

NiMH TH-D7/universal fast charger

Introduction

The project for this NiMH fast charger originated from the widespread use of AA-rechargeable-NiMH batteries for the Kenwood TH-D7 portable transceiver, common in our radio club.

Eliminating the need for the standard 16-hour wall-charger and other multi-purpose-battery-chargers by creating a specific milled and 12V-powered charger was a surplus in the portable, exercise and emergency use of our set. The standard Kenwood 16-hour wall charger also puts the portable transceiver out of service for the charging time.

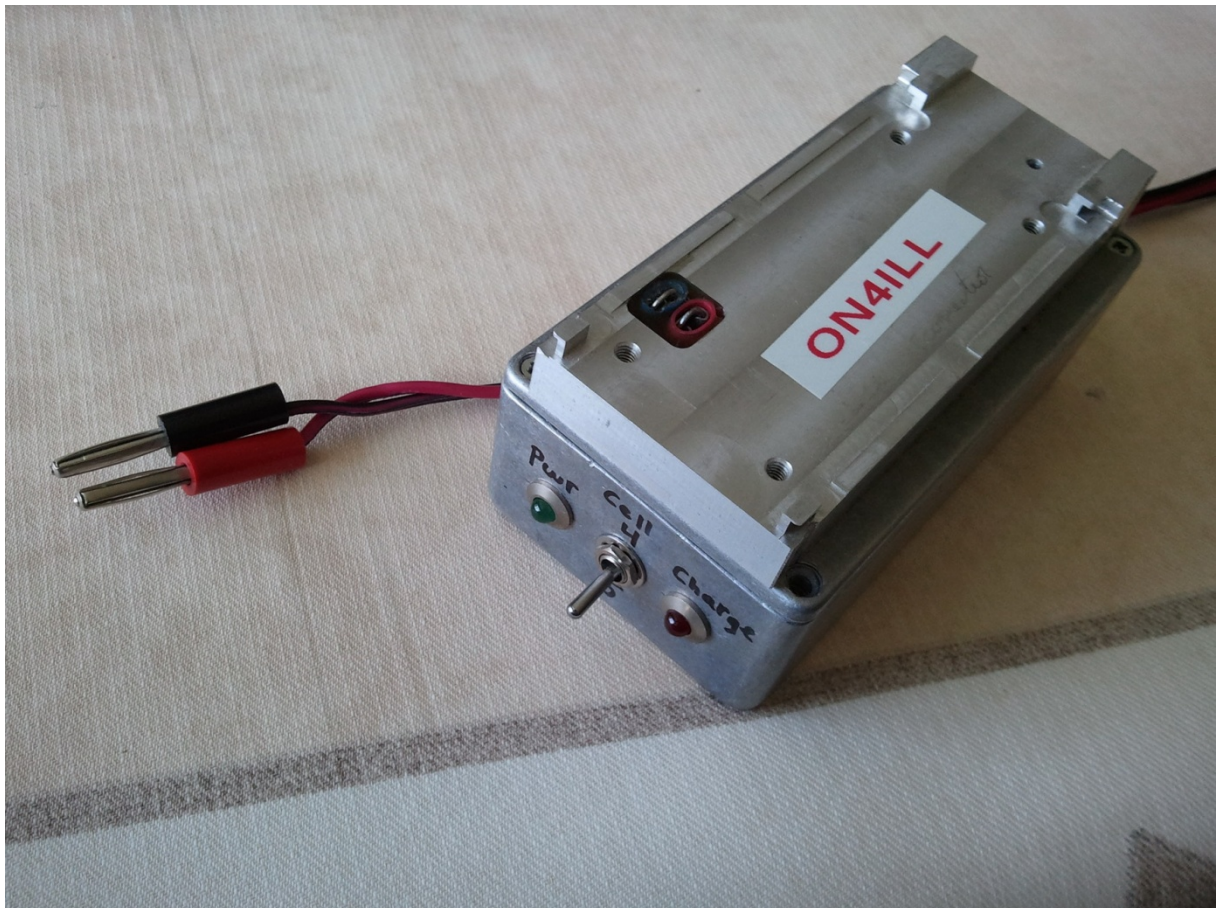


Figure 1

We want to thank everyone who contributed to the successful completion of this product, even though a name or callsign may be forgotten to be mentioned in this paper.

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I. Description

The NiMH fast charger is a compact and sturdy fast charger for NiMH batteries, based on the Maxim 712 IC. Other conditions to meet are selectable number of battery cells to load, and solid mounted battery pack.

The basic "Typical operating circuit" provided by the Maxim datasheet was implemented to maintain simplicity. Some components were added as described to set certain values concerning charge time and number of cells.

Indication of "Power-on" and "Fast charge" is available with LED's

For fixed operation a DIP switch is foreseen to select the number of cells to be charged.

Common battery packs used have 4 or 5 cells. Pins PGM0 and PGM1 are connected to different other pins of the IC selecting the right cell count

For more flexible operation, the DIP switch can be omitted, and instead have a toggle switch installed to the outside of the case. That way one can easily switch the charger to 4-, 5- or 6-cell charging. 6-cell is a nice addition with both PGM0 and PGM1 in open position, as 6-cell battery packs are coming into practice.

The charging timeout was fixed to 264 minutes including Voltage slope detection for charge termination. PGM2 and PGM3 are therefore connected to BATT-.

The charging current is defined by the R_{sense} resistor value over which the MAX712 will maintain a constant voltage of 0.25V

The TH-D7 battery pack was reverse engineered to create a solid milled aluminum mounting block for attaching the battery pack to the charger.

This aluminum block can also act as cooling rib for the power transistor.

The milled block is what makes this charger specific for the TH-D7 model. All electronic circuitry is off course universal to every NiMH/NiCd battery.

B. Circuit implementation by ON4RST

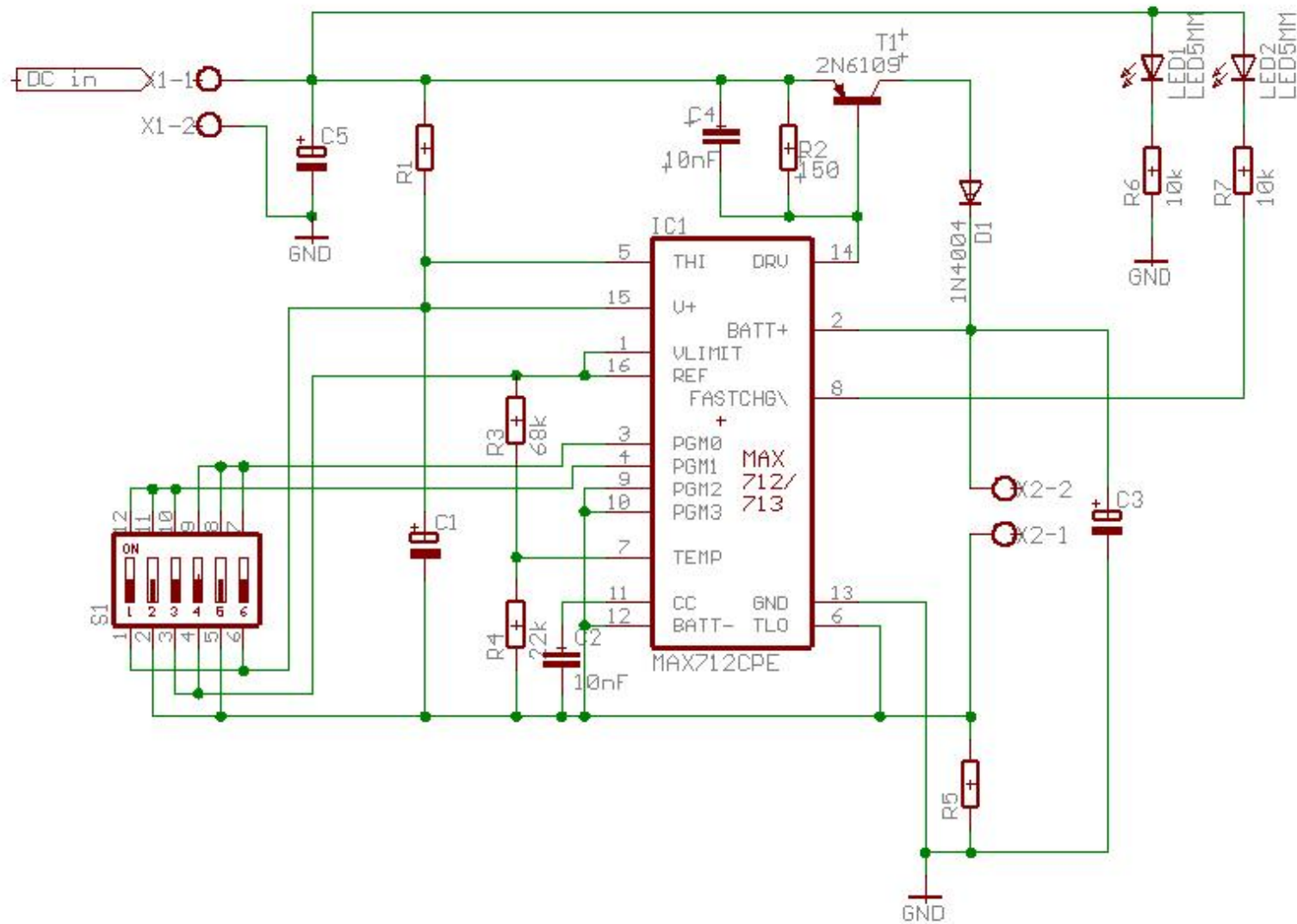


Figure 3

C. Calculation of components

The Maxim datasheet should always be used as a detailed reference.

1. Determining fast charge current

$$I_{fast} = \frac{(\text{capacity of battery in mAh})}{(\text{charge time in hours})}$$

*The 2N6109 transistor has a maximum of 7A collector current

2. Choosing input voltage/wall cube

The input voltage should always be minimally 6V and at least 1.5V higher than the maximum battery voltage when charging.

Operation at 12 or 13.8V is used throughout our design.

Operation up to 20VDC should be permitted without modifications to the circuitry, yet still the power requirements of different components should be verified

3. Power transistor power dissipation

$$PD_{pnp} = (\text{maximum DC input voltage} - \text{minimum battery voltage}) \times I_{fast}$$

4. R1 value

$$R1 = \frac{(\text{minimum DC input voltage} - 5V)}{5mA}$$

$$PD_{R1} = < 0.25W \text{ (if DC input } < 17.5V)$$

$$PD_{R1} = < 0.3W \text{ (if } 17.5V < \text{DC input } < 20V)$$

5. Rsense (R5) value

$$R_{sense} = \frac{0.25V}{I_{fast}}$$

$$PR_{sense} = I_{fast} \times 0.25V$$

6. Fuse

A fuse should also be connected in series with a value depending on the required charge current. Mostly a 2A fuse will do.

7. Other components

The DIP switch used is a 9-switch version. A 6-switch version would suffice but at the time being only a '9' was available. Yet a 6-switch should fit just as fine in the same position.

The DIP switch settings will determine the number of cells to be charged.

As a replacement for the DIP switch a regular dual pole toggle switch can be used. Using a two-position ON-ON switch makes 4 or 5 cell choice available. When a three-position ON-OFF-ON switch is used, one can choose 4, 6 or 5 cells. The center position is an open position which turns the MAX712 into 6-cell mode.

Each pole center contact shall then be connected to PGM0 or PGM1.

The other contacts will be wired following this schematic:

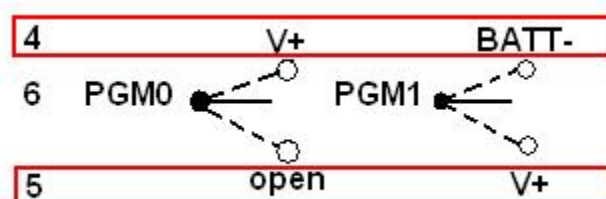
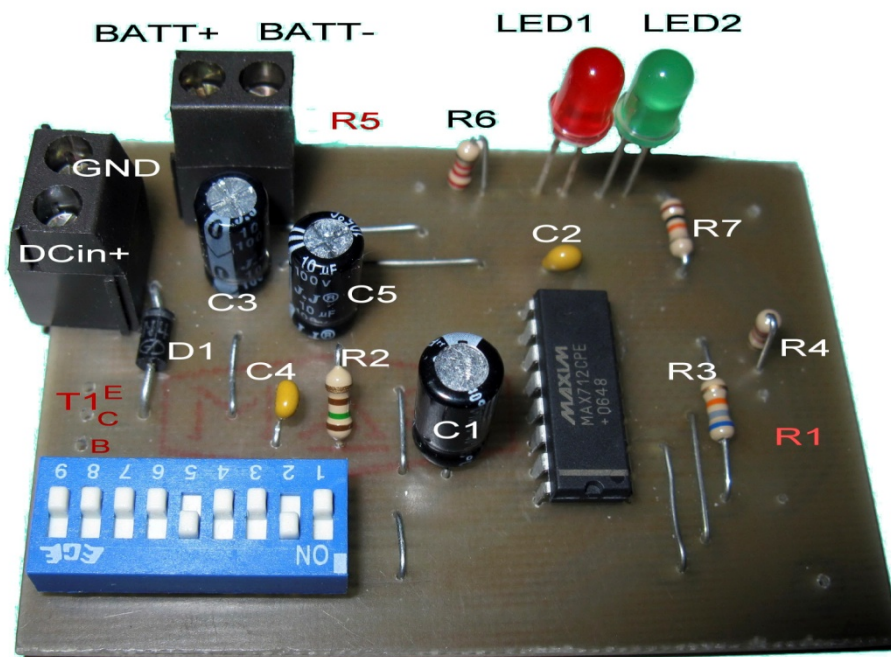


Figure 4

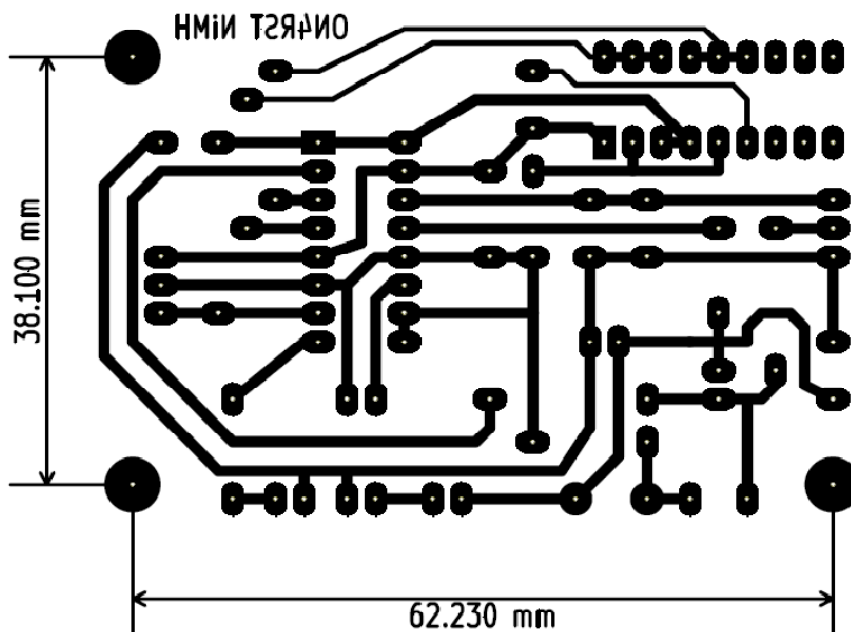
D. PCB Layout – component side



Items marked in red are not yet placed on this picture. Parts not shown are T1 transistor, R1 (R_{shunt}) and R5 (R_{sense}). R5 and R1 shall be calculated according to paragraph C.4.

E. PCB Layout – track side

A PCB layout is shown here for the enthusiast willing to replicate the project. The PCB has been drawn with the freeware program **KiCad**, available for Linux and Windows operating systems. The data file can be obtained on simple request or via <http://www.on4rst.org> to facilitate PCB replication.



III. Component list

A. Resistors

- R1 (R_{shunt}) - 1k3 1/4W (See also II.C.4)
- R2 – 150R 1/4W
- R3 – 68k 1/4W
- R4 – 22k 1/4W
- R5 (R_{sense}) dependent of charge current (See also II.C.5)
- R6, R7 – 10k 1/4W

B. Capacitors

- C1 – 1 μ F/35V
- C2, C4 – 10nF/35V
- C3, C5 – 10 μ F/35V Electrolytic

C. LED's

- LED Green
- LED Red

D. Diode

- D1 – 1N4001 (or 1N4004)(or 1N5822 for I_{fast} between 1A and 3A)

E. Transistor

- T1 – 2N6109 TO-220 package or equivalent
- TO-220 mica mounting kit (e.g. RS402-456 from RadioShack)

F. IC

- IC1 – Maxim MAX712

G. Other

- Fuse (See also II.C.6)
- DIP switch 6-switch (DIL12)

IV. Mechanical realization

A. Milled battery mount

The milled battery mount is what makes this charger special and specific for the Kenwood TH-D7 portable transceiver.

A simple battery contact point can be created with some crimp terminals and an inserted paperclip. (See Figure 1 on introduction page)

A modified version with a spring loaded contact point recovered from a broken Nokia 6210 Cell phone was made later on.

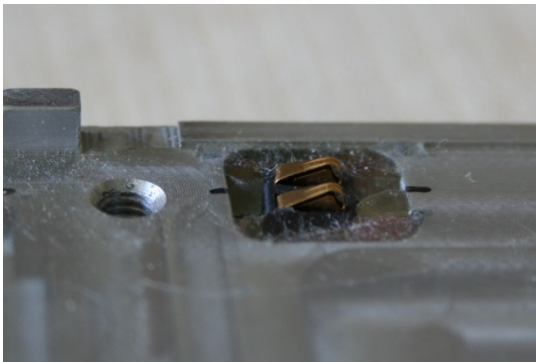


Figure 6

The spring loaded contact is actually built up from 2 separate springs and one plastic cover, soldered to some experimentation board.

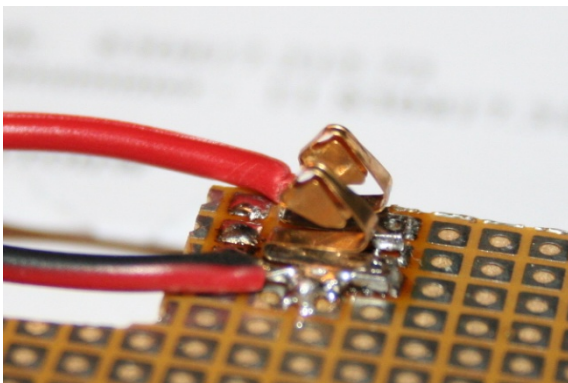


Figure 7



Figure 5



Figure 8

The whole part is then first positioned with some 'superfast glue' and then fixed with epoxy-resin.

B. Case

All members were left free of choice in mechanically mounting the charger.

The die cast aluminum box in the example picture comes from RadioShack (RS226-4127).

V. Project cost

The electronic components can be roughly bought for about €15~€20 in an electronics shop.

PCB creation is not included but for the electronic enthusiast not undoable.

The die cast aluminum case costs about €10.

The milled aluminum battery mount was a onetime creation and thus will take more effort from an experienced technician in reproducing it.

VI. Participating members

ON4ILL, ON2SWT, ON2KLS, ON2MAB, ON3RG, ON4DNL

VII. Project responsible

ON4ILL, Bonneux Stijn, on4ill@gmail.com

VIII. Project reference

<http://www.on4rst.org>

IX. Logbook of activities

End 2010 a request was made to create a charger for the Kenwood TH-D7.

On January 31, 2011, the project entered the UBA Homebrew challenge.

In February 2011 the aluminum blocks were reverse engineered and milled, ON2SWT handled this part.

March and April were then used to create the schematic, buy components and make a few test-PCB's using the "iron-method". Main operators were ON2KLS, ON2SWT, ON4ILL and ON4ABS. ON4ABS successfully experimented a lot in creating PCB's using the "iron-method".

Second week of May ON4CMO and ON4ILL created 10 PCB's in an etching tank.

The rest of May and June was then used to build up the chargers by participating members.

Except for some specific actions (e.g. milling and PCB ironing/etching), all activities were performed only on Wednesday evenings at the clubhouse.