

Service  
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HQ 3865/B  
HQ 4845/B  
HQ 4865/B  
HQ 4885/B

Domestic Appliances and Personal Care

# Circuit Description

## INTRODUCTION

The Nudos shavers with NiCd cells can be recharged in 30 minutes by means of a Fly Back Self Oscillating Power Supply (SOPS).

This electronic circuit enables cells to be recharged at 100-240 V<sub>~</sub>.

It is possible to shave directly from the mains, provided the voltage exceeds 100V<sub>~</sub>.

The on/off slide has a locking device, which prevents the shaver from being switched on accidentally. Leaving it connected to the mains after it is fully charged will not damage the shaver.

However, the life of the cells may be shortened if the shaver is kept permanently connected.

If the shaver is kept in the case when charging, make sure that the lid is open to prevent overheating.

## HINTS FOR REPAIRS

### a. Disassembly

- Remove the shaving unit, to prevent damages during repairs.
- Remove screws A1 (4X, of which 2 are under trimmer slide).
- Put the shaver on the table and remove the cover (item 26) from the shaver.
- The trimmer can be removed by pushing the hinge points ('Y' in exploded view, near item 11) slightly inwards.
- Detach the motor clamping springs (item 18) on the bearing block with a small screwdriver.
- The PC-boards with motor can now be removed from the housing.
- Remove screws A2 (2X).
- Unlock the snap connection (3X) between frame (item 14) and hair chamber (item 11).
- If the Power Module (item 23) and Time Control Module (item 7) have to be separated, read the instructions under IMPORTANT.

### b. Assembly

- The assembly must be carried out in reverse order of what is described under a. Disassembly.
- The trimmer slide can be snapped into the cover last.



## TECHNICAL DESCRIPTION

The electronics for the Nudos shavers with NiCd cells consist of 2 modules: a Power Module (PM) and a Time Control Module (TCM), connected via a 5-pin connector.

## POWER MODULE

The PM consists of a High Voltage Integrated Circuit (HVIC) and some external components, regulating the following functions:

- a. a current controller to adjust the charge current at 1200 mA or at 100 mA.
- b. a 2.5 V  $\pm$  dynamic supply controller for shaving from the mains.
- c. a primary current limiter (max 400 mA) to protect the transformer from saturation.
- d. a frequency limiter (max 60 kHz).
- e. an open cell protection ( $V_{bat} > 5V$ ).
- f. a temperature protection ( $T_{chip} > 140^{\circ}C$ ).

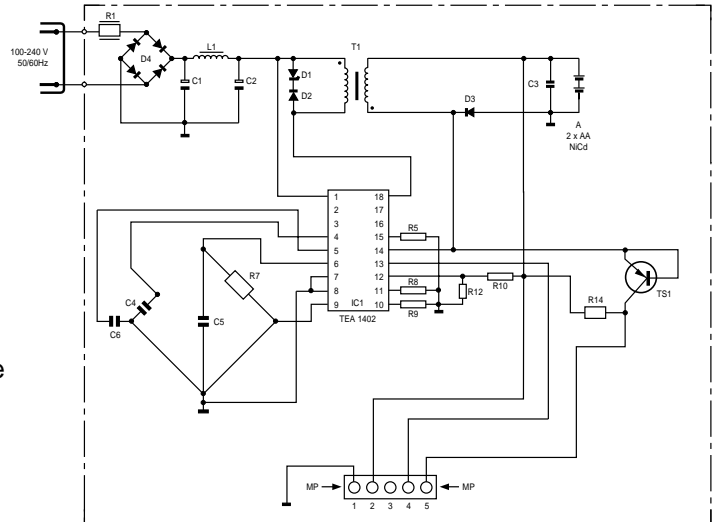
The mains voltage is full-wave rectified by D4 and smoothed by  $\pi$ -filter C1-L1-C2. This filter also serves as a radio interference filter (RIF) for the SOPS and motor and as a suppressor of voltage transients from the mains. Resistor R1, which functions as a fuse, limits the switch-on (inrush) current and the transient (surge) current. The resistor interrupts in case of a too large mains current due to improper use or internal short circuit. The primary-current circuit consists of the primary winding of T1 and the high-voltage switch inside the HVIC (IC1). Snubber circuit D1-D2 limits the voltage across the primary winding during commutation. During the flyback of the converter (when the switch is open) the secondary winding of T1 will deliver the primary energy across D3 and R2 to the cells or to the R26 sensed motor.

## TIME CONTROL MODULE

The primary function of the TCM is:

Monitoring the capacity of the cells during charging and discharging.

- controlling the 3 charging modes:
  1. 1200 mA during max. 30 minutes.
  2. 100 mA if the voltage across the 2 cells exceeds 2.5.V and charging exceeds 30 minutes.
  3. 200-1800 mA at 2.5 V when the motor is switched on at the same time.



The TCM has 3 variants:

- HQ3865 with 4 green LEDs and 1 red/green duoLED.
- HQ4845 with 1 red LED and 1 green LED.
- HQ4865 with 4 green LEDs and 1 red/green duoLED.
- HQ4885 with LCD, 1 red LED and 1 green LED.

When the PM is connected to the mains, a signal will be generated by the SOPS, which is recognised by the TCM as 'mains on'. Depending on the frequency of this signal, the TCM forces the PM into the quick charge mode as long as the capacity counter has not reached the 'full' state. After max. 30 minutes the PM is set to the slow charge mode. If during charging the shaver is switched on, the PM is set to the dynamic 2.5 V mode, in which the control switches from TCM to PM. With empty cells this means that no charging takes place till the cells reach the 2.5 V  $\pm$  level, consequently the capacity counter is not activated. If the cell voltage is higher than 2.5 V, the motor current will come from the cells. The capacity counter will now count down, as signalled via R26. If the voltage drops below 2.5 V again, the PM takes over the supply of the motor current.

During charging and discharging the IC calculates the capacity available in the cells and subsequently generates signals to activate the LEDs and/or LCD, the sequence being:

**HQ4845**

The green LED '+' goes on.

If the cells are almost empty the red LED '-' will go on as well.

When the red LED goes out, there is enough capacity for one cordless shave of approx. 3 minutes.

After 30 minutes the green LED starts to blink, to indicate that the cells are full.

The signals during shaving are described under 'ALL'.

**HQ3865 + HQ4865**

One of the LEDs of the capacity indicator will start to blink.

If the cells are almost empty, the block '20' will be red. When it turns green, there is enough capacity for one cordless shave.

Each time when another 20 % of the full charge has been reached, the next block of the indicator will start to blink.

After 30 minutes, the '100' block starts to blink.

This LED stops to blink as soon as shaver is fully charged.

If charging is continued (in the 100 mA mode now), the IC will force the PM to supply 1200 mA for half a sec. every 10 secs to compensate for the continuous burning of the LEDs.

When switching on and off, the actual capacity is shown for approx. 8 seconds.

After shaving cordless with a fully charged shaver for some time, the '100' LED will be no longer visible. Then, the other blocks will gradually disappear one by one.

The next signal is described under 'ALL'.

**HQ4885**

The green LED goes on and one segment of the LCD will start to blink.

If the cells are empty, this will be the '20' segment.

The red LED will remain on until there is enough capacity in the cells for one cordless shave of approx. 3 minutes.

Each time when another 20 % of the full charge has been reached the next segment will start to blink.

After 30 minutes the word 'FULL' and the green LED start to blink.

When shaving cordless with a fully charged shaver, first 'FULL' will disappear.

After some time the '100' segment will disappear, etc. Finally, a blinking '20' segment will show together with the red LED, as described below.

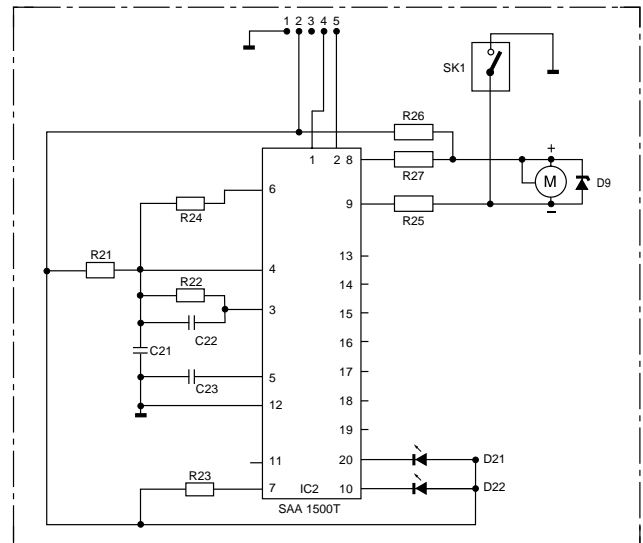
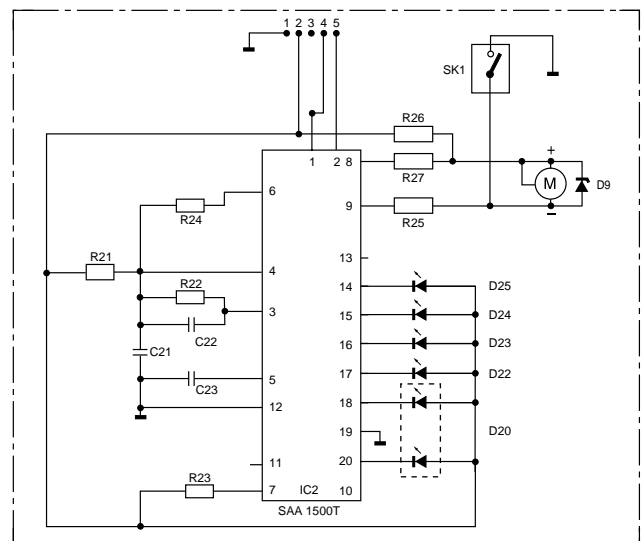
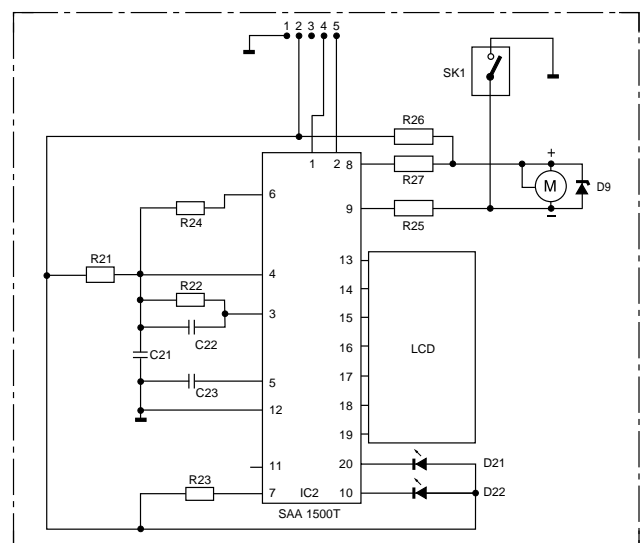
**ALL**

During discharging the capacity counter counts down proportional to the motor current.

When the counter reaches the 'zero' state, a Nearly Empty Indication (NEI) is given by the red LED.

After the shaver has been switched off the red LED will blink for 4 seconds.

If the shaver is not in use, the counter will count down at a slow rate during approx. 200 days, to compensate for the self-discharge of the cells and the power consumption of the ICs.

**HQ 4845****HQ 3865/HQ 4865****HQ 4885**

## SELF TEST FUNCTION

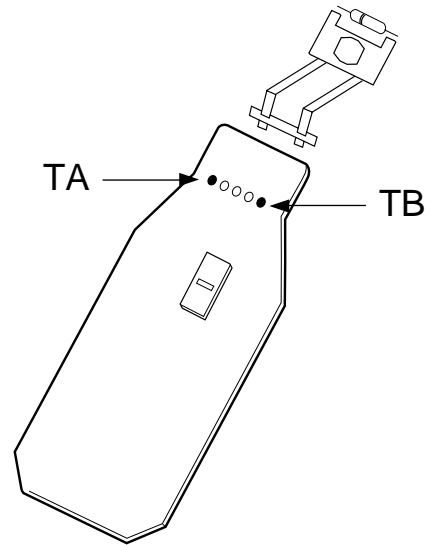
The TCM has a test mode, which can only be used to test the TCM.

A precondition is that the appliance is not connected to the mains and that the cells are in a good condition.

Take the PCB-unit with motor out of the appliance and put it on the table upside down.

Disconnect the PCBs for a short moment to reset the TCM.

Connect points 'TA' and 'TB' (the outer contacts of the connector) with a test cord.



### Be careful, don't cause a short circuit!

The LEDs/LCD will now indicate the charging cycle in an accelerated way.

Disconnect 'TA' and 'TB'.

The discharge cycle is simulated by operating the on/off switch and by connecting 'TA' and 'TB' again. After approx. 1 sec. the Nearly Empty Indication is given by the red LED.

Disconnect 'TA' and 'TB'.

After the motor has been switched off, the red LED will blink for 4 secs.

## IMPORTANT

If the 2 modules have to be separated during a repair, the TCM will lose all data on charging status.

When reconnected, the TCM will indicate the 'Recharge' status.

If the shaver is now connected to the mains, the charging current will be 1200 mA during 30 mins. Depending on the capacity left in the cells, this high current may overheat the cells (but will not harm the cells), resulting in a higher temperature of the rear cover.

**To prevent this, always let the shaver run till the motor stops and then recharge again.**

As peak voltages may destroy electronic components on the TCM, a good working Zener diode (D9, item 20) is essential.

Therefore a new Zener must be fitted after replacement of a PM or TCM.

Never let the motor run without Zener diode!

ICs and other components are susceptible to electrostatic discharges (ESD).

Careless handling during repair can result in a drastic reduction of their lifetime.

When making repairs, make sure that you are connected to the same potential as the mass of the PC-boards via a wrist wrap with resistance.

Keep components and tools also at this potential.



NiCd cells contain substances which may pollute the environment.

Dispose of old cells at especially assigned places.

For a good performance of NiCd cells the shaver is to be recharged at least twice a year for 8 hours or longer.

This also applies to discharging: run the shaver until the motor stops at least twice a year.

The production code can be found in the hairchamber (item 11) as YYWW.

The batchnumber is indicated by the next digits and is for factory use only.

## NOTES: