode it is possible to view on the display data relating to the operation of the TSDZ2 Motor.
The data is displayed in the speed field, with values between 3.4 and 99.9. Lower values are ignored, this is a limitation of the displays.
For better data resolution, set the wheel diameter, only on the display, to the maximum available.
The data display is active at all driving levels (from 1 to 4, ECO - TOUR - SPORT - TURBO)
Level 0 - OFF is reserved for display's functions.

Usage. When the lights are turned on, the data is automatically displayed in sequence, for the time set for each individual data, then the lights can be turned off or left on.
The type of data, the number of data, the order of the sequence and the display times of each individual data, are set in the configurator.
By default, two data are displayed, 1 - residual battery percentage, 2 - battery voltage, for a time of 5 seconds each.

If the "Set parameters" function is enabled, first the code and status of the selected parameter is displayed for 5 seconds, then the sequence of data.
If the time of a data is set to zero, the display of that data is continuous, without time limit.
It is possible to interrupt the display sequence by turning off the lights.
Changing the level before the end of time moves on to the next data, up to the last of the sequence.
If the lights are already on, to repeat the data display, simply turn them off and on again.

Attention, be aware that the display always interprets the data received as a speed and consequently increases the odometer value, even when the bike is stationary.

Enabling "Odometer compensation" in the configurator (default disabled), it will compensate for this increase not traveled.
During compensation the speed displayed while driving remains at zero until the compensation operation has completed.

When the display is turned on, a data selected in the configurator is displayed for 5 seconds.
Available data: None = no data, Soc% = residual battery percentage (default), Volts = battery voltage.
The displayed data also serves as a reference for the waiting time before putting your feet on the pedals.

PARAMETERS SETTING – FUNCTIONS

Parameter management is organized as a menu, where the 5 levels (OFF + 4 assists) are the main items and 3 sub-items for each level.
Some new displays have 6 levels (OFF + 5 assistances). The menus, in addition to OFF, can be in levels 2 to 5, or 1 to 4. It depends on the position of the fifth level, whether before ECO or after TURBO. The fifth level has no menu function.
See "Assist level 5" in the configurator guide.
To changing the settings, "Set parameters" function must be enabled (default disabled).

Usage. Choose the level (item in the main menu), the first time the lights key (on) is pressed, a code is displayed which, combined with the selected level, identifies the parameter to be modified.
By pressing the lights button a second time (off) within 5 seconds, the change is confirmed and the code flashes.
At this point you still have 5 seconds while the code flashes, to pass to the next parameter, again by pressing the lights button. In this case the previous modification is ignored, otherwise at the end of the 5 seconds with a flashing code, the modification is confirmed.

The codes of the secondary menus are in sequence E02, E03, E04 (E01, E02, E04 for EKD01).
Attention, in the sequence of the secondary menus only the last parameter set remains confirmed.
Attention, do not confuse the error codes with those of the parameters, the latter are always voluntarily displayed by pressing the lights button. Error codes are displayed automatically.
Even in the presence of an error, you can access the parameter setting.
Once the operation is completed, the error code returns if still present.

The "Set parameters" function is enabled/disabled at level 0-OFF by setting E02 - SET PARAMETER, lights button twice (on/off) until E02 flashing (E01 for EKD01).
Now you can change the setting of the other parameters as shown in the menu listed below.
It is an extra step, but also a safety against involuntary changes.
Select the desired menu level and the parameter to be modified following the procedure described.

During the modification of a parameter, in addition to the identification code, the status of the parameter is also displayed.
The first time the lights button is pressed (on), the current status is displayed, the second time (off) with a flashing code, the new modified status is displayed.
With XH18, code and status are in two different fields and therefore are displayed simultaneously.
With VLCD5/6, code and status alternate as they are displayed in the same speed field.
The parameters are always enabled and disabled in the same menu position, the status is indicated by the first number on the left in the speed field, 1 = enable 0 = disable.
The assistance modes can be identified with a number from 1 to 6 as listed below.
The configuration of the lights with a number from 0 to 8 according to the choices made in the configurator.

The menu items are in order of priority, with the ones most likely to be used first.
There is no command to return to default values, if necessary, just turn it off and on again.

The "Auto display data" function is enabled/disabled at level 0-OFF by setting E03 - AUTO DISPLAY DATA, lights button 4 times, 2(on/off) + 2(on/off) until E03 flashing (E02 for EKD01).
It is possible to save the current settings as default, at level 0-OFF, set E04-SAVE DEFAULT, lights button 6 times , 2(on/off) + 2(on/off) + 2(on/off) until E04 flashing.

Procedure for manually setting the remaining battery percentage (Soc)

Within 5 seconds of turning on the display, select the 0-OFF level, press the Walk assist button and hold it down.
The previously stored percentage is displayed and, after a few seconds, the actual percentage, calculated with the voltage values used for the notches.
Useful when installing a battery that is not fully charged or at the first start-up after loading the program, or with “Soc % calculation” set to Wh.
With “Soc % calculation” set to Auto, the reset is automatic only if the actual Soc deviates more than +/- 15% from the previously stored one, otherwise a manual reset is necessary.
With a fully charged battery, the 99.9% reset is always automatic.
When the battery is fully charged, the 99.9% reset is automatic.

Description of the menu items and values of the default assistance levels:

Warning: for the EKD01 display the menu codes are in this order E01, E02, E04.

LEVEL 0 - OFF -> DISPLAY FUNCTION		display’s functions and save settings
E02	- SET PARAMETER	enable (1) / disable (0)
E03	- AUTO DISPLAY DATA	enable (1) / disable (0)
E04	- SAVE DEFAULT	to save the current settings (become the default)
LEVEL 1 - ECO -> MOTOR FUNCTION		street and motor functions
E02	- STREET MODE	enable (1) / disable (0)
E03	- STARTUP BOOST	enable (1) / disable (0)
E04	- TORQUE SENSOR ADV.	enable (1) / disable (0) and torque sensor calibration
LEVEL 2 - TOUR -> ASSIST MODE 1		change of assistance mode 1
E02	1 - POWER ASSIST	ECO-70 TOUR-140 SPORT-230 TURBO-340 (30-500%)
E03	2 - TORQUE ASSIST	ECO-40 TOUR-80 SPORT-110 TURBO-140 (up to 254)
E04	3 - CADENCE ASSIST	ECO-80 TOUR-100 SPORT-130 TURBO-160 (up to 254)
LEVEL 3 - SPORT -> ASSIST MODE 2		change of assistance mode 2
E02	4 - EMTB ASSIST	ECO-60 TOUR-100 SPORT-140 TURBO-180 (up to 254)
E03	5 - HYBRID ASSIST	combined values of POWER and TORQUE
E04	6 - CRUISE MODE	ECO-12 TOUR-16 SPORT-20 TURBO-24 (km/h)
LEVEL 4 - TURBO -> LIGHTS MODE		lights configuration
E02	1 - Lights ON (0)/Lights FLASHING (1)	
E03	6 - LIGHTS ON & BRAKE FLASHING or	ASSIST WITHOUT PEDALIG ROTATION (0 / 1)
E04	7 - LIGHTS FLASHING & BRAKE ON or	ASSIST WITH SENSORS ERROR (0 / 1)

Choice of assistance mode

6 types of assistance modes are available, choose your preferred one.

1 - POWER ASSIST	assistance proportional to the power on the pedals
2 - TORQUE ASSIST	assistance proportional to the torque on the pedals
3 - CADENCE ASSIST	assistance subordinated to the movement of the pedals
4 - EMTB ASSIST	assistance with progressive percentage of the torque on the pedals
5 - HYBRID ASSIST	combined power + torque assistance
6 - CRUISE MODE	assistance with speed control.

In each mode, there are 4 levels of assistance ECO(1) - TOUR(2) - SPORT(3) - TURBO(4).
The assistance values for each level and for each mode can be modified in the configurator.
At level 0-OFF the motor provides NO assistance.
The assistance mode is set at level 2 or level 3, as indicated in the previous table, by pressing the lights button twice (on / off) for each position E02 - E03 – E04 (E01 – E02 - E04 for EKD01).
When the lights are turned on, the current mode is displayed for 5 seconds (first number on the left, values from 1 to 6 as described above), when they are turned off within 5 seconds of turning them on, the changed mode is displayed.
The power-on assistance mode (default "Power assist") can be changed in the configurator, or by saving the chosen mode on the display.

How to activate WALK ASSIST

To be used when assistance is needed to push the bike on foot. (Up to 6 km/h.).
Activated with the dedicated button, consult the manual of your display.
There are 4 levels of assistance ECO(1) - TOUR(2) - SPORT(3) - TURBO(4).
The assistance values can be modified in the configurator.
At level 0-OFF no assistance (with exceptions, see below).

There are limitations due to the XH18 and VLCD5 displays, activating the walk assist button also decreases the level, it is a defect of the displays that must be taken into account, the assistance of the set level is not activated but the lower one. Not only that, but by activating the walk assist button at level 1-ECO, you go to level 0-OFF and the motor stops, but not always. Sometimes it maintains the assistance of level 1, it is a limit of the displays.

In the configurator, for each level, a speed to reach and maintain is set.
When starting "Walk assist" the set speed will be exceeded, this is an automatic calibration.
It is used to define the relationship between wheel speed and motor revolutions, and to calculate the maximum power required in those conditions of use (transmission ratio and slope to overcome), then stabilizing at the set speed.
The regulation occurs on the motor revolutions, therefore it remains constant even when setting speed values that cannot be detected by the sensor.
If necessary, it is possible to repeat the self-calibration, release the button and press again.
The set speed may not be reached due to the power limitation.
In case of problems with the speed sensor, the walk assistance will not work correctly.

Using low gears, high gears stress the transmission.
An anti-rebound time is available on the walk assist activation button, useful on rough terrain when a jolt to bike can cause the button to be released accidentally.

To be enabled and configured, see the parameter configuration guide.

STARTUP ASSIST mode

It must be enabled in the “Startup assist enabled” configurator.
It is used for starting from a standstill on difficult climbs.
It is activated with the lights on by pressing the “Walk assist” button and, holding it down, start pedaling. After starting, release the button. The speed is limited to 6 km/h.
With the button pressed, the operation is similar to the throttle but to start you need to pedal, the power delivered depends on the level of assistance and the thrust on the pedals.
Attention, if “Startup assist” is enabled, “Walk assist” is only available with the lights off.

Choice of Street / Off-Road mode

Street mode, it is enabled/disabled at level 1, by setting E02 - STREET MODE, lights button twice (on/off) until E02 flashing (E01 for EKD01).
It is a function that can be configured as a legal driving mode, it is possible to limit the speed and power of the motor. The throttle, cruise mode and walk assist are disabled.
For these settings, see the Parameter Configuration Guide.

Find out about the legal restrictions in your country regarding speed and motor power limits.
Off-road mode, activates with road mode disabled.
For use outside public roads, you can set speed and power limits other than those in road mode.

Choice of Startup boost

The BOOST function, if enabled, increases assistance at departure and at low cadence, only in “Power assist” mode.
It is enabled/disabled at level 1, by setting E03 - STARTUP BOOST, lights button 4 times, 2(on/off) + 2(on/off) until E03 flashing (E02 for EKD01).

Choice of torque sensor advanced

It is enabled/disabled at level 1, by setting E04 – TORQUE SENSOR ADV, light button 6 times, 2(on/off) + 2(on/off) + 2(on/off) until E04 flashes.

To use this parameter, it is necessary to perform the calibration procedure by entering the data in the configurator.
The operation changes according to the "Calibrated" and "Estimated" settings in the configurator.

"Calibrated" enabled and "Estimated" disabled.

- With "Torque sensor advanced" enabled, the motor works with the calibration parameters. If different from zero, "Pedal torque adc range adjustment" and "Pedal torque adc angle adjustment" are also used, they optimize the response of the torque sensor.
- With "Torque sensor advanced" disabled, the motor works without calibration.

"Calibrated" enabled and "Estimated" enabled.

With these settings you can get two different assistance profiles, available in all modes.
- With "Torque sensor advanced" enabled, the motor runs with the calibration parameters. If different from zero, "Pedal torque adc range adjustment" and "Pedal torque adc angle adjustment" are also used, they optimize the response of the torque sensor.
These are the parameters to use if you want to set two assistance profiles.
- With "Torque sensor advanced" disabled, the motor runs with the alternative calibration.
"Pedal torque adc range adjustment" and "Pedal torque adc angle adjustment" are ignored.
However, if they are set to zero, the assistance is the same as with "Torque sensor advanced" enabled.

"Calibrated" disabled and "Estimated" enabled.

- With "Torque sensor advanced" enabled, the motor runs without calibration.
- With "Torque sensor advanced" disabled, the motor runs with the alternative calibration.
"Pedal torque adc range adjustment" and "Pedal torque adc angle adjustment" are ignored.

"Calibrated" is disabled and "Estimated" is disabled.

The motor always runs without calibration, regardless of the "Torque sensor advanced" setting.

Torque sensor calibration

Torque sensor ADC calibration.

The calibration of the torque sensor is performed at the 0-OFF level, “Set parameter” must be enabled.
Turn on the display and select the 0-OFF level, if “Set parameter” is not enabled, turn the lights on and off to enable it, then leaving the pedals free, press the Walk assist button until the ADC value of the torque sensor is displayed and release the button, the displayed value must be entered into the configurator in “Pedal torque ADC offset”.
Subsequently, check the ADC value of the torque sensor with the maximum push applied to the pedal (cyclist standing, on the right pedal in a horizontal position), this value must be entered into the configurator in “Pedal torque ADC max”.

In the configurator also enable "Torque sensor advanced", "Calibrated", "Estimated", all three.
This is the recommended procedure.
To finish the operation, change level, or continue to the next step.

Calibration of the ADC conversion factor of the torque sensor, estimated

This is an alternative calibration procedure that can be completed on the display without reflashing.
This feature was added because, over time, the torque sensor values change to the point of causing the E02 error, in which case a quick "on the road" calibration may be useful.

Press the Walk assist button again and release it.
The values of “Pedal torque ADC offset” and “Pedal torque ADC max” are displayed alternately.
Check if they match those obtained previously.
An estimated value of “Pedal torque adc step” is then calculated, “Estimated” is enabled and “Torque sensor advanced” is disabled.
Now you can test the bike. Change level to exit, or continue to the next step.

Warning: this calibration is not the same as the one obtained by entering the data in the configurator: the result is similar, but there are some differences to consider.
With the display calibration, the parameters "Pedal torque ADC range adjustment" and "Pedal torque ADC angle adjustment" are ignored. While "Pedal torque ADC offset adjustment" has a different operation.
It is used with "Torque sensor advanced" disabled.
While with "Torque sensor advanced" enabled, if the calibration has not been performed in the configurator, the motor will work without calibration.

Warning: by turning off the display, the data of this alternative calibration are lost, to keep them they must be saved in eeprom.
Disable “Set parameter” (at 0-OFF level turn lights on and off)
Save to eeprom (at 0-OFF level turn lights on and off 3 times)
This alternative calibration, unlike previous OSF versions, applies to all modes. The same is achieved by enabling “Estimated” in the configurator.

Calibration of the ADC conversion factor of the torque sensor, estimated, with weight

This calibration is not essential, it is recommended only if you want a precise calculation of human power and possibly display it on the display.
Consider that the estimated values of “Pedal torque ADC step“ and “Pedal torque ADC step adv“ obtained by the configurator are still adequate for the purpose.

Press the Walk assist button again and release it.
The values of "Pedal torque adc step" and "Pedal torque adc step adv" are displayed alternately.
Prepare a weight of 24 to 25 kg, which can be hung on the pedal in a horizontal position, or use a luggage scale.
With the values displayed, press Walk assist and hold it.
Another number is displayed that gradually increases, release Walk assist when the value displayed corresponds to the weight on the pedal.
After releasing Walk assist, the display shows the new calculated value of “Pedal torque ADC step” which alternates with “Pedal torque ADC step adv” by default 34..
Take note of the value of “Pedal torque ADC step”, check in the configurator if it corresponds to the estimated one.
It is not possible to enter the value of “Pedal torque ADC step” in the configurator if “Estimated” is enabled.
Then try to change the value of “Pedal torque ADC step adv” (by default 34), until you obtain an estimated value of “Pedal torque ADC step” equal to that obtained with the weight.
In this way, “Pedal torque ADC step adv” will also be calibrated with the weight.
See the “Estimated” function in the configurator guide.

Torque sensor hardware calibration.

When the working range of the torque sensor is very limited, a mechanical calibration may be necessary.
Follow the instructions on GitHub:
https://github.com/bbeschea/TSDZ2_wiki/wiki/Torque-sensor-hardware-calibration

After turning on the display, follow the first part of the calibration procedure, the torque value will be displayed for as long as necessary.

Choice of lights configuration

There are 3 modes besides the default one, choose the preferred one (at level 4).
Default With light control ON, on
E02 With light control ON, flashing (E01 for EKD01)
E03 With light control ON, on and flashing during braking also with light control OFF (E02 for EKD01)
E04 With light control ON, flashing and on during braking also with light control OFF

Braking modes are only available with brake sensors installed.
For other modes, consult the parameter configuration guide.
The lighting configuration is set at level 4, as indicated in the previous table, by pressing the lights button twice (on/off) for each position. For use, the lights must also be enabled in the configurator.

Positions E03, E04 can be used for alternative functions, see the configurator guide.
E03 - To enable / disable assistance at start-up without pedals rotation (E02 for EKD01).
E04 - To enable assistance even in the presence of an error, such as a sensor failure.

Original display settings.

Notes on settings in the hidden display functions menu.
Consult the manual of the installed model.

- 6 km/h, if present set to 1-ON to use the walk assist mode. Also enable in the configurator.

- wheel diameter, set the wheel diameter in inches. Attention, this value is no longer used for calculating the speed and kilometers traveled, but only for displaying the data. For better data resolution, set the wheel diameter to the maximum available (on display only).

- speed units, speed unit and odometer. Set your preferred km/h-km or mph-miles. Set the same units of measure also in the configurator.

- speed limit, by default it is not used, the speed limits are those set in the configurator, if you prefer to use the one on the display as the maximum speed limit, enable the "Set max speed from display" parameter in the configurator.
  However, the speed limit in STREET mode is always active.
  Attention, when the speed limit on the display is lower than that in STREET mode, the one on the display has priority.
  Example: - display limit 30 km / h, STREET limit 25 km / h, limit used 25 km / h
  - display limit 20 km / h, STREET limit 25 km / h, limit used 20 km / h

- TE e TE1 (only with VLCD5 display). Torque sensor values, display only.
  Useful in the calibration procedure.
  - TE, adc value without pushing on the pedals. To be inserted in “Pedal torque ADC offset”.
  - TE1, pedal torque delta, the value without thrust is zero, increases with the thrust on the pedals. The value to be entered in “Pedal torque ADC max” is the maximum value (obtained with the cyclist standing, on the right pedal in a horizontal position) added to the value of TE ”.

ERROR CODES

The errors and related codes listed in the original display manuals are no longer valid.
Attention, the presence of an error disables assistance in all modes. It is however possible to force assistance even with an error if this is caused by a problem with a sensor, torque, cadence or speed.
You will have to choose the assistance mode that does not involve the use of the faulty sensor.
In the configurator "Lights mode 3" must be set to 10 - "Assistance with sensors error".
Enable at level 4-TURBO, E04 - ASSIST WITH SENSORS ERROR, by pressing the lights button 6 times, 2(on/off) + 2(on/off) + 2(on/off) until E04 flashes. Attention, this function cannot be set in the configurator, at power on it is always disabled, it is however possible to save the setting in eeprom on the display.
Use only in case of need, with this function enabled there are limitations in assistance.
After each error, you need to turn the display off and on again.

Error codes and description:

E01 - ERROR_OVERVOLTAGE (E06 flashing for XH18)

Battery voltage higher than the maximum expected value.
Probable error in setting the battery parameters.

E02 - ERROR_TORQUE_SENSOR

A mechanical problem may have occurred with the torque sensor or the calibration at startup has not been performed correctly. A torque was probably applied to the pedals during power on.
Switch off and on again so that the system can recalibrate, without forcing the pedals.
If the "Torque sensor advanced" function is enabled, check on the display if the value of "Pedal torque ADC offset" with free pedals and "Pedal torque ADC max" with maximum effort, correspond to those entered in the configurator.

E03 - ERROR_CADENCE_SENSOR (E13 for EKD01)

While pedaling, no pulses are generated by the cadence sensor, possibly defective.

E04 - ERROR_MOTOR_BLOCKED

Motor or wheel blocked, excessive current absorption without motor rotation.
Check the cause.

E05 – ERROR_THROTTLE (E03 flashing for XH18) (E10 for EKD01)

Throttle input check at power on failed.
Check the throttle and ADC values in the configurator.

E06 - ERROR_OVERTEMPERATURE

If the parameter “Temperature error with min limit” is enabled (default enabled), it indicates that the motor temperature has exceeded the minimum set value. The motor is running on limited power.
The power gradually decreases up to the maximum temperature limit, then the motor stops. If, on the other hand, the parameter is disabled, the error code indicates that the maximum temperature limit has been exceeded, the motor has stopped after the power limitation.
Only with temperature sensor installed and enabled.

E07 - ERROR_OVERCURRENT

Excessive current draw. Turn the display off and on again.

E08 – ERROR_SPEED_SENSOR (E14 for EKD01)

Faulty speed sensor or magnet too far away.

E09 - ERROR_WRITE_EEPROM o ERROR_MOTOR_CHECK (E08 flashing for XH18)

Error writing to eeprom. Turn it off and on again to try again.

Writing to eeprom occurs only the first time it is turned on after loading the program, or manually via the display command.
Or: Check the motor to see if it spins without pedaling (phantom pedaling).

Attention, there are errors that disable assistance, but they cannot be signaled with a code on the display. Example: interruption of communication between motor and display, or problems in the execution of the program.
In such cases, turn off the display and turn it on again.