Understanding and Using

Your Ride1Up™

KD21C E-bike Display

Explanation

and reference to the

State Transition Diagram

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1   The State Transition Diagram is in a separate document downloadable from Ride1Up.com/support under Tech Support – Interactive Displays – 500 Series and Core5 Display.

Introduction

The KD21C Key-Disp LCD E-bike display functions as the rider's **interface** to the E-bike electronic motor controller that is buried in the down tube of the Ride1Up Series 500 frame. This document presents a comprehensive guide for the operation of that interface as received as a component of the Ride1Up Series 500 ST Gold E-bike that I received in October 2020.

This document is an entirely **new** document, based on my actual hands-on experience with the KD21C. It supersedes the "LCD state diagram" document that has been available on the Ride1Up website since August 2020. That document, which I shared with Ride1Up, was my attempt to demystify the KD21C manufacturer's manual and based solely on the information distilled from that manual.

This document **evolved** into a rather **complete operating manual** for the newer KD21C pointing out the differences between it and the available resources and updating default power assist levels. Its main goal is to capture the entire functioning of the KD21C in a 4-page block diagram. Such a diagram provides the "map" for navigating and understanding the KD21C as supplied by Ride1Up.

If you believe that you are familiar or comfortable with the KD21C, you can skip the text and go directly to the state diagram pages and Table 1. You do not need any knowledge of what a "state diagram" is because the end result is a block diagram depicting every possible display screen and how to get there using the buttons.

In writing this document I have assumed that you have downloaded this document from the Ride1Up website because you were having difficulty in using the KD21C or are just curious. Section 8, page 19, of the printed "Owners Manual Series 500 E-bike" that is packaged with the E-bike has very little on the details of operating the KD21C. I assume that you may have 1) read that owner's manual, 2) downloaded and attempted to read the manufacturer-provided manual for the KD21C from Ride1Up website and/or 3) watched the video for the KD21C display/controller also available from the Ride1Up website.

Although it is not absolutely necessary, you should take a look at those resources since they provide a familiarity that can facilitate understanding and utilization of the State Transition Diagram for the KD21C.

The State Diagram presented herein is a definitive and comprehensive reference for the operation of the KD21C E-bike controller interface. It is a valuable resource for tweaking a particular E-bike operating parameter and correcting/preventing an errant setting. After reading the text, you most likely will only need the four pages of diagram to fully utilize the KD21C controller interface. "A picture is worth a 1000 words."

Important differences from the manuals

The KD21C that I received with the Series 500 E-bike in October 2020 differs from that described in the manuals mentioned above.

KD21C buttons and display

The middle button to the left of the display is now labeled with the "universal" icon for On/Off. I will continue to use "M" for that button this document.

The format of the display screen of KD21C unit received in October differs from the version shown in the documents and video mentioned previously. These differences are 1) the position of Headlight symbol and Battery Level symbols have been flipped (mirror image) left to right, 2) the "*PAS*" under the Assistance-Level in upper right box no longer appears; 3) the "*W MOD*" in lower right is now "*W POWER*." See Illustration 1 on page 3.

Instructions in Series 500 Owner's Manual

The printed manual received with the Series 500 bike is identical to the digital version of the Series 500 Owners Manual downloadable from Ride1Up as "Ride1UP-500-series-Gen5-Manual.pdf" as of November 2020.

It provides the new E-bike owner with the experience of using the buttons on the KD21C to access a setting state and change a parameter value. The setting of the distance units to km or miles reveal the various ways of using the buttons to "navigate" the KD21C. The concept of **pressing** a button briefly, **holding** a button down for 2 seconds, holding 2 buttons down simultaneously for 2 seconds and using the + and – buttons to change the value of the flashing item in the display are introduced.

Section 8.1) General Operation, page 19 of that manual describes holding the "Mode" button for 2 seconds to Power-On or Power-Off the KD21C which controls power to the E-bike. (It does not indicate that the "Mode" button is the On/Off button.)

Section 8.2) LCD KM/H to MPH provides an example of using buttons for transitioning to a parameter setting state and changing its value: namely, **holding down two buttons** (+ and -) for 2 seconds, using the M button to transition to the desired parameter (Distance Units), and using the + or the – button to change the value the flashing digit "1" or "2" (where U=1 sets the units parameter to miles).

However the necessary final step is missing: You must press and hold the M for 2 seconds which will save the displayed "U" value and return to the Power-On display which I prefer to call the Dashboard.

This and other actions including the Clear Trip action are shown in the video referenced previously.
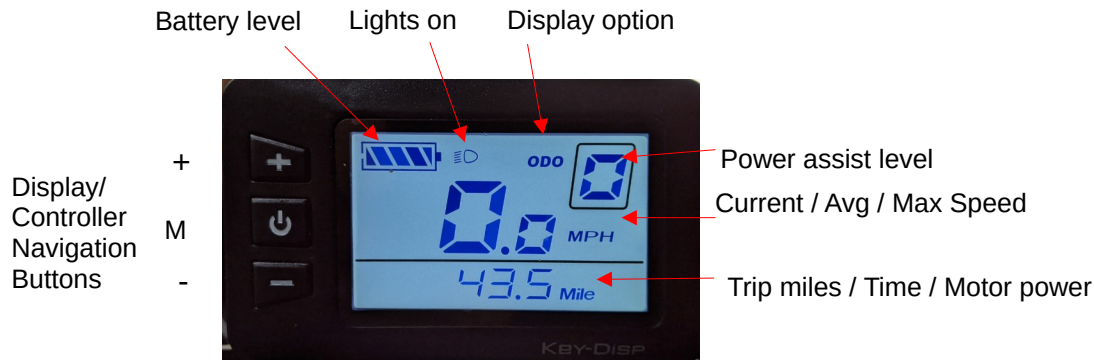
The two tables on page 20 of the Owner's Manual" define symbols used in the KD21C display. I have combined these two tables into one as Table 2 on Page 9 of this document.

Manufacturer-provided KD21C manual

The manual for the KD21C Key-Disp – provided by the manufacturer – is downloadable from Ride1Up as "Users Manual-KD21C-KDS.pdf." However this "manufacturer's manual" is difficult to read, not up to date, and gives the wrong procedure to access General Parameter Settings for the KD21C as received in October 2020. The new LCD display format is different and the Dashboard now has an extra Odometer display.

Also the power assist default power levels are no longer valid. The observed ones are those shown in Table 1 later in this document and give you an acceptable riding experience out of the box.

The new KD21C display

Battery level   Lights on   Display option

Display/
Controller
Navigation
Buttons

\+

M

\-

Power assist level

Current / Avg / Max Speed

Trip miles / Time / Motor power

Illustration 1: My photo of KD21C controller interface received October 2020. It shows the "navigation" buttons and the Power-On display, which I call the Dashboard.

Illustration 1 shows the configuration of the KD21C LCD display immediately after powering on.

The buttons used to navigate the KD21C are to the left of the display. I have denoted the On/Off button as **"M"** in keeping with the manuals referenced and the absence of a suitable typographical symbol. The **M** button is between (in the **M**iddle of) the plus and minus buttons. I also refer to the Power-On display as the **Dashboard** since that it is its main function. It is the only display while you are riding.

The LCD display is also used to display various setting options. In that case the areas labeled on the right convey different setting information as will become clear later on.

Button navigation of the KD21C

Most users who read and follow the Display Instructions starting on page 19 of the Series 500 owner's manual that came with the E-bike or have watched the video available on the Ride1Up website will grasp how the buttons are used to access the KD21C displays and settings.

Three buttons, the +, M, and – (Plus, Middle/On-Off, Minus) are used to navigate the KD21C to change the displayed on the Dashboard and to allow changes to the parameter values that affect the operation of the E-bike. They can be pressed briefly or held down for ~2 seconds singly or as a pair. **[2s]** is the shorthand notation used in this document to indicate the pressing and holding the button(s) for 2 seconds, e.g., **M[2s]**. When in any settings state, any item that is **flashing** can be changed by using the + or – button. When you are in one of the three settings groups and the repeated pressing of **M** results repeating a series of displays (you are in a loop), then **M[2s]** will exit that situation.

Navigation to frequently accessed items

Below is a short list of the button sequences for the most frequently performed operations of the KD21C. The shorthand notation used in the block diagram is also revealed. Many settings need not be changed.

Used for "every" ride

1. **Power on the E-bike:** Hold On/Off button for 2 seconds or in shorthand **M[2s]**.

2. **Power Off the E-bike:** Hold On/Off for 2 seconds, i.e., **M[2s]**

3. **Dashboard Display Options:** Press **M** (briefly) to transition sequentially through the seven display options. Pressing **M** at the 7th item (Average speed) advances (loops back) to the 1st item (the Odometer which in this context is <u>total</u> distance traveled since first time use). Note the Odometer display appears twice, once as the initial display upon Power-On and again between Motor Power and Max Speed.

4. **Clear Trip Data**: With the Power-On Dashboard being displayed, hold **+** and **–** buttons for 2 seconds (the display changes), i.e.**+-[2s]**. The LCD display transition to show *tC-"n"* (my use of "" signifies flashing of surrounded item) in the lower part of the LCD display with the "n" flashing. Use **+** or – to change the "n" to "y". Then press **M[2s]** (with *tC=y*). This button action will reset all trip data to zero and return to the Dashboard. In sum the button sequence to clear trip data is **+-[2s], +, M[2s].** See the second page of the state transition diagram.

   Note: **All values associated with a trip are reset** – Distance traveled, time – defined as the length of time the bike has been powered on, Max and Avg speeds.

Much less frequently but most useful

5. **Change the Number of Power Assist Levels that are available on the Dashboard** You can change number of power assist levels that are available on the Dashboard, the so-called "power assist mode." You can have 3, 5, 7, or 9 levels and they can start at 0 or 1. The manual calls these power assist modes.

   You may want to change the assist mode from 5 levels starting at 0 (0-5) to 7 levels starting at 0 (0-7) for example. Hold **+-[2s]** then hold **+-[2s]** *again.* Now press the **+** button. The display will show SCA with a flashing "*2*" at upper right. Pressing **M** enters the Select Number of Levels **sub-menu** with the current level (e.g., "0 - 5") flashing in the lower part of the display. Use **+** or **–** to change it. With the desired power assist mode being displayed, hold **M[2s]** to save and exit to Dashboard. In sum, from Dashboard: **+-[2s], +-[2s], +, M, + or –** to scroll through list of level ranges until the desired one is displayed. Then use **M[2s]** twice to return to the Dashboard with the Odometer display.

   The updated default assistance levels are shown in Table 1. They are probably reasonable settings for most riders, but they can be tweaked to your preferences. Here's how. Follow all the steps above but <u>stop short of pressing</u> **M[2s].** Press **M** briefly to enter a **sub-sub-menu** that allows adjusting the **% power for each of the levels** for the chosen mode. This is fully shown on the third page of the state transition diagram.

Access only once

6. **Set speed/distance units to miles or kilometers:** From Dashboard, hold both **+** and – for 2 seconds. Press **M** twice to get to the units setting state and its display. Use the **+** or **–** to change from U- "1" to U- "2" or vice versa. U- "1" sets distance and speed units to miles and mph; U- "2" sets distance and speed units to kilometers and kph. When the display represents the

number desired, hold **M** for 2 seconds to save the setting and return to Dashboard. See the second page of the state transition diagram. The speed unit for the speed limit settings are unaffected and remain kph.

New default power assist levels table

Table 1, shows the default Power Assist Power levels in percent for each of the levels of the assist modes. They seem to be reasonable values, but they can be tweaked as you prefer. The default Assist Mode is 0 – 5.

Table 1: Default Power Assist Level Values for KD21C received October 2020. The default is in bold type.

Level Assist modes	1	2	3	4	5	6	7	8	9
0-3 / 1-3	10%	28%	60%						
0-5 / 1-5	**08%**	**14%**	**24%**	**40%**	**70%**				
0-7 / 1-7	07%	11%	16%	24%	34%	50%	75%		
0-9 / 1-9	06%	10%	14%	20%	28%	38%	50%	65%	82%

State transition diagram for the KD21C

The four State Transition Diagram pages (a separate document downloadable from Ride1Up.com/support page under Tech Support – Interactive Displays – 500 Series and Core5 Display) fully describe the operation of the KD21C. I constructed it to provide myself and Ride1Up riders with a description of the operation of the KD21C that was more understandable and concise than the manufacturer's manual. The manual's narrative is akin to being provided a turn by turn directions to a destination without an accompanying road map. The big picture is missing. The state transition diagram provides the "map" of action pathways to reach any setting (display) of the KD21C. The state transition diagram consists of named blocks (towns) and arrows (roads) connecting them.

Each and every one of the possible **display screens** represents a unique **state** of the KD21C interface. Each of the states is represented by a rectangular block in the diagram.

An **action** – such as your pushing or holding (long press) one or a pair of buttons – causes the KD21C to **transition** from one state to another or to change a value of a parameter. An **event** – such as being parked for longer than 10 minutes – also causes a transition (from Power-On to Power-Off).

In the diagram, a transition is represented by an **arrow**. The arrow is labeled with the button(s) that are pushed (the action) that cause the transition. When a **condition** must be true (a guard condition) for the action to complete, that condition is enclosed in ( ) following the button(s) used. A notable example is the transition from the Dashboard to the General Settings. This transition can only occur when the E-bike is parked. In the diagram the arrow representing this conditional action to cause the transition is labeled **+-[2s] (Bike is parked)**.

Using not much more than labeled blocks and labeled arrows and other formalisms of state transition diagrams, one can completely capture and represent (map out) the **behavior** of the KD21C interface. In order to provide "everything you need to know", I have added **important notes** to clarify the meaning/effects of some settings, add details, or caution the user. The nomenclature used for the buttons is defined when it if first used on the first page of the diagram but is rather self evident.

Comments on each page

This section and the four pages of diagrams fully describe <u>everything</u> needed for operating the KD21C interface. Nothing is omitted. Each display state is represented by a rectangle that closely emulates the LCD display. The symbols used in the LCD display for the settings and for the parameters are described in Table 2.

Page STD-1 – Overview

The first page presents a birds-eye view of the KD21C. It shows that it is organized into four major state groups each of which consist of several states. When the KD21C is powered on it is in the Power-On state and displays the Dashboard which is one of the four major state groups within Power-On state. **Only the Dashboard (and its display states) are accessible when the E-bike is moving.** The three settings states within the Power-On state are only accessible when the bike is parked. These four state groups are shown as large rectangles with different colored backgrounds. They are shown in detail on diagram Pages STD-2 to 4.

The highlighted text provides definitions for the button-push (action) nomenclature as well as supplementary information.

The Powered-Off state and button actions used for powering on the KD21C are at the top of the diagram and only appear on this page.

Interpreting the STD

Wide arrows represent transitions 1) from Power Off to the Power-On state, 2) from the Dashboard to General Settings and 3) from the General Settings to the General Parameter Settings group or to the Personalized Parameter Settings group.

If a Power-On password is required then pressing **M[2s]** enters the password entry states. Correct entry of the password then is a **condition** for entry to the Power-On state.

When you power on the KD21C it **enters** the Dashboard state group. This **entry point** is represented by an arrow with a solid circle at one end and an arrow at the other pointing to the Dashboard major state. The Dashboard also contains a similar entry point that points to the Odometer display state. These entry points do not change. Entry to the Dashboard from any other of the settings states **always** shows the Odometer display state at the lowest power assist level, either 0 or 1.

Several arrows terminate at the bottom of the Dashboard rectangle. That suggests that quite a number of actions or events transition to the Dashboard. Several of them start at the **edge** of the (Settings) rectangles which host several states. For example, holding **M[2s]** from **any state** within the General Settings or the General Parameter Settings saves setting and transitions to the Dashboard.

The Personalized Parameter Settings state is different. The entry point first item of an 8-item menu of settings. **M[2s]** from any of these menu items transitions to the Dashboard. These individual menu items (a "parent") has a group of sub-states ("children"). **M[2s]** from these "child" sub-states returns to the "parent" menu item. The birds-eye view of this behavior is represented by the shaded ovals and transitions for any "parent menu" state, and any child sub-states.

The **Restore Defaults** state is accessed from the Dashboard and only appears on this page.

Also the KD21C can time out and these **events** are also shown. If you haven't used a button for greater than 1 minute while in any settings state, that **event** causes the transitions to the Dashboard. If the bike does not move for longer than 10 minutes, the KD21C powers off.

[FYI: The situation of having a state within another state which is within another state is termed nested states.]

Page STD-2 – Dashboard, General Settings & General Parameter Settings

For this and subsequent pages, the KD21C interface is in the power-on state. This page shows the states for the Dashboard, General Settings, and General Parameter Settings. The highlighted text in the diagram provides additional information.

Notes under the three state rectangles, provide important explanatory and clarifying information necessary for a complete understanding of the KD21C. They detail the meaning of several settings and other helpful explanatory information such as what is cleared by clear trip and meaning of Time, for example.

You may have had trouble following the manufacturer's manual while attempting to verify or set either of the two General Parameter Settings: the *Ld* wheel diameter and *LS* the speed limit because they are not correct. The diagram is correct and reveals a couple of general "rules" for the KD21C operation.

 As shown in the diagram, the entry point for the General Parameter Settings shows in the display as a **flashing** *"Ld"* the wheel diameter symbol for that parameter in the display center and the current wheel diameter in the bottom area. Using + or – will transitions to showing a **flashing "***LS"* the speed limit parameter with the current speed limit displayed below it. Pressing + or – alternates between these two states. You need to press **M** from either state to confirm that you want to change the value. The Ld or LS become steady and the value is now flashing in the lower part of the display. Pressing **M** saves and transitions to other state with its setting value flashing. Moreover, **repeated pressing** of **M** now only transitions between displaying the flashing values for speed or diameter. You need to press **M[2s]** to transition out of this loop and return to the Dashboard.

General Rules of KD21C behavior

You do not need to know these rules. I deduced them from observation. They may come in handy if you get confused and don't have the diagrams handy.

The above example demonstrates two rules governing the behavior of the KD21C. First, any **flashing** symbol, character or digit can be changed by using the + or – button. Second, when the repeated pressing of **M** keeps looping through a set of states, you must use **M[2s]** (or – **[2s]**) to transition out of that loop.

A couple of more rules: If you have changed a value, you must press **M** to save it and that usually transitions to a successor state. **M[2s]** also saves but additionally transitions out of the loop or settings group. Pressing – **[2s]** does not save the changed setting and transitions to wherever the **M[2s]** goes.

Page STD-3 – Personalized Parameter Settings

Page STD-3 presents the states and transitions within the Personalized Parameter Settings. The entry point is on the left and is the first item (*VOL*) of and 8-item menu. The number "1" is **flashing** in the box on the display. Since it is flashing, the + and – buttons must be used to transition to the next or previous item. The menu is a loop: a + at item 8 transitions to item 1; a – at item 1 goes to item 8.

The notes to the right of the sub-menu items explain more about each item and the defaults. The top note on the right describe how the **M[2s]** and **-[2s]** buttons work for all of the sub-menu states.

Item 2, *SCA*, Power Assist Levels has two sub-menu states: 1) the set assist **mode** and 2) the set % power for each level within the selected mode. The Power Assist **mode** sets the number of power assist levels available to you in the Dashboard. There are eight of these modes. The lower level of a mode can be 0 or 1; the top level of a mode can be 3, 5, 7 or 9 and KD21C uses these as the mode identifiers in the % power for each level.

The diagram shows that if you want to change **only the mode** (number of assist levels) you need to use **M[2s]** immediately after selecting the mode. This action saves and transitions you to the menu item 2. If you want to **change the % power** for each level within a mode, use **M** from the select mode state. This transitions to a looping set of states used to change each power level in the selected mode. The display shows 'm- n_xx,' where m is the mode number (3, 5, 7, 9), n is the level number and xx is the % power. (Strangely nothing is flashing when setting power %.) Press **M** to save power setting and transition to next numbered power level. When you set the highest level for the mode (n=m), pressing **M** loops back to level 1 for that mode. You must use **M[2s]** to escape this loop and transition to menu item 2, *SCA*. Use **M[2s]** again to transition to the Dashboard. The default power levels are shown in Table 1. They seem to be quite reasonable to me as a new E-bike rider.

Item 8, *PSd*, Password enable/disable is on page STD-4.

Page STD-4 – Personalized Parameter Settings – Passwords

Page STD-4 shows the state diagram for two items: 1) *PSd* for enabling/disabling and setting the Power-On Password, and 2) the Procedure for Powering on the KD21C when a password is required shown on Page STD-1 between Powered Off and Power-On state.

Follow the diagram carefully when changing the password and enabling it. Heed the caution to **write down the password** after you change it. If you decide to not use a password later, then I would suggest changing it back to the default 1212 for safety.

The 4-page state transition diagram for the KD21C interface controller follows after the table of symbols used by the KD21C LCD display to indicate to you its current state.

You probably will not need to refer to the preceding narration again. The diagram pages should be sufficiently complete that it alone will suffice.

Symbols appearing in KD21C display

Table 2: Parameters whose values can be set. These appear in the bottom line of the LCD display.

Parent State Location	Parameter Symbol[2]	Definition (Defaults in Bold)
General Settings	*tC*	Clear trip distance; **n** , y
General Settings	*bL*	LCD Backlight Intensity, **1**,2,3.
General Settings	*U*	Distance units: **1** or 2
Gen. Parameter Set *Ld*	*Ld*	Wheel Diameter: 28, **700C**, 26, 25,...12
Gen. Parameter Set *LS*	*LS*	Speed Limit : **32 km/h.** Max 45 km/h (~28 mph)
Personal Parameter Menu Description--Symbol--Menu #	Parameter Symbol[3]	Definition (Defaults in Bold)
Battery bar volts *VOL #1*	VOL	Battery bar voltage
Power Assist Levels SC$_A$ #2		See Table 1, and explanation .under Page 4 description
Current Limit *CUr # 3*	*cur*	Maximum current to motor: 7 to **18** amp
Power Assist Sensor *PAS # 4*	*run-b*	Power assist motor direction backward
Power Assist Sensor *PAS # 4*	*run-F*	Power assist motor direction **forward**
Power Assist Sensor *PAS # 4*	*SCn*	Power assist sensitivity; **2** (most responsive)- 9
Power Assist Sensor *PAS # 4*	*n*	Number of magnets in cadence sensor: **012**
Speed sensor *SPS #5*	*SPS*	Speed sensor selection: **01** – 15
Throttle Function *Hnd #6*	*HL*	Throttle Push Enable[4]: **n** , y. No effect on bike. Leave at **n**.
Throttle Function *Hnd #6*	*HF*	Throttle Level Enable[4]: **n** , y. Only available if HL=n.
System Settings: *SYS #7*	*dLy*	Power delayed time
System Settings: *SYS #7*	*LS*	System Speed Limit[5]
System Settings: *SYS #7*	*PUS-y, PUS-n*	Enable holding **–** button for walk (Push) assist: **y** or n
System Settings: *SYS #7*	*PUS-nn*	Probably assigns a power level for Push (walk) Assist: **20** to 35% unverified
System Settings: *SYS #7*	*SSP*	Slowly start up : **1** – 4. No observed effect.
Password enable or change *PSd #8*	*P2* *PSd-"n", "y"* *P3*	Password entry to access enable/disable/change Password enable; **n**, y Password entry to change password
Dashboard (Power-On display)	*dEF*	Reset KD21C settings to "as received" defaults.
General	*y*	Yes
General	n	No

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2   Appears in bottom of the LCD display.
3   Appears in bottom of the LCD display.
4   Neither HL or HF settings have observable effects. The throttle always turns on the motor unless a brake is applied.
5   Under Personalized Parameters, Item 7, System Settings, sets the maximum speed up to manufacturer's limit. It puts and upper limit to the LS in General Parameter Settings which may be set to a lower limit.