

VARTA EasyPack

design-in handbook



**The easy way to
Lithium Polymer powered devices!**

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1. Introduction





The unique VARTA EasyPack is an off the shelf solution allowing design engineers to use a fully certified (UL, CE, IATA), safe, and professional LiPolymer battery pack, without worrying about non recurring engineering (NRE) cost for the pack itself, complex battery design management, worldwide regulations, or complex charger designs.

Electrical as well as mechanical integration into any customer device is easy and simply done. VARTA Microbattery provides chargers blueprint as well as ready to use 3-D CAD models for battery casing. So it's easy to slip the state of the art battery power into your device.

In addition, 3rd parties offer external charger solutions, either off the shelf or as customized solution for your individual design.

Standard 2.5 mm pitch connectors available from various suppliers allow easy electrical interconnection between EasyPack and your device electronics.

VARTA EasyPack batteries are currently available as a 3.7V Series in 4 different mechanical sizes: S, M, L and XL.

VARTA EZPack S-3.7V	VARTA EZPack M-3.7V	VARTA EZPack L-3.7V	VARTA EZPack XL-3.7V
			
VARTA EZPack S-3.7V Mechanical: Height 5.8 mm Width 35.4 mm Length 43.5 mm Typical Capacity: 550 mAh (A)	VARTA EZPack M-3.7V Mechanical: Height 5.2 mm Width 36.6 mm Length 64.5 mm Typical Capacity: 750 mAh (A)	VARTA EZPack L-3.7V Mechanical: Height 6.4 mm Width 36.6 mm Length 64.5 mm Typical Capacity: 1000 mAh (A)	VARTA EZPack XL-3.7V Mechanical: Height 11.4 mm Width 36.6 mm Length 64.5 mm Typical Capacity: 2000 mAh (A)

The battery capacity ranges at the moment from 500 up to more than 2000 mAh. Capacity improvements are under permanent development.

EasyPack fits best to devices like PDAs, POS, measurement equipment, communication equipment, GPS devices, and data loggers.

EasyPack is also a future proven system. Future capacity increases will automatically boost your device power – the associated EasyPack components like charger know already today how to manage the future.

This design-in handbook demonstrates the easy integration of VARTA EasyPack Li-Polymer battery packs into customer's devices.

Mechanical as well as electrical aspects are discussed.

In any case, the latest version of the VARTA EasyPack data sheets as well as the 'Handling, Precautions and Prohibitions for Varta PoLiFlex[®] batteries' must be observed in any design process.

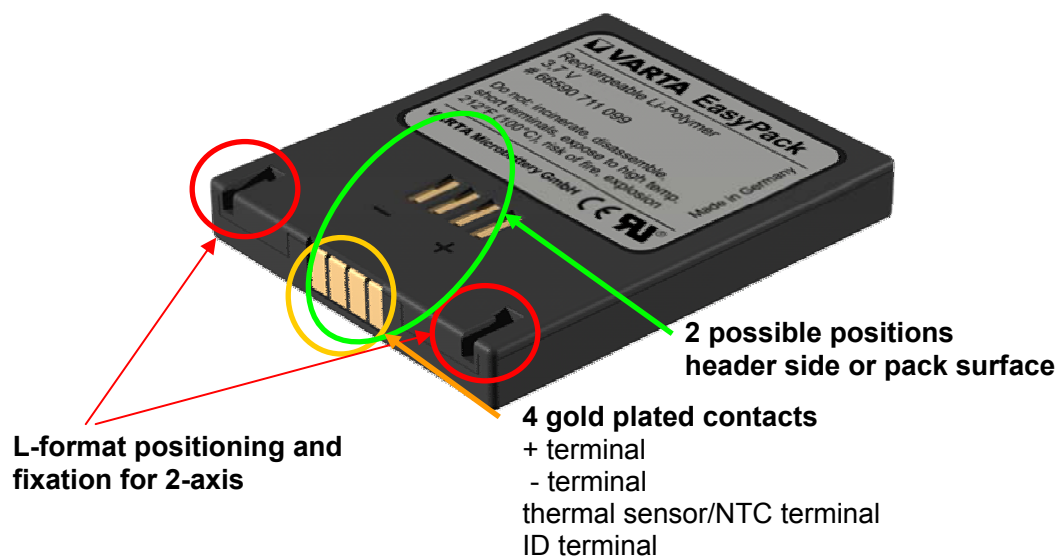
The documents are available at www.varta-microbattery.com.

2. EasyPack Concept

When design-in a Lithium battery, design engineers have to consider 3 major points:

- ➔ The pack itself:
Robustness, safety, worldwide legal regulations, performance.
- ➔ Mechanical integration:
How to get the pack fixed in my device and electrically connected.
- ➔ Charging:
What is the best way to get the battery charged?

VARTA EasyPack simplifies the handling of above mentioned points significantly. The pack it self bases on leading VARTA PoLiFlex[®] cell technology, which shows excellent performance, robustness and durability. Incorporated into a clever designed plastic shelf, the pack full fills worldwide binding regulation for Lithium Ion based packs, and is fully UL, CE and IATA certified. Thus, selecting VARTA PoLiFlex[®] ensures that your device can be used and sold world wide without the hassle to undergo lengthy and expensive certification procedures before your device mass production.



For mechanical integration, VARTA EasyPack incorporates two L shaped positioning recesses, which fix the pack mechanically in your device. 3D CAD models, available through VARTA Microbattery local sales offices, allow the simple design of fitting counterparts into your housing. Gold plated contacts (2.5mm pitch) give reliable electrical interconnection. Fitting contact blocks for your own PCB are available from multiple sources.

Last but not least, charging needs to be addressed. A detailed charge blueprint, including BOM, is available from VARTA Microbattery. Even simpler, the use of a external charge minimize layout efforts and circuit design on your side. 3rd parties offer appropriate solutions.

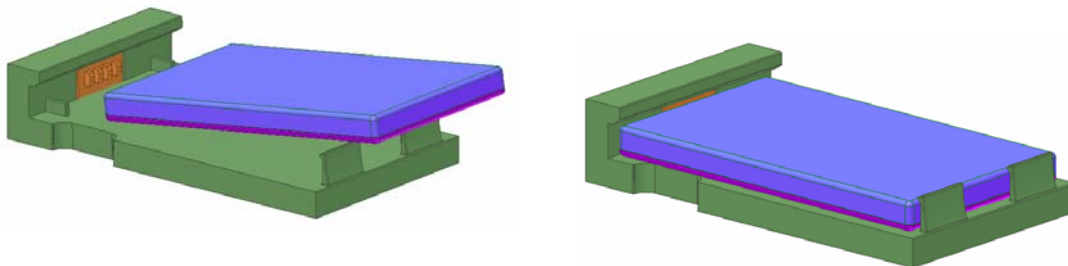
3. Mechanical integration

VARTA EasyPack offers two ways to contact with the device, either from the flat (bottom) side or from the header site. The decision which way is used depends from the mechanical requirements of your device. For the pack itself, it does not matter.

In the following, two typical ways to incorporate the VARTA EasyPack into a device are described.

a) Fixation by snap fit

Actually, the battery casing is a simple flat section with fitting counterparts towards the L-shape recesses of the pack, and a snap fit on the other side of the pack. In this case, the mechanical fixation of the pack towards x and y direction is given by the L-shape recesses in the pack itself and fitting L-shaped noses in the customer device. The z axis is fixed by the snap fits on one side and the nose on the header side of the battery pack.

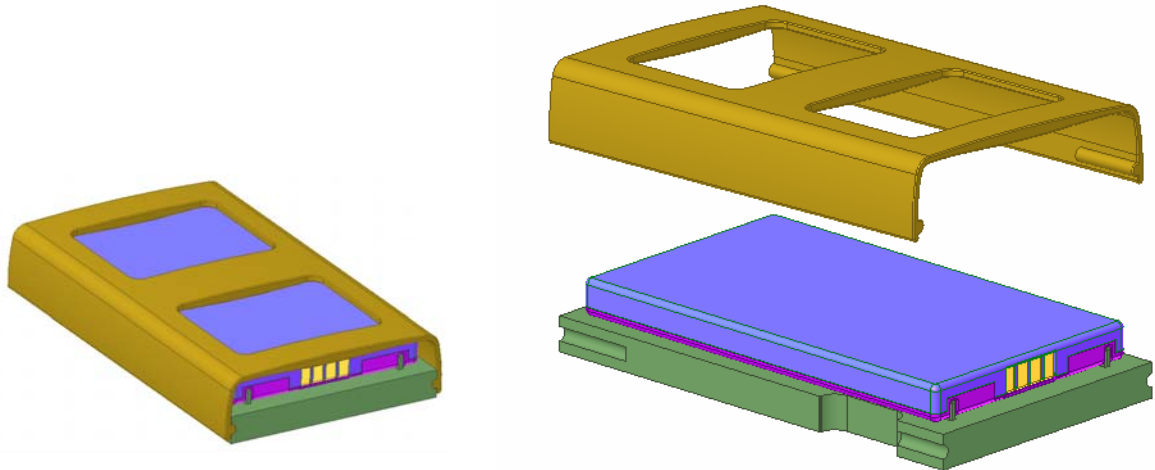


An additional device cover closes the battery casing.

The figure above shows how the battery packs are fitted into that cabinet. A 3D CAD model of above shown part is available from your VARTA Microbattery sales person.

b) Fixation housing

Using housing as shown in below figure is also a common alternative.



Once again mechanical fixation of the pack towards x and y direction is give by the L-shape recesses in the pack itself and fitting L-shaped noses in the customer device. The z-axis is fixed by cover – which in this case is sided onto the base plate. An additional sponge within the cover will compensate for tolerances.

The figure above shows how the battery packs is fitted into that cabinet. A 3D CAD model of above shown part is available from your VARTA Microbattery sales person.

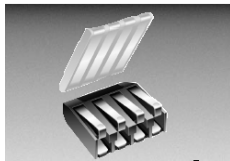
Of course, different designs of the device covers are possible. Above is just one example. The important point here is that the cover ensures a proper fixation towards the z axis.

c) Electrical interconnection

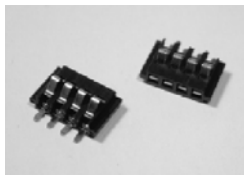
3 different vendors provide a fitting contact block to the VARTA EasyPack.



AVX 9155 MOBO (www.avxcorp.com)



Bourns 70 AAM (www.bourns.com)



SUYIN 25007 (www.suyin.com)

For detailed information about above mentioned contacts, please contact the vendors sales and technical offices.

d) EasyPack battery holder

Under investigation under investigation by 3rd party

4. Charging solutions

When deciding for a charging solution, it must be differentiated between

- internal charger
- external charger
- external charger – stand alone

However, before we start to discuss the implementation of the charger, let's understand first the principle charging techniques used for Lithium Polymer.

a) General hints about VARTA EasyPack charging.

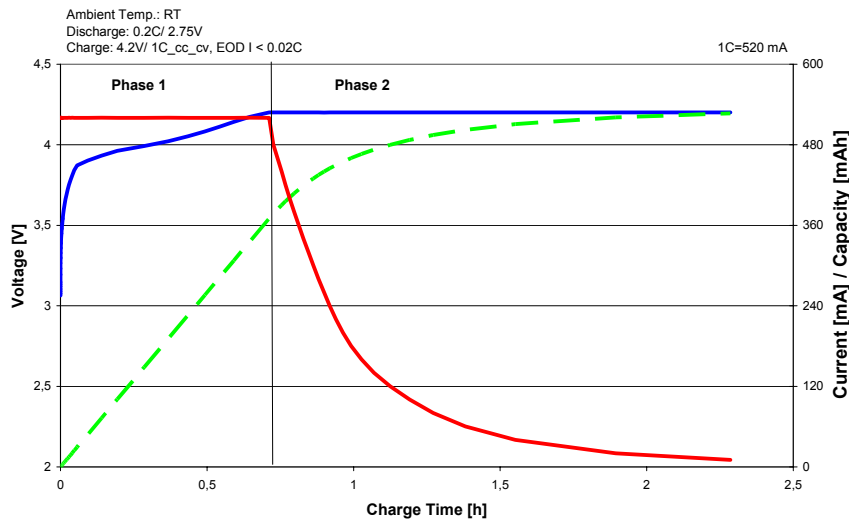
The optimal charging method for VARTA PoLiFlex® / VARTA EasyPack batteries is to apply constant current and constant voltage, same as the method used today for charging lithium-ion batteries.

Constant current is applied at the beginning of a typical full-charge cycle, when the battery voltage is low. When the battery voltage rises to a specified limit, the charger switches to constant voltage and continues in that mode until the charging current declines to the cell specific minimum charge current, or until the max charge time is reached. Under both conditions, the battery will be fully charged.

The maximum charge voltage is limited to 4.2V and should be controlled within tolerances of +/- 50 mV.

For standard charging, the initial charging current is limited to C/2. In this case, charging must be cut-off after 5 hours. For rapid charge, the initially used current is limited to 1C. In this case charging must be cut-off after 3 hours. In any case, charging must be cut-off when the minimum charge current 0.02C is reached.

Beside current and voltage limits, ambient temperature conditions should be considered for proper charging. Charging of VARTA EasyPack systems is allowed between 0°C and 45°C.



Above figure illustrates the different phases during a rapid charge cycle.

The battery in this example is a VARTA EasyPack 550, discharged down to 3.0V. So the battery is empty.

In phase 1, the maximum charge current of 1C is applied until the voltage level of 4.2V is reached. It shows how the discharged battery is rapidly charged by the maximum current of 1C. The Voltage level of 4.2V is reached after approximately 45 minutes. The 'Charged Capacity' line shows that approximately 70% of the capacity is reached at this point in time.

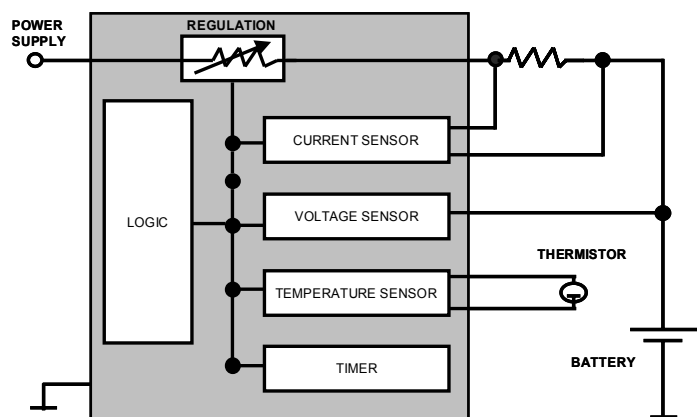
When the max charge voltage of 4.2V is reached, phase 2 of the charging starts. Now the voltage is controlled and the current is floating. During the constant-voltage phase, current drops exponentially due to the sum of battery resistance and any resistance in series with the battery (much like charging a capacitor through a resistor). When the minimum charge current (0.02C) is reached, the charging is stopped and the cell has reached 100% capacity. Alternatively, a build in time stops charging after maximum defined charge time is reached.

The semiconductor industries offer a broad range of charging ICs and application notes with implementation hints to support electronic hardware engineers to design the appropriate charging circuit for their devices. The figure below gives a building block for the main functions of such a charging IC.

The key elements of such charging IC are:

- current sensor
- voltage sensor
- timer
- temperature sensor
- logic and regulator block

Based on the sensor inputs, the logic controls the regulator block and ensures that neither voltage limits nor current limits are exceeded. The same is done with



the timer info. The temperature sensor is connected with a thermistor (PTC/NTC). Thus the charging IC is able to ensure proper charging within the specified temperature limits.

Additional, the charger design may support the reading of an ID resistor, allowing the charger to know what battery is attached, and thus allows to set an appropriate charge current.

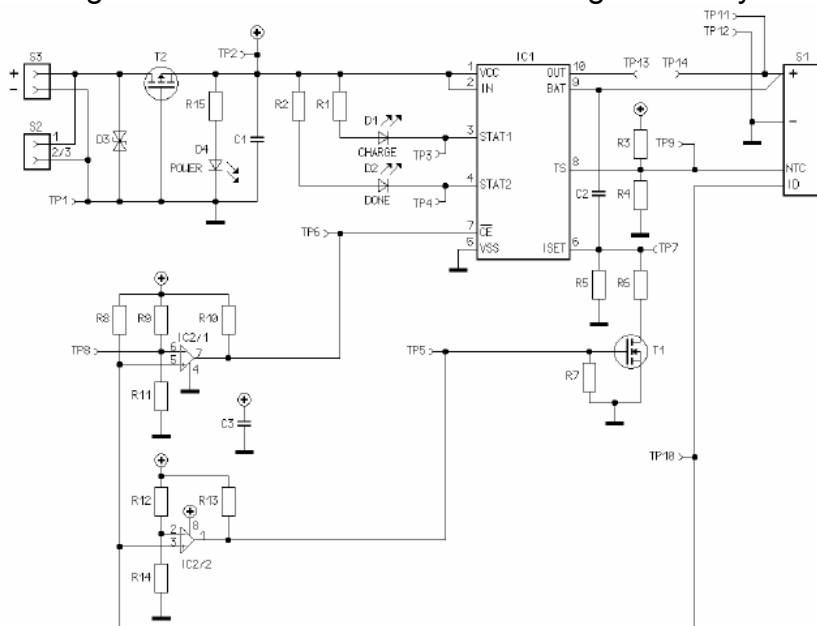
b) Integrated device charger

An integrated charger is the most common one for hand held devices. In this case, the device is just connected to an external power supply, typically max 6V DC, with an appropriate maximum current to source charger and may be device if it's in operation.

The industry offers a variety of charging IC solutions. However, to make your charger design easy, VARTA Microbattery offers you a ready to use blue print for charging based on the widely used Texas Instruments BQ24014 charger IC. This solution is designed to read the NTC and ID resistor of the actually connected VARTA EasyPack, so for appropriate charge temperature and appropriate charge currents. Is the ID resistor $\leq 9.1 \text{ k}\Omega$, a 500 mA charge current is applied. With an $ID > 9.1 \text{ k}\Omega$, 1000 mA is applied.

The pack NTC may be disregarded if it is made sure by other means that the allowed temperature charging for charging is followed.

Below figure shows the recommended charger circuitry for VARTA EasyPack.

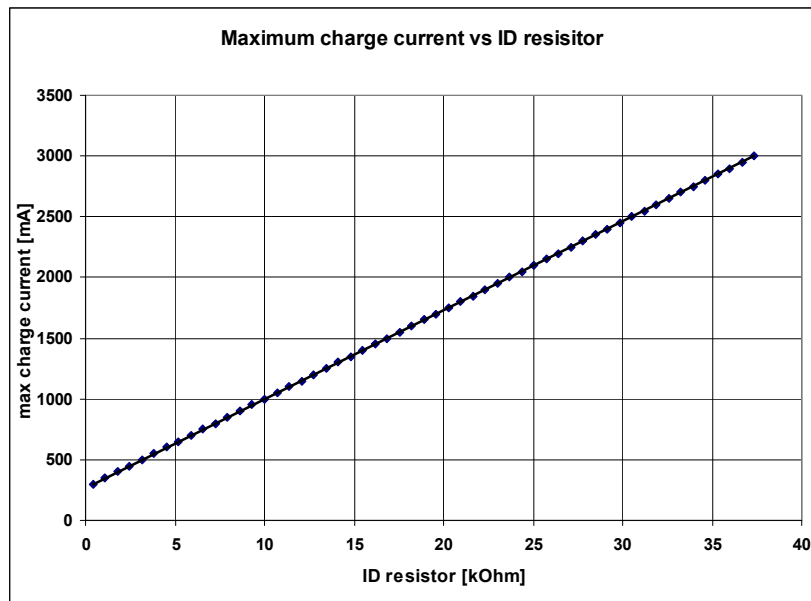


To evaluate this circuitry before putting it onto your own PCB, an Evaluation Kit is available from your local sales representative. For a complete documentation of the circuitry, please ask also for the 'VARTA EasyPack Evaluation Kit 1.0 Operating Instructions 50211.pdf'.

Detailed information about the TI charging chip you get from the TI web pages.

The circuitry above selects the appropriate charge current based on the ID resistor found within the EasyPack. The exact resistor value of an individual EasyPack is noted within it's technical data sheet. The table below shows the recommended maximum charge current versus ID resistor. Please follow this recommendation when designing your own charger in case you want to incorporate an automatic optimization of the charge current.

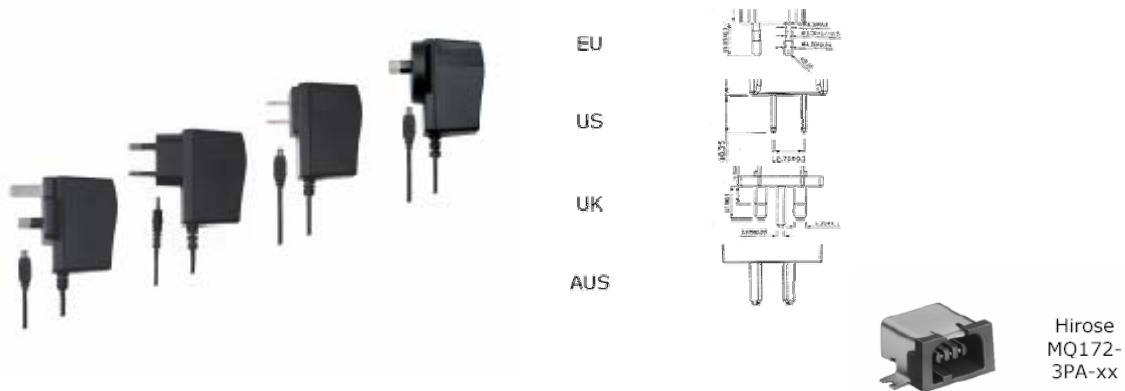
It will also ensure forward compatibility in case of future capacity upgrades of the easy pack. The noted resistor values follow the E96 / 1% accuracy definition.



current [mA]	ID [kOhm]	current [mA]	ID [kOhm]
300	0,432	1700	19,600
350	1,100	1750	20,000
400	1,780	1800	21,000
450	2,490	1850	21,500
500	3,160	1900	22,100
550	3,830	1950	22,600
600	4,530	2000	23,700
650	5,230	2050	24,300
700	5,900	2100	24,900
750	6,490	2150	25,500
800	7,150	2200	26,100
850	7,870	2250	26,700
900	8,660	2300	27,400
950	9,310	2350	28,700
1000	10,000	2400	29,400
1050	10,700	2450	30,100
1100	11,300	2500	30,900
1150	12,100	2550	31,600
1200	12,700	2600	31,600
1250	13,300	2650	32,400
1300	14,000	2700	33,200
1350	14,700	2750	34,000
1400	15,400	2800	34,800
1450	16,100	2850	34,800
1500	16,900	2900	35,700
1550	17,400	2950	36,500
1600	18,200	3000	37,400
1650	18,700		

c) External charger

Using an external charger does simplify your design further, and removes any charger design duties from your project schedule. Other than the internal solution discussed before, the external charger combines power supply and charging electronics within a wall plug housing. A cable plugs into device, and charging is applied to the battery according the constant current / constant voltage method as explained before.



At this point in time RRC Power Solutions offers an EasyPack compliant wall plug charger (part number RRC EPC06WC) . The charger is a universal solution with a fixed cc/cv of 750mA/4.2V. Below table indicates the typical charge time for the different EasyPack sizes.

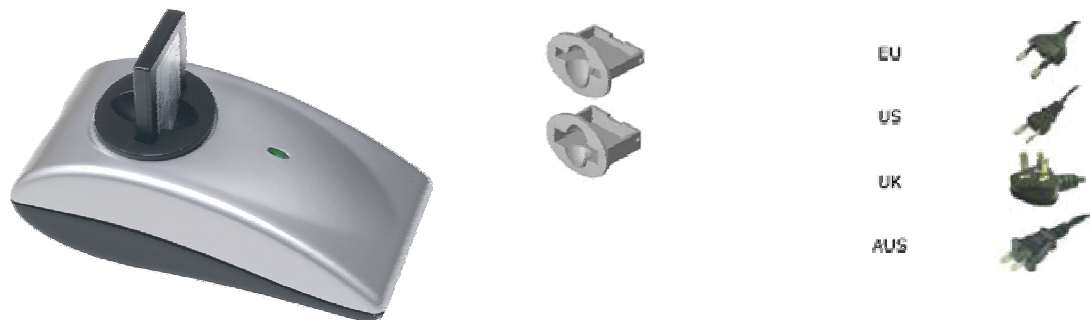
Charger	Easy Pack Size			
	EZP S - 3.7V	EZP M - 3.7V	EZP L - 3.7V	EZP XL - 3.6V
Wall-Plug-Charger RRC EZPC 06 WC 003 RRC EZPC06 WC xxx	√	√	√	√
Charge time (typ.)	1 h	1.25 h	1 h	2 h

On the device side, the Hirose MQ172-3PA-xx mating connector is used. For detailed information please visit RRC Power Solutions web page (http://www.rrc-ps.de/index_en.htm).

d) External charger – stand alone

Like the above discussed external charger, at a stand alone solution all charging electronics and power supply is within an external box. But rather than plugging the cable into the device, the battery is removed from the device and plugged into a battery charger cradle.

Currently available stand alone charger solution is the RRC EPC 06 DC.



Different inserts allow using the charger with the EasyPack sizes S / M / L / XL 3.7V series. Charge current is automatically adopted to maximum allowed charge current, respectively to the maximum charge current of 1.2A supplied by the charger. Below table show the typical charging time.

Charger	Easy Pack Size			
	EZP S - 3.7V	EZP M - 3.7V	EZP L - 3.7V	EZP XL - 3.7V
Desk-Top-Charger RRC EPC06DC	✓	✓	✓	✓
Charge time (typ.)	1 h	1 h	1 h	2 h

For detailed information please visit RRC Power Solutions web page (http://www.rrc-ps.de/index_en.htm).

5. Appendix

a) List of reference documents:

2D mechanical drawings / spec sheets

- EZPack S – 3.7V mechanical drawing: 688819_EZPack_S_3_7V.pdf
- EZPack M – 3.7V mechanical drawing: 688820_EZPack_M_3_7V.pdf
- EZPack L – 3.7V mechanical drawing: 688821_EZPack_L_3_7V.pdf
- EZPack XL – 3.7V mechanical drawing: 688822_EZPack_XL_3_7V.pdf

3D mechanical modes

- Snap fit fixation: EZPack_SMLXL_3_7V_snap_fit.igs / EZPack_SMLXL_3_7V_snap_fit.stp
- Housing fixation: EZPack_SMLXL_3_7V_housing.igs / EZPack_SMLXL_3_7V_housing.stp
- EZPack models S – 3.7V: EZPack_S_3_7V.igs / EZPack_S_3_7V.stp
- EZPack models M – 3.7V: EZPack_M_3_7V.igs / EZPack_M_3_7V.stp
- EZPack models L – 3.7V: EZPack_L_3_7V.igs / EZPack_L_3_7V.stp
- EZPack models XL – 3.7V: EZPack_XL_3_7V.igs/ EZPack_XL_3_7V.stp

Above mentioned technical data is available through your local sales representative.

Further readings

- EasyPack Evaluation Kit documentation:
VARTA EasyPack Evaluation Kit 1.0 Operating Instructions 50211.pdf

For latest specifications and general product info please visit
www.varta-microbattery.com/EZPack.php

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