Service
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HQ 5830/A
HQ 5850/A HQ 5853/A
HQ 5870/A
HQ 5890/A

Domestic Appliances and Personal Care

Circuit Description

INTRODUCTION

The CIRRUS shavers with NiMH cells can be recharged in 60 minutes by means of a Fly Back Self Oscillating Power Supply (SOPS).
This electronic circuit enables cells to be recharged at 100-240 V≂.
It is possible to shave directly from the mains, provided the voltage exceeds 100 V≂.
By means of charging cord HP1957, the shavers can be recharged at voltages in the 12-24 V⎓ range.
A full charge then requires approx. 16 hours.
The HQ5830 and HQ5850/HQ5853 on/off slide has a locking device which prevents the shaver from being switched on accidentally, where the HQ5870 and HQ5890 have an electronic on/off push button.
The shaver will not be damaged by leaving it connected to the mains after it is fully charged.
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.

The name 'CIRRUS' has no special meaning.
From now on all new shaver families will bear names related to things that can be seen in the sky.
This name is for factory use only.

HINTS FOR REPAIRS

a. Disassembly

- Remove the shaving unit, to prevent damages during repairs.
- Remove screws A1 (2X, of which 1 is under trimmer slide).
- Put the shaver on the table and remove the cover (item 19) from the shaver.
- To remove the trimmer, first disassemble the trimmer slide by pushing down the locking pegs (2X 'X' in exploded view).
  Make room between trimmer and cover at 'Y' with a small screwdriver.
- Remove screws B2, brackets (item 4 and item 15), side panels (item 3/25, not in HQ5830) and screws B1.
- The PC-boards with motor can now be removed from the housing (first lift the PCB from the housing, then slide the motor out).
- Detach the motor clamping springs (item 14) on the bearing block with a small screwdriver.
- If the Power Module (item 16) and Time Control Module (item 10) 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.

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TECHNICAL DESCRIPTION

The electronics for the Cirrus shavers with NiMH cells consist of 2 modules:
a Power Module (PM) and a Time Control Module (TCM), connected via a 8-pin connector.

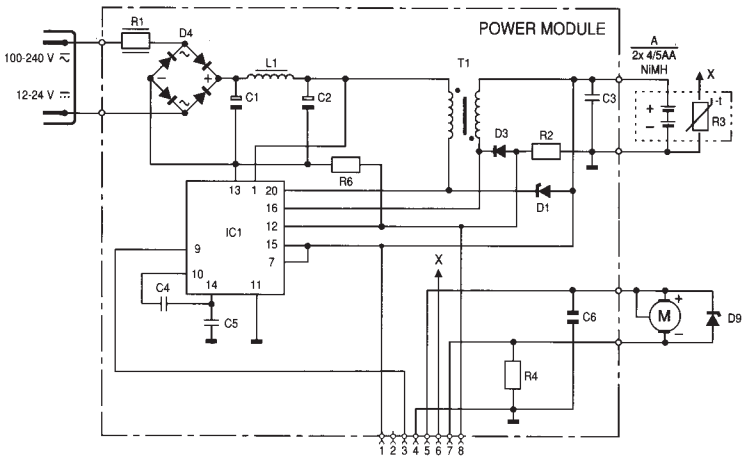
POWER MODULE

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

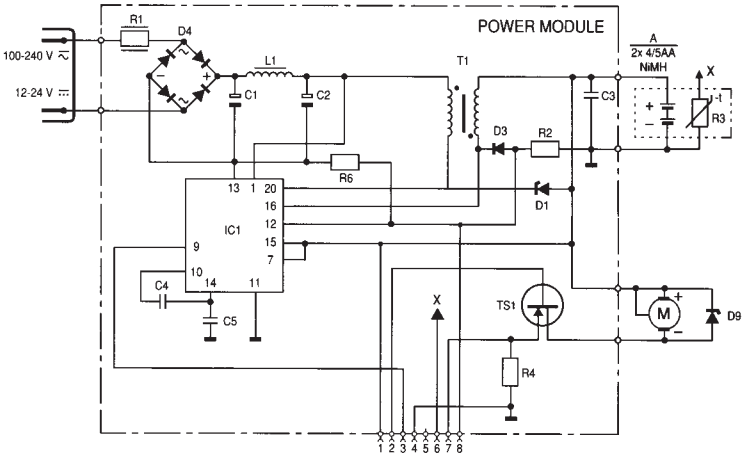
a. a current source to deliver the charge current.
b. a 2.5 V⎓ dynamic supply controller for shaving from the mains.
c. a primary current limiter (max 460mA) to protect the transformer from saturation.
d. a frequency limiter (max. 50 kHz).
e. an open cell protection (Vbat>5V).
f. a Vin-low detector to signal charging in the 12-24V range.
g. a temperature protection (Tchip>140°C).
h. a cell temperature protection (Tbat>65°C).

The mains voltage is full-wave rectified by D4 and smoothed by π-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).
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 R4-sensed motor.
As the life of NiMH cells decreases when the operating temperature is too high, a temperature protection has been provided by means of NTC resistor R3 (when it is switched on the charging current is reduced from 1100 to 110 mA.)
The life of NiMH cells may also be reduced by too high charging currents.
Compared to the Cirrus NiCd shavers this has led to a reduction of the charging currents and a consequent lengthening of the charging time.

There are two basic versions of PM:
a. a PM for the HQ5830 and HQ5850/HQ5853, where the motor is operated via a mechanical switch on the TCM.
b. a PM for the HQ5870 and a PM for the HQ5890, with an electronic switch TS1 (HQ 5890 not shown).



HQ 5830 HQ 5850/HQ 5853



HQ 5870 (HQ 5890)

TIME CONTROL MODULE

The primary function of the TCM is:

- monitoring the capacity and the temperature of the cells during charging and discharging.
- controlling the 5 charging modes:
  1. Quick Charge - 1100 mA during 1 hour.
  2. Slow Charge - 110 mA during 2 hours.
  3. Trickle Charge - approx. 25 mA if the voltage across the 2 cells exceeds 2.5 V and charging exceeds 3 hours.
  4. Dynamic Charge - 200-1800 mA at 2.5 V when the motor is switched on at the same time.
  5. Car Charge - 70 mA during max. 16 hours when connected to 12-24 V⎓.

There are four versions of TCM:

a. an IC-controlled version for the HQ5830, with 1 red LED and 1 green LED.
b. an IC-controlled version for the HQ5850/HQ5853, with 4 green LEDs and 1 red/green duoLED.
c. an IC-controlled version for the HQ5870, with switch electronics, LCD, buzzer and red/green duoLED.
d. a microcontroller (µC) version for the HQ5890, with interface IC, LCD, buzzer and green LED.

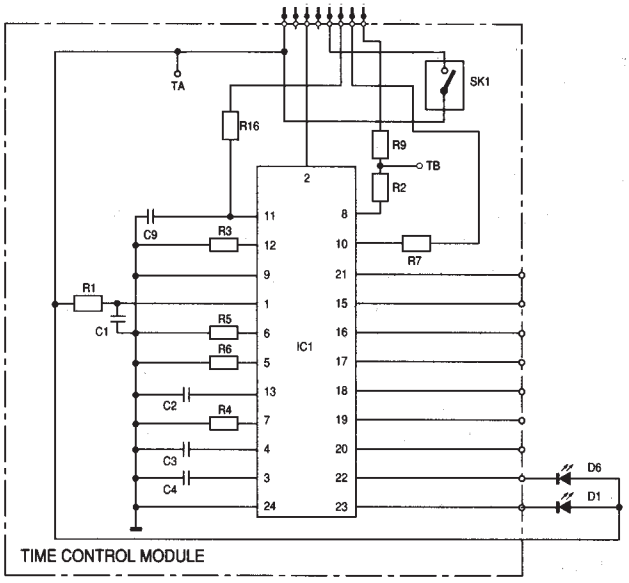
a-c. IC-controlled TCM - HQ5830, HQ5850/HQ5853

When the PM is connected to the mains the SOPS starts to deliver a current, resulting in a voltage over R2.
This voltage is sensed by IC1 on the TCM and is recognized as 'mains on'.
This voltage is also used to measure and adjust the charging current for the cells and to count the time during the 5 charging modes.
In quick charge mode the temperature is monitored via NTC resistor R3.
If Tbat>65°C, 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⎓ 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 R4.
If the voltage drops below 2.5 V again, the PM takes over the supply of the motor current.

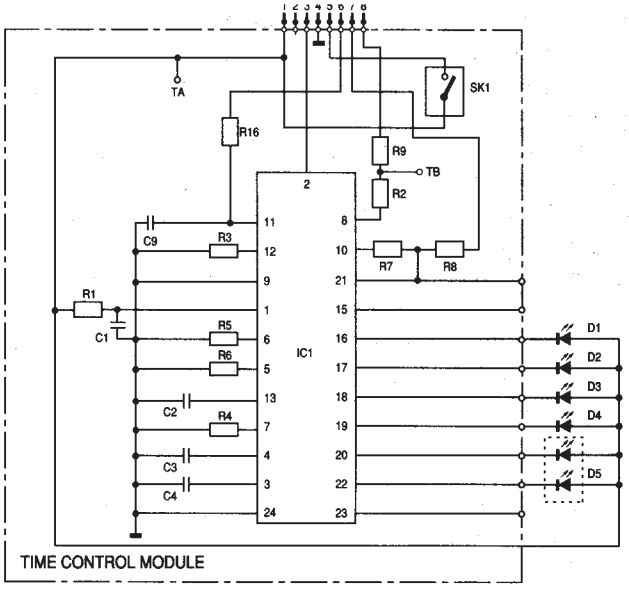
During charging and discharging the IC calculates the capacity available in the cells and subsequently generates signals to activate the LEDs and/or LCD, the sequence being:

HQ5830
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 mins.
After 60 mins. the green LED starts to blink, to indicate that the cells are full.
The signals during shaving are described under 'ALL'.

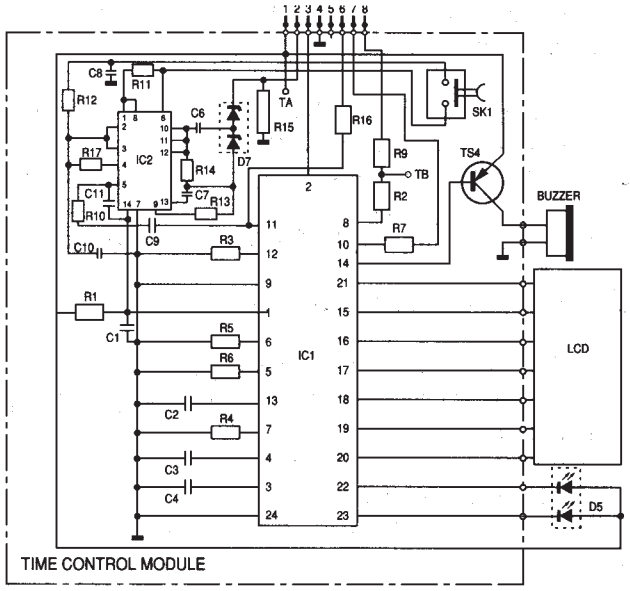
HQ5850/HQ5853
One of the LEDs of the capacity indicator will start to blink.
If the cells are almost empty, the block '20' will be red.
When it turns green, there is enough capacity for one cordless shave.



HQ 5830



HQ 5850/HQ 5853



HQ 5870

Each time when another 20 % of the full charge has been reached the next block of the indicator will start to blink.
After 48 mins., the '100' block starts to blink.
This LED stops to blink as soon as shaver is fully charged after 60 mins.
If charging is continued (in the 110 mA mode now), the IC will compensate automatically 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 no longer be visible.
Then, the other blocks will gradually disappear one by one.
The next signal is described under 'ALL'.

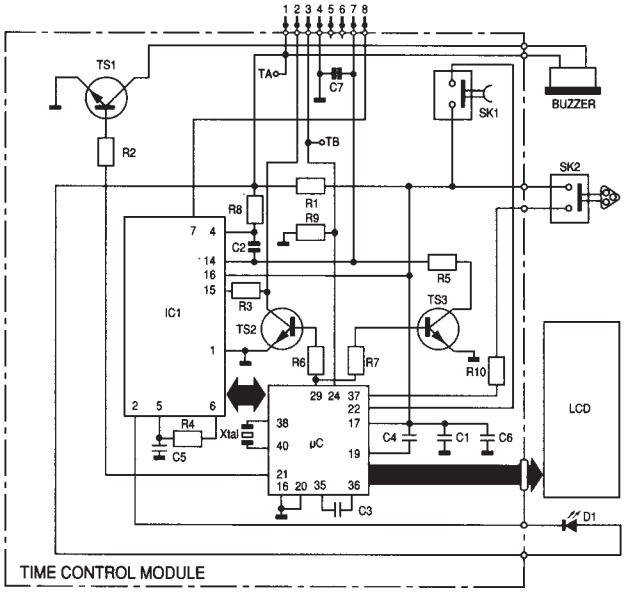
HQ5870
The green LED goes on and one segment of the LCD will start to blink.
If the cells are empty, this will be the '20' segment.
The red LED will remain on until there is enough capacity in the cells for one cordless shave of approx. 3 mins.
Each time when another 20 % of the full charge has been reached the next segment will start to blink.
After 60 mins., 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 a red LED.
After the shaver has been switched off, the red LED will blink for 4 secs., while the buzzer, if present, gives an attention signal (4 times 2 short beeps).

If the shaver is not in use, the counter will count down at a slow rate during approx. 100 or 200 days, to compensate for the self-discharge of the cells and the power consumption of the ICs.
(100 days at Tamb>35°C, 200 days at Tamb<35°).

d. TCM with microcontroller - HQ5890

The µC-TCM performs the following tasks:
- monitoring the capacity of the cells during charging and discharging.
- controlling the 5 charging modes.
- driving LCD and LEDs.
- electronic switching on/off of the motor.



HQ 5890

These functions are performed by 3 key components:
- the microcontroller (µC)
- an Interface IC (IC1)
- an LCD

Completely empty cells will be fully charged in 60 minutes, when the PM is in the fast charge mode (it will take approx. 16 hours in the 12-24 V car charge mode).
Theoretically, the cells are now charged to the maximimum capacity of 1100 mAh.
Due to tolerances in the charging process and the capacity of cells, the capacity stored is at least 750 mAh, which equals 70 % of the physical maximum.
This value is used by the µC to make the capacity calculations.

The cells can be charged to their physical limits by charging for another 4 hours in the trickle charge mode.

The capacity in excess of 750 mAh is available as reserve capacity and will not influence the capacity calculations.

During charging the LCD will continuously display the available capacity as 'SHAVES', displayed by 1 or 2 digits.

When the cells are almost empty, but there is enough capacity left for the µC to work, 'SHAVES' shows '0' and the mains plu symbol will blink.
Shaving is impossible now.
The µC 'knows' there is no capacity and refuses to activate TS1 when the on/off knob is operated.

At the moment the shaver is connected to the mains, the green LED at the bottom of the display will light up, the mains plug symbol will be black and '0' shaves will blink.

If the mains is disconnected now, the display will show 'RESERVE' and the mains plug symbol will blink.
However, if charging is continued, the SHAVES value will increase.
When the maximum capacity is reached, SHAVES shows 'FULL' as a running text and the green LED will blink.

If the shaver is charged for the first time, SHAVES show '23', being a programmed value.

Discharge takes place in 2 ways:
- during rest by self-discharge of the cells and power consumption of the ICs and µC.
- during shaving.

Because it is practically and physically impossible to measure the self-discharge current, the µC calculates that the cells will be empty after 200 days.
The µC will count down at a slow rate and adjusts the SHAVES digits accordingly.

If the shaver is left unused for a very long time, the cell voltage may drop below 1.95 V⎓.
This value, being the minimum working voltage of the µC, will reset the µC and will cause the LCD to go blank.

During shaving, the cells are discharged by the motor current.
This current is measured by the interface IC and converted to a freqency, which is the countdown input for the charge counter in the µC.
The SHAVE digits will be displayed accordingly.
To get accurate SHAVE values, the µC will have to learn the average motor current.
During the first discharge cycle (from 'FULL' to 'RESERVE') 'LEARNING' and programmed values will be displayed.
The second discharge cycle will show accurate values, based on shaving habits.
This implies that reliable calculations can be done only if discharge take place after a 'FULL' signal and recharge after a 'RESERVE' signal.

When the shaver is new, the 'FULL' signal will show the programmed 23 shaves.
After a certain time the SHAVES value may be lower, due to a higher motor current caused by insufficient cleaning of cutters and hairchamber.

When the LCD has jumped from '1' to 'RESERVE' and the motor is switched off, a Nearly Empty Indication (NEI) is given by means of a continuously blinking mains plug symbol, while the buzzer will give an attention signal.

When the cell voltage drops to 1.95 V⎓ during a shave, the shaver will stop working.
In this way the µC is protected from being reset, which would cause all data on shaving habits to be lost.
This status can only be cancelled by connecting the shaver to the mains.

As it is necessary to clean the hairchamber and shaving heads at regular intervals to obtain good shaving results, the µC will give an attention signal in the following ways:
-After every 21 minutes of shaving time the head holder symbol will blink on the display, while the buzzer will give an attention signal.
If the shaver is cleaned (i.e. the shaving head holder is removed) in between two regular cleans, the cleaning indication counter will be reset by switch SK2 (item 10B in the exploded view).
-During every ninth hairchamber cleaning indication, the cutter cleaning indication (shaving heads symbol) will be activated as well.
The shaving heads symbol will be displayed with the hairchamber symbol, while the Buzzer will give an attention signal.

In order to prevent false cleaning indications, only shaves longer than 10 seconds and shaves up to 4 minutes will be taken into account.
Shaves up to 10 secs. are considered as 'playing' with the shaver, while shaves lasting more than 4 minutes will not bring extra hair in the hairchamber.

The shaver is switched on by means of electronic switch TS1.
If a pulse is generated via on/off switch SK1, the µC will force the interface IC to supply a voltage higher than the cell voltage, resulting in a conducting state of TS1.
A next pulse will stop the motor.

SELF TEST FUNCTIONS

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

a. TCM with IC (fig. A and B.).

Connect points 'TA' and 'TB' with a test cord for a few seconds.

Be careful, don't cause a short circuit!

The LEDs/LCD will now indicate the charging cycle in an accelerated way.
During approx. 96 sec. the display will show the 'FULL' state.
This status cannot be interrupted.
When the self test is completed, the display and counters are set to the 'EMPTY' state.
Due to lack of memory in the IC the discharge cycle cannot be showed.

b. TCM with µC (fig. C).

1. Functional test
Take a test cord and press point 'TA' with a test pin.
Apply 4 pulses in all to point 'TB' with the other testpin (so that the original state of µC is reached again).
After the first pulse all segments of the display are visible (step 1).
During the second and third pulse the buzzer will give a short beep, while the display shows step 2 and 3.

2. Display test.
All segments will be visible when the on/off button and head holder release knob are pressed simultaneously.
This test can be done best when the shaver is assembled again - it will give a check on a proper working of the reset switch SK2 too.

3. Demo mode
When the on/off button is pressed for a few seconds, the µC will activate the demonstration mode.
The display will show all signals for 1 minute.
During the demonstration the motor is automatically switched on three times.
The demonstration mode can be stopped by pressing the on/off button again.

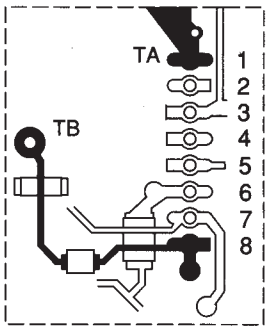


fig. A

HQ 5830
HQ 5850/HQ 5853

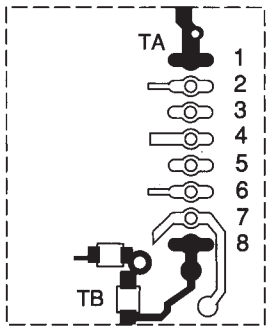


fig. B

HQ 5870

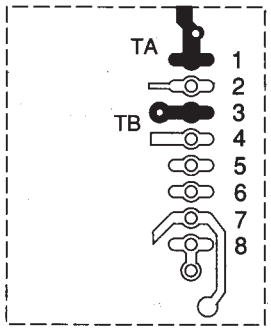
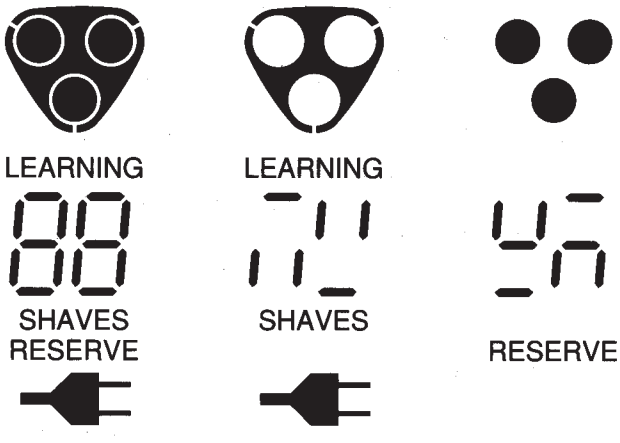


fig. C

HQ 5890



STEP 1 **STEP 2** **STEP 3**

IMPORTANT

If the 2 modules have to be separated during a repair, the TCM will lose all personal data on shaving habits. When reconnected, the TCM will indicate the 'Recharge' status.
If the shaver is now connected to the mains, the charging current will be 1100 mA during 60 mins. Depending on the capacity left in the cells, this high current may heat the cells and may cause the cell overheat protection to come into operation, resulting in a difference between cell capacity and TCM indication.
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 8 or 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!

ESD

ICs, µC and some 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.

NiMH cells contain less then 0.01 % cadmium.
Yet it is advised to ensure that the cells are separated from the normal household refuse and that they are disposed of at an officially assigned place.

NOTES:

The production code can be found in the hairchamber (item 2) on the ring near the release knob as YYWW. The next digits indicate the batchnumber and is for factory use only.