dicodes E-Cigarette Control Unit "Dani Extreme": Technical Specification and Manual

1. Common

The electronic control unit from **dicodes** is equipped with an electronic, that incorporates a small 2-digit 7-segment display and a push-button to adjust several parameters by means of a menu structure and to show different measured values. The top M7x0.5 metric thread is compatible with most available types of vaporisers on the market today.

To use the different Li-Ion accumulators, namely 18650, 18500 and 18350, the device is offered in three different lengths. The electronic is designed to work with a single Li-Ion cell and must not be supplied with voltages more than 4.5V.

The adjustments and handling is intuitive by pressing the button short term or for a longer interval. With the button actuated for more than 0.25 sec., power is applied to the heating winding, until the button is released or the maximum vapour time of 20 second (10 sec. >15W) is exceeded.

The **dicodes** control unit is world wide the only one, which works with a technology enabling the device to handle high power in a very small volume. The power output is achieved by a true alternating current (+/- relative to housing or ground) and not with an adjusted voltage or a pulse-width –modulated constant voltage.

The selected power is – combined with the creation of the heater winding – decisive for the vaporising result. The device is designed to work within a resistance range of 0.7 to 3 Ohms. Most users judge the vapour as optimal with a heater resistance of about 1.5 Ohms and 10-12W. In general, the output power is independent of the heater resistance. The power chosen is always transferred to the load (power controller). Outside the permitted resistance range vaporising is possible but with certain power limitations.

The control unit is powered up by consecutive fast pressing of the button for 1 to 5 times, see extended functions menu (Oc "On clicks"). With continued pressing of the button the user steps through the programming menu and the error menu. When the button is released, the current value of that specific menu is displayed after a short time. The value can be changed by repeated pressing of the button or keeping the button pressed (auto repeat). The display duration of the menu item and value and thus the speed is selectable in the extended functions menu.

As soon as the display is off and the button is pressed for longer than 0.25 seconds, the heating winding is powered.

2. Menu Structure

The main menu is explained first at this point. It serves to change most used values in the daily usage. Beside this, there is a sub-menu, designated as the extended functions menu, which enables the user to choose several individual settings. This menu is explained later in the text. As far as the extended functions menu has an impact on the main menu entries, the text includes related hints.

Pu => Power up increases the output power in steps of 1W or 0.5W or counts up during auto repeat. When reaching 15W the power adjustment jumps back to 5W (roll over). Also see half wattage steps option in the extended functions menu.

Pd => Power down decreases the output power in steps of 1W or 0.5W or counts down during auto repeat. When reaching 5W the power adjustment jumps up to 15W (roll over). Also see half wattage steps option in the extended functions menu.

Co => Check ohms performs a resistance measurement of the heating winding by means of a constant current pulse. The accuracy is about 2% or +/-0.05Ohms. When the button is pressed again during the display of the value, as second measurement result is display, referred to as the AC-resistance. Moreover, for this AC-resistance there are two options built in, see item 10 for further explanations.

Cb => Check battery measures the accumulator voltage under load, or displays the last voltage measurement, respectively.

Sb => Set battery defines the minimum battery discharge voltage and also the threshold for the power reduction slope. See below item 7 for further explanations.

So => Switch off. When this menu item is displayed and the button is kept pressed, first the decimal points are lid and then "- -" and the electronic switches off completely. It can be switched on again by consecutive short term pressing of the button, the number of which is defined via the extended functions menu.

EF => Extended Functions menu, see item 12. of this datasheet.

F- => Fault indication. With no fault pending the display shows F-. The error codes are defined as:

F1	=> Resistance of heater winding open
F2	=> Resistance too high (> 3.0 Ohms)
F3	=> Resistance too low (< 0.7 Ohms)
F4	=> Short or loose winding or overload
F5	=> Battery (accu) voltage too low
F6	=> Temperature too high (PCB-temperature > 55°C)
F7	=> maximum vapor time exceeded

Note: Depending on the setting of Ec (Error control) in the extended functions menu, certain Errors are either not displayed at all (F2/F3) or are no longer to be acknowledged to reset the fault condition.

3. Power Controller

The electronic within the device is able to govern the output power in a range from 5 Watts to 20 Watts. The power control is independent from the wiring resistance. I.e. it does not matter whether the heater has 0.7 Ohm or 3 Ohms of resistance, the power will always be adjusted to the pre-set value. In case that the resistance check (Fault-codes F1 to F3) is enabled in the extended functions menu, the permitted range for the resistance is 0.7 to 3.1 Ohms up to a power of 15W and 1.0 to 3.0 Ohms from 15.5 to 20W.

Remark: Even when the wiring resistance is outside the nominal and checked range of 0.7-3 Ohms, vaporising is possible in a certain range.

For resistances outside the recommended range (or checked range if enabled), full power of 20W (15W respectively) cannot always be achieved. For example, the maximum power of 15W with 0.7 Ohm is reduced to about 10W with 0.3 Ohm. These values were measured on a typical device, but cannot be guaranteed. In case that the requested power can not be transferred to the load, fault F4 indicates the overload condition. After reduction of power and fault acknowledgement, vaporising is possible.

4. Time limited power output

The maximum uninterrupted activation time for vaporising is limited to 20 seconds for a power of up to 15W, and 10 seconds from 15.5W to 20W.

So in case that the button is accidentally activated permanently, further power output is stopped after 20 (10) seconds and the displays shows F7.

5. Short Circuit Protection

When the heating winding is applied, unintentional shortages between housing and the wire can happen. If the button is pressed then, the electronics will not be damaged, but shows the error condition with "F4 short or wobbling contact or overload" in case of a low-ohmic short or intermitted contact. After acknowledgement of the error message – and removal of the shortage – vaporising is possible again. Error message F4 is displayed in contrast to error F1 (open winding), when a short or opening happens during power output. So F1 is displayed as soon as the winding is removed or opened with no power applied, e.g. when the winding is applied or created.

6. Reverse Polarity Protection

Several accumulator manufacturers offer devices whose polarity is hard to identify compared to standard batteries. In the past it could happen that the heater-winding was powered permanently or the power switch was even damaged in case that the accumulator was insert with reversed polarity. The **dicodes** control unit is equipped with a reverse polarity protection so that no current flows in this condition. Vaporising is impossible then, of course.

The battery should always be inserted with the +pin first in the direction of the electronics and the device in an angular position.

7. Deep Discharge Protection and Power Limitation

Common Lithium-Ion accumulators have a voltage of about 4.2V when fully charged. During discharge the voltage reduces to 3.7V down the 3.3V and stays within this range while reducing slowly for a longer period of time. At the end of the capacity (about 70-80%) the voltage decreases somewhat faster until it's value reaches about 2.5 to 2.7V, below which the accumulator is irreversibly damaged or even destroyed due to chemical reactions inside.

Most electronic cigarettes in the market using a lithiuim-ion-accu abruptly disable further power output when the voltage under load drops to about 3.3V. This is somewhat unpleasant for the user especially when no replacement accumulator is at hand.

In contrast to this, the electronic within **dicodes** device does not switch off all of a sudden. Beginning at an user adjustable voltage, a power reduction is activated, which enables further steaming at a reduced power, without changing any other adjustments. The output power is reduced proportional as the voltage under load of the accumulator decreases.
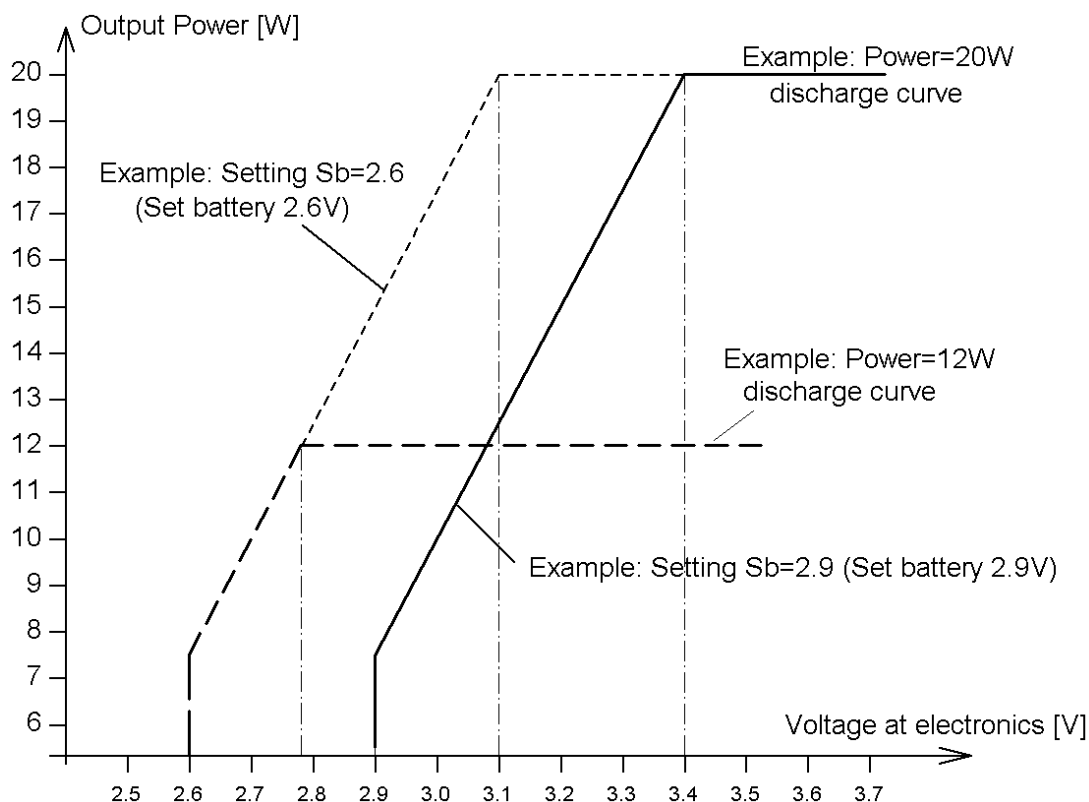
The user adjusted value under Sb defines the point where the maximum output power will be reduced to 7.5Watts. If the voltage of the accumulator drops below this value, further power output is not permitted. In this case error message F5, voltage too low, is displayed. The reduction always starts 0.5V above the adjusted value when referenced to 20W. With a value of 2.9V, for example, the power reduction with 20W selected begins at 3.4V. If the power output was adjusted to 12 Watts, the power limitation only starts at about 2.8Volts, i.e. before the voltage reaches 2.8V there is no power reduction.

The reduction in power is displayed by flashing decimal points.

8. Temperature Check

The electronic checks for it's own temperature (temperature of printed circuit board). Any electronic has so called power losses, which increase the temperature in the end. To protect the electronics from over-heating, power output is stopped at temperatures above 55°C (approx.). Normally the value is never reached, even under persistent maximum power output.

9. Auto-Power-Off

When the device is not used for a certain time, it switches off itself. This time-out can be selected in the extended functions menu to be 1, 5, 10, 20, 30, 60, 90 minutes. So if you forgot to actively switch off the device, using menu item So (Switch off), the battery is not discharged further. Note that in conjunction with the options under "Oc" (On clicks) selected to be 0, power output is immediately possible when pressing the button as if the device is still on. Thus the battery discharge can be limited to a minimum, when 1Minute is chosen for the time-out.

10. Resistance Measurement

The resistance measurement supports the user during the application of the heating winding.

The Dani Extreme is equipped with a DC-resistance measurement, which will show identical values compared to commonly used other products. The result is always displayed, once the menu item Co (Check ohms) is selected.

Beside this DC-measurement, the Dani Extreme can perform two sorts of AC-measurements. Which of those is used, depends on the setting of parameter "SA" in the extended functions menu: SA=1 => This is the same measuring method used in the Basic-Version and Dani V1. The measurement is done by applying a 50kHz signal to the winding. The measured values are standardised and linearised in order to display values near the DC-measurement. The deviation depends on the individual winding, though. Especially for MicroCoils and thicker wire (0.32mm) the specified accuracy of +/-10% might not be achieved.

SA=0   => For the use of micro-coils or other "non-standard" windings the Extreme includes an AC-measurement which is performed with 200khz, which is the operating frequency of the control unit. This measurement can give additional information of the performance to be expected. For very long wiring with a big area (e.g. 0.32mm NiCr, 12 windings, 3mm diameter) values of >6 Ohms can be expected. Above about 6.3 Ohms and high power selected (16-20W), power might be limited. In this case, the user should reduce the turns or use a thinner wire.

Typical heater windings have a resistance of 0.7 to 3 Ohms, assuming a Kanthal-wire of 0.16mm diameter is used. The device is optimised for this resistance range. Nevertheless the user is free to choose almost any other winding resistance and different materials like NiCr.

The appliance of a winding typically is as follows: Once you have created a winding, switch on the device by pressing the button single or multiple times (Oc setting). Pu for adjusting the power is displayed. Directly press the button again for two times to get to menu item Co (Check ohms) and wait shortly for the resistance being displayed.

The following refers to the <u>error control </u>for F1 to F3 being <u>enabled,</u> only: In case your winding is outside the recommended range of 0.7-3 Ohms, F2 is displayed, if your winding is greater than 3.2 Ohms and F3, if your winding has less than 0.6Ohms. See also item 12 in this menu.

In order to display the resistance measured, despite the error message, simply press the button several times until you reach Co again, with the lately measured resistance displayed after about 0.5 seconds.

If you have reset the error by pressing the button for a short time during the appearance of F2/F3 in the display (it changes to F-) and then are going to item Co again, you will instantly get the error message again, because the resistance is still outside the specified range.

Normally you will now open the winding to change it. As soon as you open it, the error code F1 will be displayed indicating an open winding. You don't have to care for that at the moment. Modify the winding and press the button. Error code F1 is still displayed. Now reset the error by immediately pressing the knob for a longer time: the display changes from F1 o F-. Now you can again step through the menu to "Co" to measure the changed resistance of your winding.

Sounds complicated, but you will quickly get a feeling of which winding and power level gives you best performance and taste and how easy the device is to handle.

11. Voltage measurement

The accumulator voltage is measured using menu item Cb. The device measures the voltage in two ways. Either during the winding resistance measurement, which represents a light load, or when power is supplied to the winding. The most lately measured value is stored and displayed once you choose Cb.

When you have powered up the device, it instantly performs a resistance measurement. If you then choose Cb (Check battery) the voltage at light load is displayed, as this was measured at latest. If you now apply power to the winding by keeping the button pressed for longer than 0.25 seconds and then shortly press the button again, that battery voltage during applied power is displayed. Thus you can also check the batteries inner voltage drop, which increases when the battery has reached its end of life.

If you like to measure the battery voltage at no-load condition, simply switch off the device, remove the vaporing head and switch it on again. As the device tries to check the resistance (no with no heating-wire) you can read the no-load voltage at menu Cb (check battery).

Please note that the no-load voltage of an accumulator gives you no reliable information about it's quality nor it's charging level. A wear-out battery can show 4.1V, although the voltage will drop dramatically when loaded, and then goes back to 4.1V after some time. If you get aware that an accumulator voltage, although fully charged, drops dramatically – depending on accumulator size and quality - under load condition, it has reached it's end of life.

12. Extended Functions Menu

The Dani Extreme includes several additional parameter settings, to consider individual user preferences. Therefore the main menu includes an item "Extended Functions".

When choosing EF in the main menu, "00" is displayed after a short delay. When the button is pressed now, a blinking pattern is displayed to indicate that the user is now entering the extended functions menu. Consecutive pressing the button, the user steps between the sub-menu items.

Note that the pattern will not disappear until the button is pressed again (without time limit).

In the following the EF menu-items are explained in detail:

1. Lu => Luminosity of display

Changing the value of Lu will set the brightness of the display in 5 steps. A value of 1 selects the least brightness, 5 selects the highest. The default setting is 4.

2. St => Switch off Time

The switch off time selects the time in minutes for the switch off, when the button is not activated. The minutes to be selected are 1, 5, 10, 15, 20, 30, 60 or 90. Note that selecting 1minute together with a setting of Oc=0 the batteries capacity can be fully exploited without any further latency. The default setting is 60 minutes.

3. Oc => On Clicks

On clicks defines the number the button has to be pressed before the devices is switched on (after it was switched off). When 0 is selected immediate power output is possible when pressing the button longer than 0.25sec. The Oc range is 0-5 and the default value is 5.

4. Ac => Activation clicks

In contrast to Oc, this menu item selects the number of clicks to enter the menu structure. The number can be selected between 1 and 5 and 1 is the default value.

5. Ct => Click Time

When you step through the menu, this value defines the duration of the item display and value display. The range is from 1 (fast), 2(medium fast) and 3(slow). Note that the timing within the EF-menu is always set to "very slow", as this menu is used less often (2 sec. menu item, 2 sec. value) and the user is not so familiar with the different entries.

6. Ec => Error Control

The user can chose whether to use the wiring resistance range-check feature or not. When disabled (0) the faults F2/F3 (resistance too high/low) are no longer displayed nor are to be acknowledged. When the vaporiser is removed, F1 is only displayed when attempting to fire. The fault condition resets after the vaporiser is attached again. The default setting is "range check disabled" (0).

When enabled the display instantly shows F2/F3 when the fault condition occurs. The fault has to acknowledged by pressing the button longer before vaping is possible again.

7. Ho => Half Watt Steps on/off

With this parameter set to 1, half wattage steps are selected for the Pu/Pd menu. For half watt steps the right decimal point in the display is lid, for example „09." designates 9.5Watt.

8. SA => Select AC-check ohms

SA selects between two different ways of AC-measurement. When set to 1 the linearised measurement is chosen (50kHz), whereas when set to 0 a 200kHz measurement is performed. The AC-resistance value is displayed when pressing the button after the DC-value in Co (Check ohms) is displayed.

9. Sd => Set defaults

Set defaults helps when the user got lost with any settings.

The default settings are as follows:

Lu	4	Display brightness
St	60	Time-out switch off after 60 minutes
Oc	5	Press button 5 times to switch on device
Ac	1	Menu is entered after 1 short click
Ct	3	slowest menu entry
Ec	0	Wiring resistance check disabled
Ho	0	On watt steps selected for Pu/Pd menu
SA	0	AC resistance check with 200kHz not linearised

13. Further remarks

1.   Fault condition F1 and resistance range check

As mentioned, on the Dani Extreme the fault or error control can be enabled or disabled in the extended functions menu (Ec=1 enabled, Ec=0 disabled).
In case the control is enabled, the permitted resistance range depends on the setting of the SA parameter, which chooses the type of AC-resistance measurement. (The fault condition must always be acknowledged when Ec=1).

1.1. With SA=1 (measurement as on Dani V1 and Dani Basic), the resistance range check only refers to the DC-resistance measurement.

a) up to 15W the minimum permitted resistance is 0.6 Ohms, above 15W it is 0.9 Ohms (DC-measurement)

b) the maximum permitted resistance value is 3.2 Ohms independent from wattage (DC-measurement)

Outside this range F2 and F3 respectively are displayed.

1.2. With SA=0 (modified AC-measurement) the limits are defined as:

a) up to 15W the minimum permitted resistance is 0.6 Ohms, above 15W it is 0.9 Ohms (DC-measurement)

b) the maximum permitted resistance value is 6.2 Ohms (new AC-measurement)

Outside this range F2 and F3 respectively are displayed.

2. Behaviour during certain values of Oc (On clicks) and Power off

The device can be switched off either explicitly by entering menu So (Switch off) or it switches itself off after the time-out minutes.
With the extended function menu OC (On clicks) the number of button actuations can be chosen to switch on the device.

Now, for an Oc-value of 0, i.e. instant power on and possible vapouring, there is a safety issue (risk), in case that the device is unintentionally clamped in a bag or whatever or lays inauspiciously on an edge. It might happen then, that the device switches on unintentionally, powers the heater winding, then goes into fault condition F7 (maximum vaping time exceeded), reaches the (short) time-out for power off and instantly powers on again and so forth in an endless loop.

Therefore a protection feature is implemented as follows:

1. If, for a value of Oc less or equal to 2 AND (at the same time) a fault condition AND after time-out power off, then the device can only switched on by consecutive pressing the button 5 times. This is only required one time for the just mentioned conditions. After this the device works again with the pre-set value of Oc.

2. If, for a value of Oc less or equal to 2 and the device is actively switched off by the user with selecting So (Switch off), the device can only be switched on by consecutive pressing the button 5 times.

14. Further technical data and specifications

Maximum ratings specify those values beyond which the operation of the device is not guaranteed and damage or even destruction can not be excluded.

Maximum input supply voltage   4.5 Volts
Maximum input current   8 Amps

As a protection against malfunctioning which could lead to high input currents and self heating, the battery holder is equipped with non-replaceable 8Amps melting fuse.

Parameter	Minimum	Typical	Maximum	Unit
Output Power (+/-10 %) @ resistance 0.7-3.1 Ohms	5		15	Watts (rms) at load (1)
Output Power (+/-10 %) @ resistance 1.0-3.0 Ohms			20	Watts (rms) at load (2)
Input voltage battery (operation range electronic)	2.5 (1.5)	3.4	4.2 (5.0)	Volt
Self-current consumption stand-by		22		mA (Vin=3.5V)
Self-current consumption display active		100		mA (Vin=3.5V)
Self-current consumption during power output		30		mA (Vin=3.5V)
Efficiency		95		% (@10 Watt)
Switching frequency		200		kHz
Resistance range, measurable	0.3		9.9	Ohm (3)
Switch off temperature limit (PCB temperature)	52	55	60	°C
Leakage current switched off		1	5	µA
Leakage current reverse polarity			10	µA
Temperature range	-20		40	°C

(1) Maximum output power within specified voltage range (Sb + 0.5V up to 4.2V) and specified resistance range (0.7 to 3.1 Ohms)

(2) Maximum output power within specified voltage range (Sb + 0.5V up to 4.2V) and specified resistance range (1.0 to 3.0 Ohms)

(3) Measurements in the range of 0.3 to 9.9 Ohms are possible, but outside the range of 0.7 to 3.1 Ohms the results might be less accurate.

- Subject to changes without further notice -