

Programmable controllers TMM[®] xxxx – 3, expert LT (Version 3.10 and higher) for brushless sensorless motors

Controllers TMM[®] xxxx – 3, expert LT are outstanding programmable controllers for brushless sensorless motors (BLCD motors). **Number of programmable parameters is lowered to an essential minimum.** They are manufactured with the use of surface mounting from high-end components and are controlled by a very powerful processor. Controllers are ready for immediate use, no programming necessary. However, if you wish to set some parameters you may do so through a very simple process using **transmitter or PC**. If PC is used for programming, it is essential to use RSCOM module or USBCOM with supplied SW. This allows to obtain some information about the last flight from the controller (such as average current in full throttle, peak current, etc.). Programmed parameters are saved permanently.

Thanks to the high-tech TMM[®] technology of MGM compro controllers feature number of outstanding properties which considerably eliminate the possibility of unwanted damage or destroy of motor, batteries and controller itself. Controllers also ensure the maximal efficiency with different kinds of motors. The revolution regulation is extremely fine - 1024 steps all the way to the full throttle. Starting is very fine. The MEGA BEC circuit (applies to versions with BEC) is also extremely powerful. All controllers are Lipol compatible and watch over their minimal voltage.

Maximum attention is paid to development which is in a continuous progress. To make our newest knowledge available to our customers SW is upgraded for free (only shipping costs are charged).

The quality of products is under constant supervision in manufacture. Every controller goes through numerous tests. The final test of each controller is done under the controller's full load.

Fast and easy to air:

To ensure correct type of the controller for each set (batteries, motor and propeller) it is best to measure (recommended is a clamp A-meter) current drawn from batteries when connected to the motor with propeller. It is necessary to carry out the measurement with the „hardest“ batteries intended for use in this set. This will prevent problems that might occur when the controller is overloaded (and batteries and motor as well). Remember to ensure proper cooling of the controller, especially when working near limit parameters.

It is not possible to control more than one motor with one controller.

1) How to connect the controller:

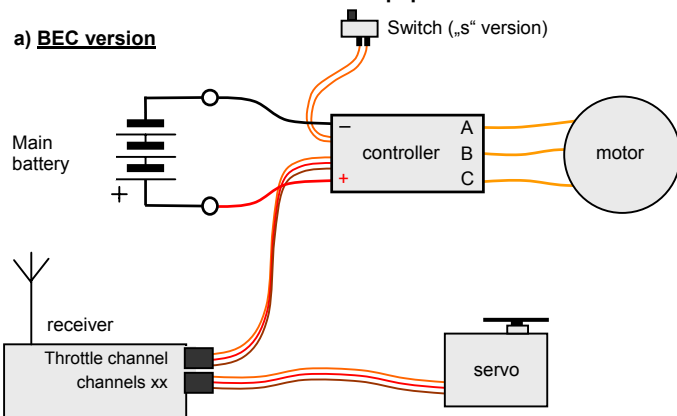
- Opposite piece of the connector, which is on your accumulators, should be soldered to the leading-in conductors to the accumulator. Use only quality golden plated kinds. Recommend are MP JET 1.8mm, 2.5 or 3.5 mm according to the type of controller and current. It is also possible to use golden plated connectors Ø 4, resp. 2 mm or Schulze 3.5 mm (connectors are not interchangeable). MP JET connectors feature smaller transient resistance and also smaller dimensions. We recommend to put socket on the „-“ wire (black wire) of the controller and the plug on the „+“ wire (red wire).



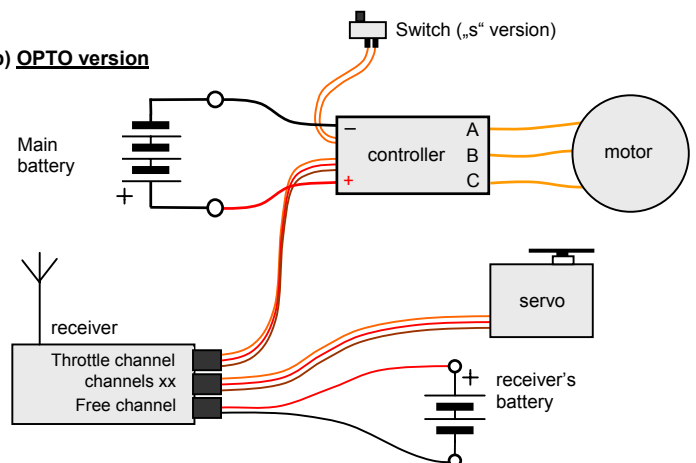
- Receiver and antenna should be placed as far as possible from the controller, the batteries and power leads. Antenna should be placed as far as possible from lead strings and cable to tail.
- NOTICE, reversal of poles on wires to the batteries will destroy the controller !** (This however, may not show immediately, but in some later starts or flights)
- The leads to the motor (yellow wires marked „A“, „B“, „C“) should be soldered directly to the motor or it is also possible to use the connectors mentioned above. If you decide to use connectors, this time solder sockets to the controller leads !
Short cut of these wires together (when batteries are connected) or short cut of these wires to the feeding voltage results in damage or destroy of the controller !
- After the connectors are soldered it is necessary to isolate them, for example with heat shrinking sleeve !
- Use power conductors as short as possible – it is better for minimum weight and for minimum interference
- Connect the controller to throttle channel on the transmitter ! **For OPTO version controllers, receiver must be fed from a separate battery. DO NOT take out the middle core of servoconnector (red wire) when using OPTO version controllers.**
- If motor runs in an opposite direction than desired, swap any two motor phases or change the revolution direction in the program setting on PC (the PC change is available only for EXPERT controllers, not expert LT).
- It is necessary to cool the controller in operation with flowing air. Do not prevent the cooling air to get to the controller (e.g. by packing it in foam).**
- The controller informs about overload and overheating acoustically (motor beeping) and also through LED.
- It is not allowed to feed the controller from any other source (such as mains power supply) than specified types of accumulators!!!**
- The switch of the controller is connected in such way that even if it gets damaged the BEC will be still functioning.
The controller is switched on by TURNING OFF the switch (applies to „s“ version with switch) or by connecting batteries (applies to versions without switch).
- o not switch off or disconnect the controller from batteries when motor runs or when it is still turning – that may lead to damage or destroyed of controller !!!**

Connection of the controller to RC equipment:

a) BEC version



b) OPTO version



Note:

(for BEC versions only !!!)

If you need to feed the receiver or servos from some other source carefully take out the central core of the servo cable connector. The taken out core of this conductor must be properly insulated.!



No disconnect for „OPTO“ versions !!!

JR servocable



Switch

OFF position

ON position (open contact)



MEGA BEC: controllers up to 12 cells are equipped with BEC. The BEC can hold peak currents up to 4A and loss power loads which are significantly big but has its limits. (*TMM4016-3BEC is an exceptions because it is designed for use with up to 16 cell, however BEC can be used only up to 12 cells.*) It may not exceed 20W. It is possible to determine for example current which may be drawn from BEC under given load and voltage and also find out for how long from the graph. The power losses of the BEC warm the controller up. **It is necessary to remove the generated heat by airflow.** If the BEC is loaded with the power loss >5W pauses for cooling are necessary so that the average power loss is ≤ 5W. **REMEMBER that the controller is also heated by the power loss generated in the motor part !**

Power loss of 5V BEC: $(U_{BATT} - 5V) \times \text{current } I$
 or for 6V BEC: $(U_{BATT} - 6V) \times \text{current } I$
 (it is favorable to use axis with difference of voltages $U_{BATT} - U_{BEC}$)

Example: (see graph) if voltage of batteries is 10,5V it is possible to draw current of 1,8A continuously for 40 sec. when the power loss of BEC is 10W. If the load would only take 5 sec. the power loss may be 15W and it is possible to draw current up to 2,7A.

Only version "MEGA BEC+" features long lasting shortcut protection!

When exceeding the maximal limits of current or power losses, BEC may be destroyed and the model may be uncontrollable !

Please, notice that servos loaded with the control surfaces (rudder, ailerons etc.) in the air draw many times more current than when you move them on the ground !

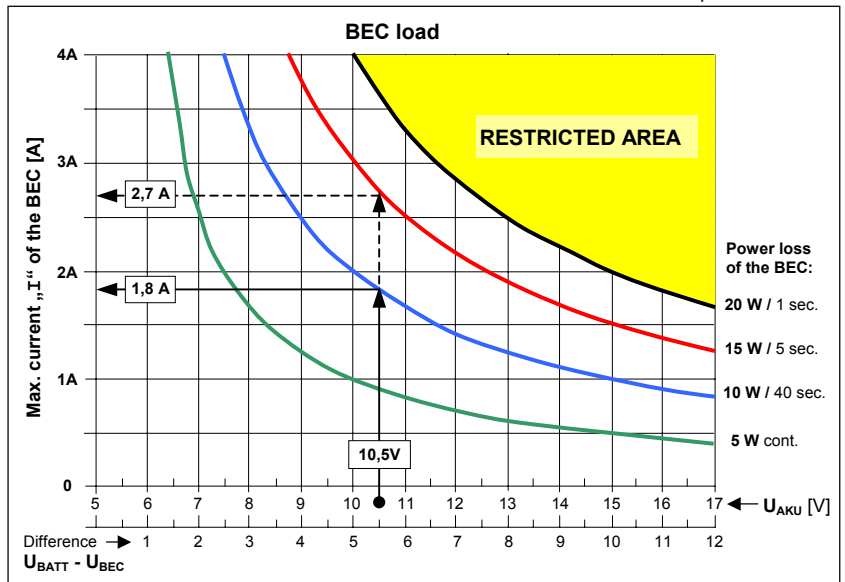
Note: be careful when determining the range of the set, especially when using more batteries – in case of signal loss servos might turn to their maximum which would cause significant rise in drawn current. This might lead to a power overload of BEC with all its consequences. The danger is lower with receivers which set a defined servo position when loss of signal occurs.

CONNECTING BEC: if two controllers are used in a model, BEC can be connected in two ways:

- if each controller is switched on separately (by switch or by connection to batteries) it is possible to use only one BEC – it is necessary to take out the middle core of servoconnector of one controller
- if a simultaneous switch on of both controllers is ensured (connected „+“ and „-“ wires of both controllers, without switches) both BECs can stay connected. This will also increase allowed current and power loads (aprox. twice) of BECs connected in this way.

SECURITY WARNING:

Always disconnect the accumulators when not operating the model !!! Small current consumption occurs even when controller is switched off. Do not leave model with connected accumulators unattended ! Do not charge batteries when connected to the controller !
If the controller is connected to batteries do not stay in the reach of the propeller even when the controller is switched off ! Please notice that running motor with propeller is very dangerous !



2) WITHOUT PROGRAMMING

The controller is default set in „BASIC“ mode. This means controller is ready for start, it is not necessary to program it if not desired. Upon each controller switch on, user sets the brake on or off by the throttle stick position. The throttle min and max position are automatically set while setting the brake. Disadvantage of this simple mode is the necessity of repeating this procedure after each switch on of the controller. Some parameters are automatically set by the controller itself and to set other parameters the user may decide to keep the default setting or may set those through additional programming. It is always possible to come back to this default setting.

Starting with the brake in Basic mode:

- switch the transmitter on
- throttle down (min. throttle)
- turn the controller on
- 1 × BEEP
- full throttle (max. throttle)
- 2 × BEEP
- throttle down (min. throttle)
- 1 × BEEP
- you may start

NOTE :

If in the starting position of the throttle stick (min position), 2 × BEEP can be heard, change the norm of deflection of the throttle stick on the transmitter.

Starting without the brake in the basic mode:

- switch the transmitter on
- full throttle (max. throttle)
- turn the controller on
- 2 × BEEP
- throttle down up to 10 sec. (min. throttle)
- 1 × BEEP
- you may start

If in the starting position of the throttle stick (max position), 1 × BEEP can be heard, change the norm of deflection of the throttle stick on the transmitter..

If you wish to use Lipol cells in this mode, it is recommended to set number and type of cell through simple programming, see next steps.

3) Programming / obtaining data from controller using PC:

If you wish to program using PC or obtain data from the controller, RSCOM module (line RS 232, order number 0420) or USBCOM module (line USB, order number 0421) are necessary for connecting the controller to the PC. Also a SW which is a part of the communication module is needed

Programming the controller using PC will make the process of setting parameters easier and clear.

Obtaining data about last flight will help determine an optimal power of your model so that both power and technical possibilities of your controller / motor / batteries are fully used and that the possibility of overloading them is avoided at the same time.

To install, and obtain data from controller and program controller please refer to instructions in manual for your communication module.

The overview of data that can be obtained from controller (from last flight):

- average current at full throttle in stable state
- maximal peak current
- end voltage of battery
- maximal temperature of the controller
- min. throttle position
- max. throttle position
- max. revolutions

Modul
USBCOM



Meaning of each parameter:

Parameter A – mode: choice of modes (BASIC / AIRCRAFT)
 – **BASIC:** basic mode with default settings. Enables the user to start flying immediately. Brake must be set on or off, as well as min and max throttle position after each switch on of the controller again. **Only type and number of cells can be set permanently (recommended when using Lipol cells).**
 – **AIRCRAFT:** all parameters can be set by user. All parameters are permanently saved. After switch on the controller is immediately ready for use with the saved settings. Throttle must be in min position to start – a safety precaution to avoid unwanted start of motor.

Parameter B – battery: sets type of batteries – NiCd, NiMH or Li-Ion, Li-Pol and number of Li-xx cells
 It is necessary to specify a type of cells to ensure correct behavior of controller and for reliable protection of battery. For Li-xx cells it is also necessary to set number of cells because a definite automatic setting is not possible.

Parameter C – brake: enables to set „brake off“ or intensity of braking in 5 levels. Set according to your preferences.

Parameter J: interference masking
 This parameter enables to set an optimal cooperation between receiver and controller when loss of signal occurs or when the signal from transmitter is noisy.
 Many processor receivers take care of this problem themselves (not like analog receivers). Controller has also very powerful ability to suppress losses due to interference. The cooperation of these two parts (controller and receiver) then may not be optimal. In such cases set this parameter to “no”. The controller in this set up, has some of the masking algorithms suppressed and leaves the receiver to handle the situation – the cooperation of controller and receiver is than much better. When using analog receivers (and some digital ones) it is recommended to leave this parameter set to “yes”, then the controller takes care of masking the loss of signal and interferences completely by itself. If you are not sure how your receiver solves this problematic, try both settings and choose the better one.

Operating data:

Temperature of the environment:	0°C to 40°C	Number of regulation steps:	1024 / full throttle
Motor controlling:	PWM 8 kHz	Max. rpm for 2 poles motor:	170 000 rpm
Control signal:	positive pulses 1,5 ± 0,5 ms, period 10 + 30 ms		
User set parameters:	see programming		
MEGA BEC / MEGA BEC+:	5V or 6V / max. 4,0 A (power losses 5W continuous, 10W / 40 sec., 15W / 5 sec., max. 20W, see graph)		
Power supply:	from batteries only: NiCd, NiMH, Li-Ion, Li-Pol		
Suitable for motors:	Mega AC, Model Motors, MP JET, PJS, Überall model, Hacker, Kontronik, LRK, Plettenberg, etc.		

	TMM®	0810-3	1210-3	1812-3	2512-3	4012-3	4016-3	4016-3 BEC
Dimensions (with external capacitor) [mm]:	25×23×6	25×23×6	42×27×6	46×27×6	57×34×6	60×34×6	60×34×6	60×34×6
Weight incl. all conductors:	9 g	9 g	17 g	21 g	35 g	36 g	36 g	36 g
Weight without power conductors:	6 g	6 g	10 g	10 g	21 g	22 g	22 g	22 g
No. of feeding NiCd/NiMH cells:	6 – 10	6 – 10	6 – 12	6 – 12	6 – 12	6 – 16	6 – 16	6 – 16
No. of feeding Li-Ion / Li-Pol cells:	2 – 3	2 – 3	2 – 4	2 – 4	2 – 4	2 – 5	2 – 5	2 – 5
Max. current (for full throttle):	8 A	12 A	18 A	25 A	40 A	40 A	40 A	40 A
Max. current for 5 sec.:	10 A	15 A	23 A	30 A	50 A	50 A	50 A	50 A
On-state switch resistance at 25 °C:	2×9,3 mΩ	2×6,3 mΩ	2×4,6 mΩ	2×3,9 mΩ	2×1,3 mΩ	2×1,3 mΩ	2×1,3 mΩ	2×1,3 mΩ
Model:	MEGA	MEGA	MEGA+	MEGA+	MEGA+	OPTO	MEGA+ *	MEGA+ *
BEC voltage:	5 V	5 V	5 V	5 V	5 V	5 V	–	5 V
Power conductors (90 mm):	7 cm/0,5 mm ²	7 cm/0,5 mm ²	1,0 mm ²	1,5 mm ²	2,5 mm ²	2,5 mm ²	2,5 mm ²	2,5 mm ²
JR gold connector, cables:	0,15 mm ²	0,15 mm ²	0,25 mm ²	0,25 mm ²	0,25 mm ²	0,15 mm ²	0,15 mm ²	0,25 mm ²

*) **Note:** BEC voltage is automatically switched off for battery voltage higher than 17V (12 cells). In this case it is not necessary to take out the central core of the servo cable connector to disconnect BEC.

Error messages (the controller must be switched off to correct error, then switched on again):

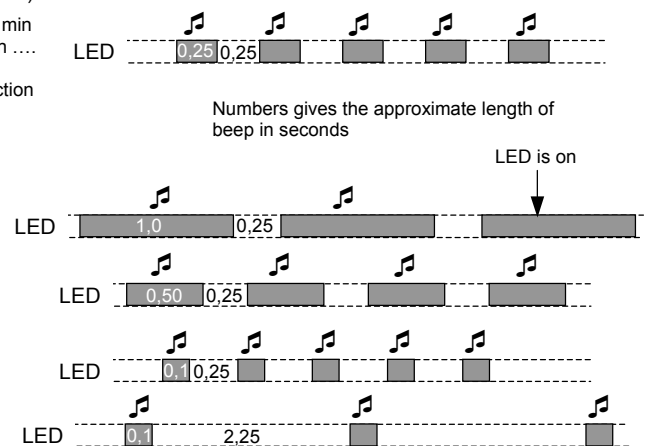
- throttle stick was moved the opposite way then it is supposed to (the thrtolle stick was not in the min or max position at the beginning, and after beep it was moved to the max or min position to which the throttle was closer and not the other (correct way)
- low size of deflection of the throttle stick on the transmitter – you must shorten the size of deflection on transmitter
- overstep max. throttle position 0,5 and 2,5 ms – you must shorten the size of deflection
- switching on the controller with turned off transmitter

- starting an overheated controller
- overheating of controller during operation (only LED blinks, motor does not beep, the power is reduced to 60%)

- more or less cells than specified

- current overload (resumes operation after dropping throttle to zero, it is not necessary to switch the controller off in this case)

- signal drop out for long time



- continual beep after switch on – data in EEPROM have been disturbed.

The controller is set to default setting.
 It is necessarz to program it again

- defective EEPROM – send for service !



WARNING :

You risk destroying the controller for:

- connecting more battery cells to the controller than the max. number specified in the technical data
- reversing connections to the accumulator
- shortcutting of wires to motor when batteries are connected
- changing motor and accumulator outlets
- overloading of the BEC with bigger currents or bigger power loss than is specified in technical data
- water in the controller (except for „hydro“ versions“)
- metal objects in the controller (screwdrivers, wires, etc.)
- disconnecting the controller from batteries or turning off the controller while motor is running (or still turning)

The appearance and operating data may be changed without prior notice

Advantages of TMM[®] controllers EXPERT line:

TMM controllers feature number of outstanding qualities which distinguish them from regular controllers. Those are:

- possibility of immediate use, no programming required
- easy programming (setting) several important parameter using transmitter or PC (for more information see „Programming“ part)
- important data measured in operation of controller may be obtained using PC – great for optimal power setting**
- outstanding protection and management of Lipol/Lion (very important) and NiCd/NiMH batteries**
- perfect masking of signal interference and losses
- extremely fine throttle step (1023 steps)
- very soft starts
- motor and controller overload protection
- small dimensions and weight
- very powerful BEC (MEGA BEC)** (for more information see on the catalog, CD, or www pages: „BEC – advantages of MEGA BEC conception“)
- version with switch is made ordinarily

Protective and safety mechanisms of TMM[®] controllers:

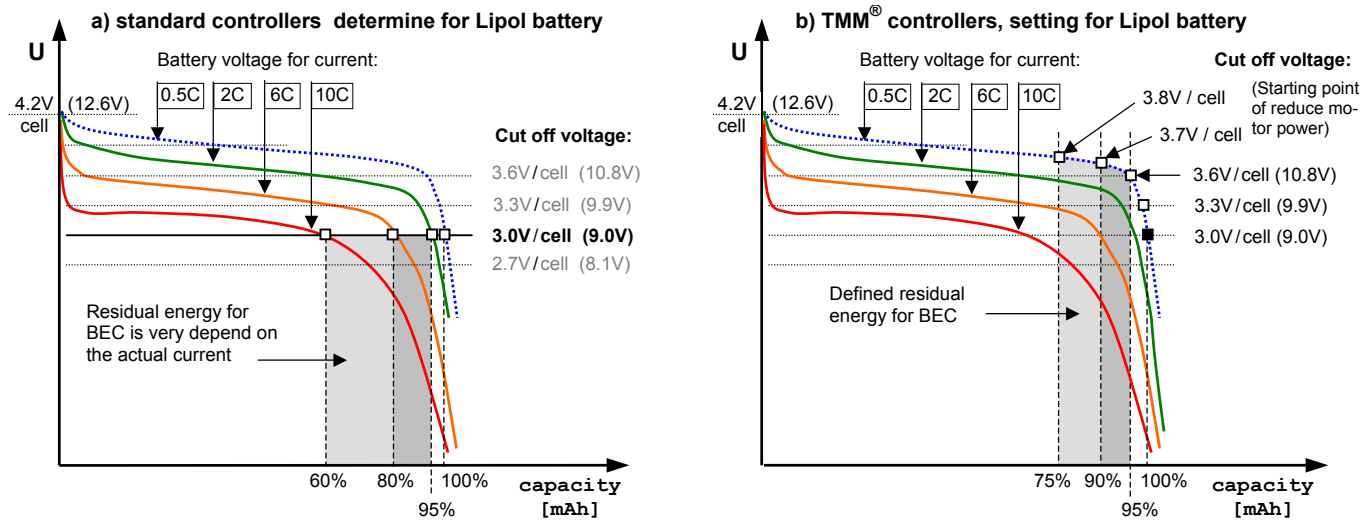
Accumulators are protected in four ways.

- Firstly, due to the use of automatic current fuse (ACF) the possibility of current overload of accumulators (and their possible damage) even at crisis points is significantly reduced.
- Secondly, the used system of intelligent power reduce (IPR) always ensures through measurements of number of voltage, currents, accumulator condition and calculations an optimal point of starting continuous reduction of motor performance (or the point when motor is switched off or point in which the motor power is reduced and then set back – according to the setting of parameter F”) so that accumulator cells do not get extremely discharged – which is very important specially for Lipol cells.. This, not mentioning other advantages, reduces the possibility of reversal of poles of lower cells (applies mainly to NiCd / NiMH cells).
- This system at the same time **enables retaining defined energy for BEC (perfect RPC)** in controllers that have BEC which is of great significance for flying models (a crash due to running out of energy for receiver and servos can be avoided) . The amount of residual energy can be user set.
- the automatic current reduce (ACR) due to which a drop in voltage for BEC under extremely big current load (for every given controller) while motor starts does not occur.

When switching (reducing power) the motor off at solid boundary as it is with regular controllers (a) there is only very little energy remaining for BEC, particularly for 8 or more Nicd / NiMH cells in battery pack. This mainly applies for controllers with the switching of boundary at 5.5V. The better accumulators are used the less energy (time) is left to land (standard ESC).

Comparing to this, TMM (b) ensures the remaining energy to be big enough; it is also possible to modify its size according to user needs (bigger for gliders). This energy is certainly insignificant as long as duration of running the motor is concerned, but it is very significant for feeding BEC.

Graphs below show situation with 3 Lipol cells. In graph a) a regular controller situation is depicted – controller is Lipol compatible and has a solid boundary of switching of. In graph b) a behavior with TMM[®] controller is shown – with a boundary on a discharging curve of inner voltage of battery..



Regular controllers (even Lipol compatible) have either a solid switching off voltage (for example 3V per cell) or it is possible to set this value. For example for set boundary 3V per cell the controller is switch off or it starts to reduce revolutions when this value is reached no matter how big the drawn current is. **This means that the residual energy significantly changes according to a instantaneous current load of batteries** (and also according to inner resistance of the cells) from 0 to 95% - depending only on the set voltage boundary. If the example on the graph above is considered with a set boundary of 3V per cell the controller will switch off when drawn current is 10C when there is still 40% of energy still left, while for 2C current when only 5% of energy is left. For boundary of 3.3V per cell the controller would switch off for currents of 10C when only few percent of energy were consumed while for 2c after 92% of energy would be consumed..

TMM[®] controllers handle the situation quite differently. The switching off voltage is always recalculated into „inner“ voltage of the battery – therefore is independent on both drawn current as well as inner resistance of the accumulator. **This means the set residual energy is always the same and does not depend on currents and inner resistance of battery.** Batteries are then always discharged to same level, regardless how big currents are drawn. The value of set residual energy is therefore only little dependent on the features of battery and the discharging current. For example for switching voltage 3.7V per cell controller switches off the motor or starts to reduce revolutions always after 90% of energy is used up no matter if the drawn current is 10C or 2c. (The voltage of accumulator after switch of the current always rises to a value close to curve of 0.5V – this discharging curve is close to „inner“ voltage of battery. This curve describes how much the controller is discharged.

The controllers efficiently **mask interference and drop-outs** up to 1,5 sec. When long-lasting drop-outs or interference occur the controller slowly reduces motor revolutions. After the signal is resumed the controller continuously gets to the requested power. Long lasting drop out of signal (or its absence) is indicated acoustically by motor as well as by LED. This can be used for example when searching for lost model.

Without the proper signal from the transmitter (e.g. transmitter is turned off), **the motor neither jerks nor runs but is at standstill**

Thermal fuse of the controller is set to 90°C when performance is reduced to ca 60%. After cooling off (even in flight) the reduction is disabled. After switching on, the temperature above 70°C is monitored; if the temperature is higher the controller does not start. New start is possible only after the controller temperature falls.

Using abbreviations

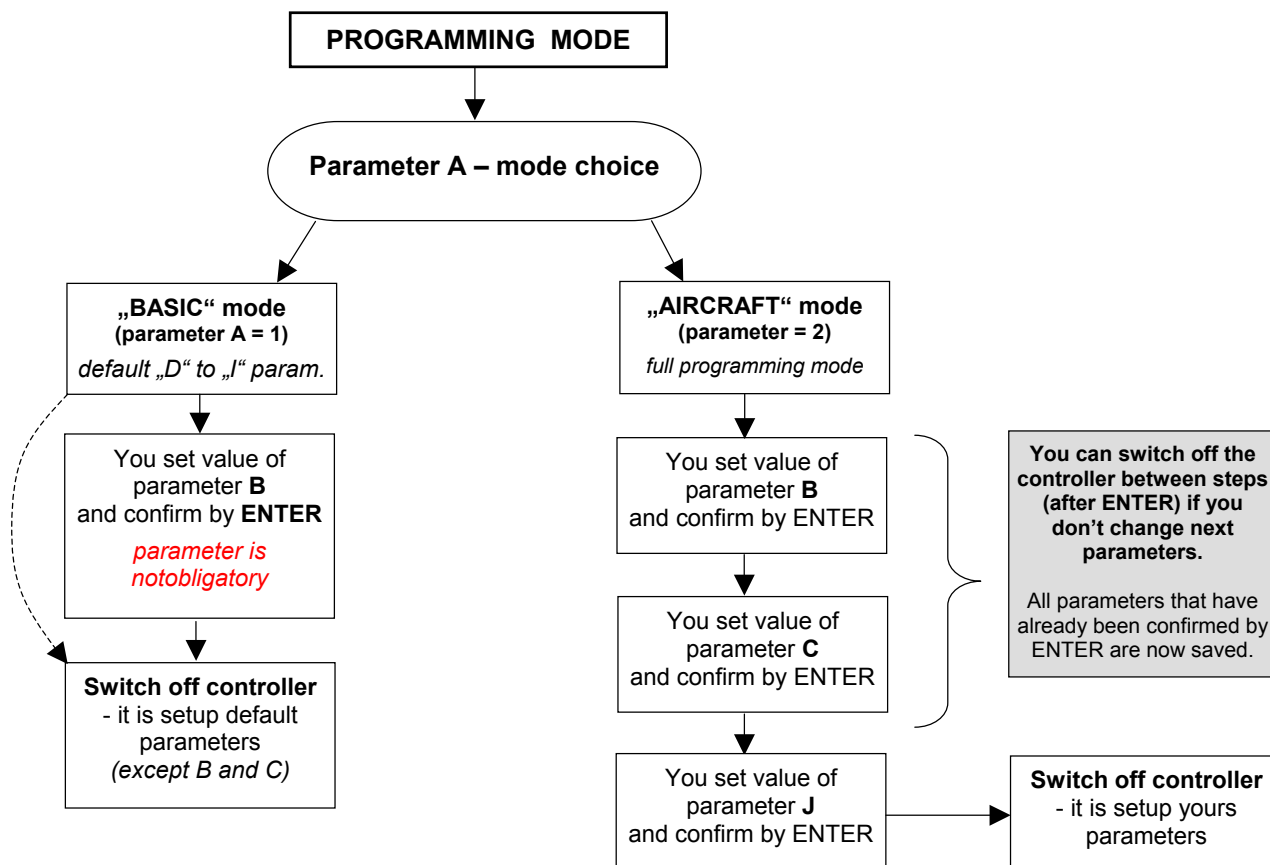
ACF	- automatic current fuse	LED	- light emitting diode
ACR	- automatic current reduce	PWM	- pulse width modulation
APS	- automatic parameter setup	RPC	- radio priority circuit
BEC	- battery eliminator circuitry	IPR	- intelligent power reduce
BLDC	- brushless DC motor		



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PROGRAMMING TMM xxxx – 3, expert LT



Examples:

A) Programming:

Basic mode, 3 Lipol cells.

- 1) Switch the controller on with throttle stick in full throttle position
- 2) Switch the controller on (If basic mode is already programmed, the controller will beep 2x – ignore this]. After 10 seconds the controller will beep 3x and the LED will blink and stay lit. Move throttle to brake position, motor beeps once, Led blinks once – you have entered programming mode and you can program the first parameter A (see table)
- 3) Move the throttle to ½ of full throttle (idle position), LED blinks twice and motor beeps twice. Move throttle back to min position, LED blinks 1x and motor beeps. (parameter A=1, that is basic mode).
- 4) This setting has to be confirmed by ENTER sequence. Move throttle to full throttle position, LED blinks 3x and motor beeps 3x. Move throttle back to min position – LED blinks 1x and motor beeps 1x = ENTER, the Basic mode has been set.
- 5) Move the throttle to ½ of full throttle (idle position), LED blinks twice and motor beeps twice. Move throttle back to min position, LED blinks 1x and motor beeps. (parameter B=1] Repeat this 2x and parameter B will be set to value 3 (B=3, that is 3 Lipol cells).
- 6) This setting has to be confirmed by ENTER sequence. Move throttle to full throttle position, LED blinks 3x and motor beeps 3x. Move throttle back to min position – LED blinks 1x and motor beeps 1x = ENTER, 3 Lipol cells have been set
- 7) Switch the controller off, programming is finished.
- 8) Now, you wish to start with brake on.
- 9) Turn controller on with throttle in min position. Controller beeps once.
- 10) Move throttle to max position. Controller beeps 2x.
- 11) Move throttle back to min position, controller beeps once.
- 12) You may start now.

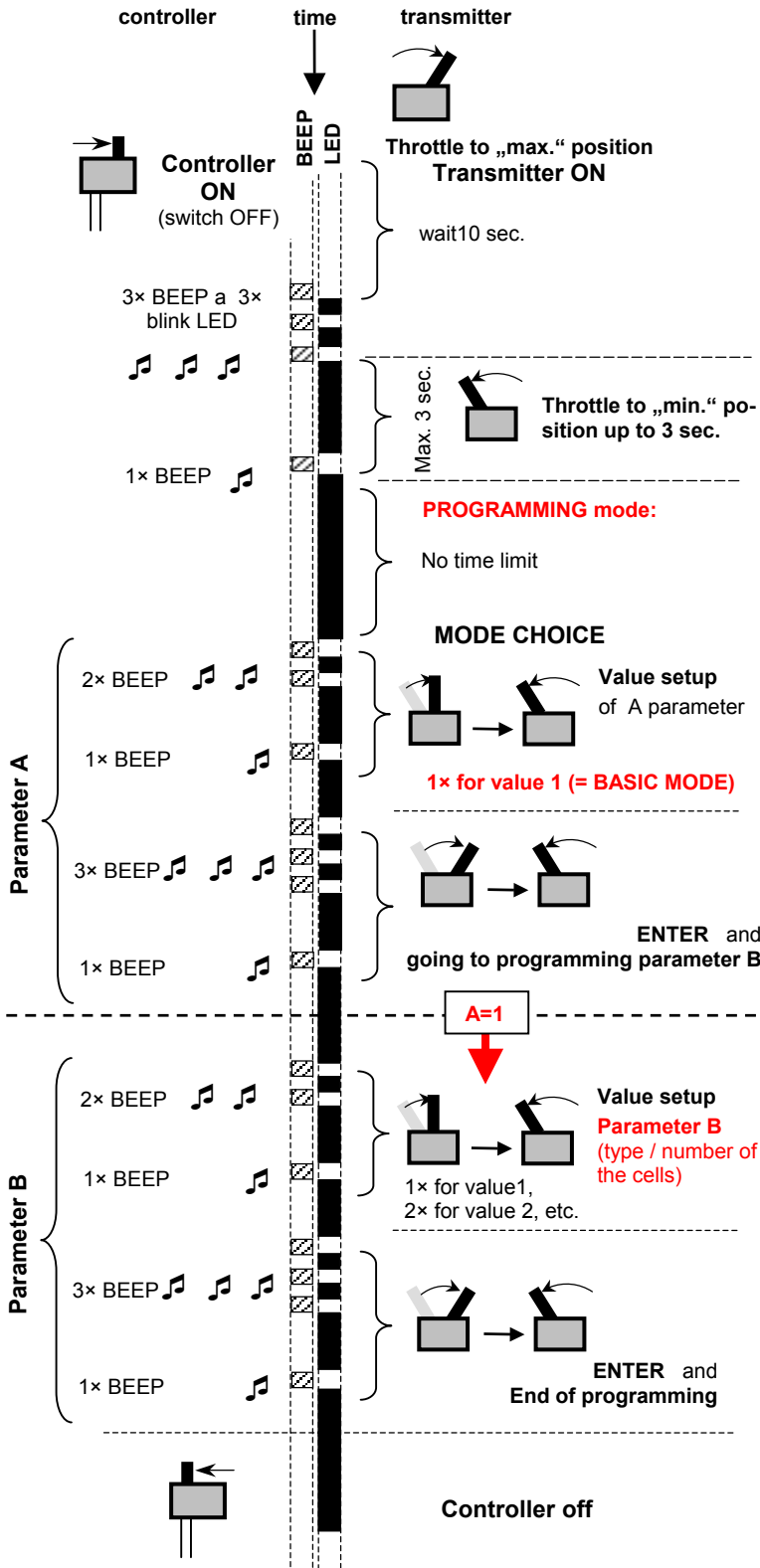
B) Programming:

AIRCRAFT mode, 4 Lipol cells, brake off

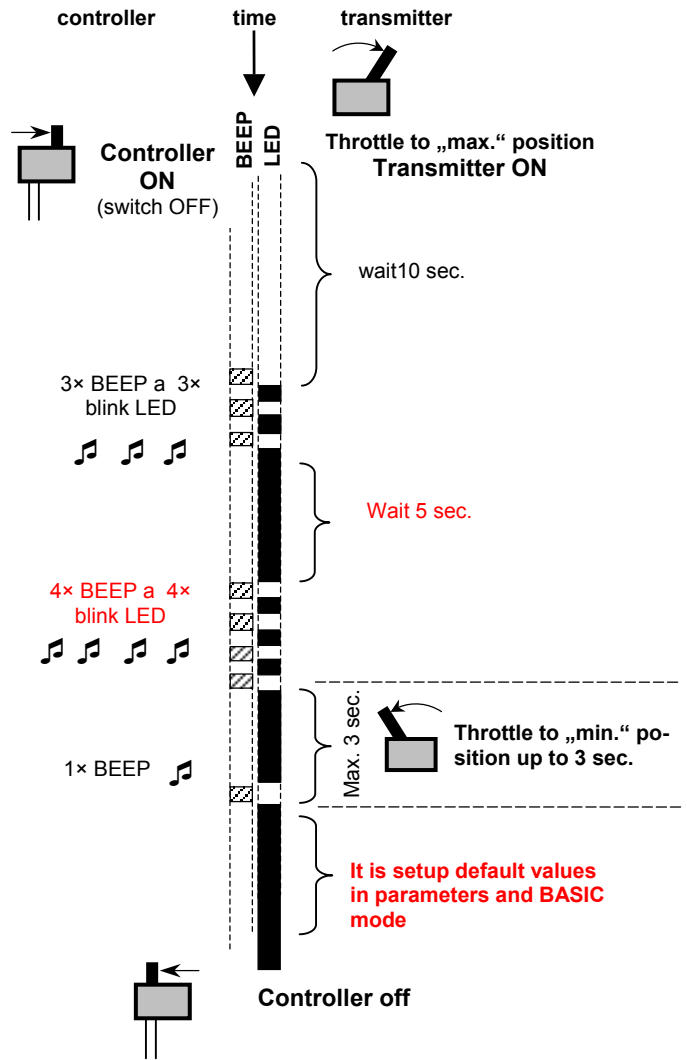
- 1) Turn the transmitter on with throttle in max. position
- 2) Switch the controller on (If basic mode is already programmed, the controller will beep 2x – ignore this). After 10 seconds the controller will beep 3x and the LED will blink and stay lit. Move throttle to brake position, motor beeps once, Led blinks once – you have entered programming mode and you can program the first parameter A (see table)
- 3) Move the throttle to ½ of full throttle (idle position), LED blinks twice and motor beeps twice. Move throttle back to min position, LED blinks 1x and motor beeps. Repeat this once more (parameter A=2, AIRCRAFT mode).
- 4) This setting has to be confirmed by ENTER sequence. Move throttle to full throttle position, LED blinks 3x and motor beeps 3x. Move throttle back to min position – LED blinks 1x and motor beeps 1x = ENTER, aircraft mode has been set
- 5) Move the throttle to ½ of full throttle (idle position), LED blinks twice and motor beeps twice. Move throttle back to min position, LED blinks 1x and motor beeps. (parameter B=1) Repeat this 3x and parameter B will be set to value 4 (B=4, that is 4 Lipol cells).
- 6) This setting has to be confirmed by ENTER sequence. Move throttle to full throttle position, LED blinks 3x and motor beeps 3x. Move throttle back to min position – LED blinks 1x and motor beeps 1x = ENTER, 4 Lipol cells have been set
- 7) Move the throttle to ½ of full throttle (idle position), LED blinks twice and motor beeps twice. Move throttle back to min position, LED blinks 1x and motor beeps. (parameter C=1), (C=1, that is no brake).
- 8) This setting has to be confirmed by ENTER sequence. Move throttle to full throttle position, LED blinks 3x and motor beeps 3x. Move throttle back to min position – LED blinks 1x and motor beeps 1x = ENTER, brake off has been set
- 9) It is not possible to program the following parameters in this version therefore switch the controller off – the programming is finished.
- 10) When the controller is switched on again, only move throttle to min position (if it was not already there), controller beeps once and you may start with newly set parameters.

PROGRAMMING TMM xxxx – 3, expert LT

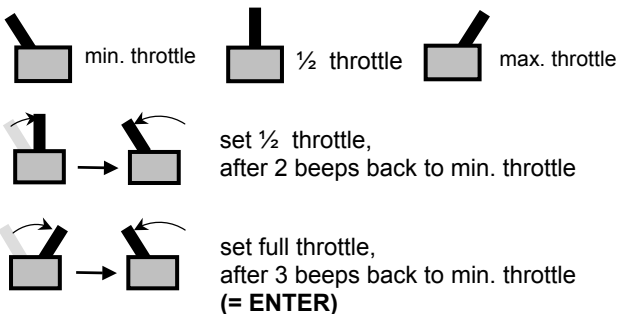
Lipol battery setup in BASIC mode



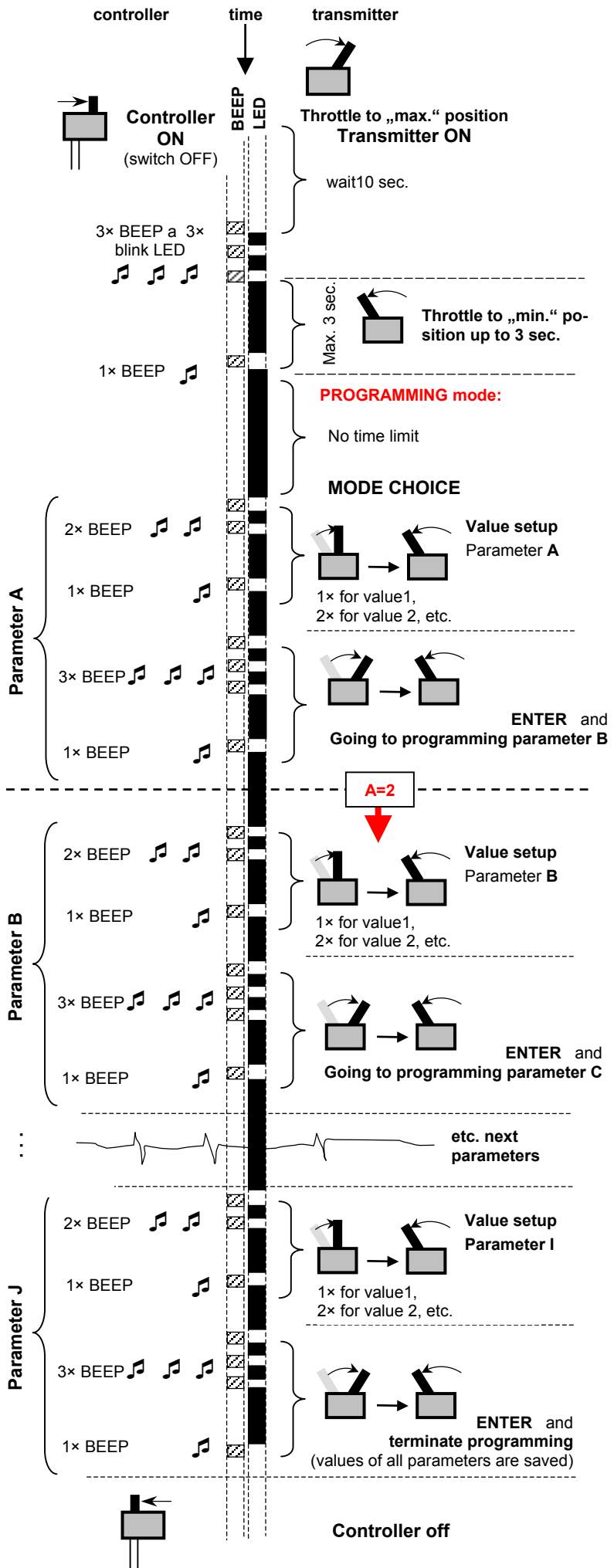
Default parameters setup (factory parameters)



Legend:



PROGRAMMING TMM xxxx – 3, expert LT



Legend:

