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DMMD usage scenarios and manual

Electric driven vehicles with RPM controller

Vehicles with RPM controllers e.g. OSET16 show a different throttle response compared to traditional combustion engines. The amount of throttle opening corresponds to motor speed (RPM) rather than torque. This means that opening the throttle even to a small amount the system will respond with almost maximum torque so that the motor will reach the equivalent RPM as quick as possible. Adjusting to a desired torque is still possible but in a very small throttle range. E.g. to set the torque between 0 and 100% the corresponding throttle range is smaller than 20% of the full throttle range. The more powerful the motor is the smaller is this adjusting range.

This behavior leads to a second issue at higher speeds. While the vehicle is running at a certain speed , opening the throttle from zero will cause no response until the throttle position matches exactly to the speed. From this equivalent throttle position only small increase in throttle position leads to further acceleration with the above mentioned small adjusting range and thus very high torque peaks.

So the throttle response is very bumpy and a smooth control of the torque almost impossible.

Methods to overcome these problems:

With additional electronics to the existing RPM controller the throttle response can be optimized.

One option is to add an open loop small signal controller, to modify the throttle signal such that these unwanted dynamic effects of the system will be more or less compensated. As a consequence of the open loop controller without any additional sensors a complex transfer function with several setting options is required. The user has to find the best setting to cover his needs as good as possible. In case of changes of the system parameters like gearing the setting has to be adapted again. The effort to get the best settings is comparable to the effort of finding suspension settings.

A second option is to apply additional sensors and realize a closed loop controller function. Such a configuration can compensate all the mentioned issues almost independently from system parameters.

The difference between these two configurations is that the open loop option requires more effort in finding the satisfying settings whereas the closed loop option requires more hardware effort.

DMMD as PI-controller (open loop)

With an open loop PI controller function the throttle range for torque control is substantially enlarged. E.g. for OSET bikes the enlarged torque control range from originally <20% of full throttle can selected between 45 % or 80% of full throttle in the actual version of parameter set for OSET bikes.

So a setting of 80% control range means instantly 80% of full throttle will cause 100% of the maximum torque on an idle vehicle.

If now the throttle will be kept still at 80% of full throttle, the output signal of the module will be increased successively according the selected time constants (four settings possible) until the motor has reached the 80% of RPM. So the torque versus acceleration time appears to be constant if the accelerating power of the vehicle approximately matches the selected time constant.

Due to the enlarged torque control range at higher speeds it is no longer required to exactly match the throttle opening to the corresponding RPM to move from retardation to acceleration. Instead, if the throttle is completely closed while driving, the motor current will follow the subsequent upturn of the throttle with a small delay (according to the selected time constant), which might lead the driver to turn up the throttle farther than appropriate. Therefore we advise to not always completely release the throttle during driving.

Special remark for OSET: The above mentioned delay effect is more perceptible in the case of a strong throttling by the OSET specific potentiometer.

The new DMMD with PI controller has a new feature which allows overcoming larger time constant settings by using a sequence of partially closing and opening up again the throttle like intermediate throttle. So do not use unwanted intermediate throttle.

If you release the throttle completely, the motor current will be stopped immediately. This is an important safety feature e.g. for emergency break situations.

Setting options for the DMMD PI-controller

The settings can be changed by using three IOs (IO1 to IO3) on the corresponding connector jack. The signal wires of the setting plug can be left unconnected or connected to ground (GND) by switches or fixed connections to set the options according to the table in the data sheet.

Without setting plug in place the default values are valid which are a torque control range of 45% and a time constant of 3.5 sec. When using handle bar switches the setting can also be changed while driving.

Due to the fact that such an extension is an open loop controller without any additional sensors a suitable setting depends on several system parameters like power, mass, gearing grip level, etc. The user hast to find the best setting to cover his needs as good as possible. The values in the setting table are comparable to the settings of the predecessor product version. On customer request all parameters and options as well as the fundamental response characteristics can be modified using different module software.

DMMD as I-controller (closed loop)

Using an additional motor current sensor and the corresponding module software the system can be changed to a closed loop controller. This results in a true current control for the electrical bike where the motor current and thus the torque is directly related to the throttle setting.

As a result there an adaptation of the above mentioned parameter settings to match the resulting torque to the system parameters is not necessary. This simplification in usage has to be traded against increased hardware cost for the current sensor.

Nevertheless the characteristics can be changed by using specific sensor current tables in the controller software. Actually the table creates a progressive torque response that reaches a maximum of 100% at full throttle. Using the setting connector the maximum value can be reduced in steps.

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Safety aspects of DMMD

The DMMD covers different safety features which lead to a shutdown when corresponding signals levels are violated. In case of a safety shutdown, the corresponding output will be switched off and the red LED will indicate an error status. Error status and the corresponding erroneous signal will be stored in the data EEPROM. Resetting from safety shutdown is only possible by switching off and on again of the module after resolving the cause of error.

The criteria which lead to a safety shutdown are:

- Low supply voltage
- Supply of the throttle is irregular (Sensor or cable defective)
- Signal of the throttle is irregular (Sensor or cable defective)
- Supply of the current sensor is irregular (Sensor or cable defective)
- Signal of the current sensor is irregular (Sensor or cable defective)

A safety feature which does not lead to a safety shutdown is:

- A valid throttle signal larger than zero when powering on the module (unwanted or blocked throttle). In this case the corresponding output will be switched off and the red LED will indicate an error status as long as the throttle signal is above zero. Turning the throttle to zero will switch the module to normal operation.

Any release of the throttle will be transferred instantly to the module output to avoid unwanted decay times of the motor current and torque.

The module is waterproof packaged in a stable aluminum case to make it suitable for all weather conditions.

General safety issues

Certainly the DMMD cannot cover the following issues:

1. Caused by defective supply of the module e.g. cable break, valid electrical signals can appear at the input of the motor controller. Since the module is powered off no measures can be made within the module. This issue has to be resolved by the motor controller.

2. In case of a crack of the housing of commercially available hall sensor throttles a safety issue could occur. If the position of the hall sensor is changed with respect to the magnet and all signal wires are still connected, the sensor may send a valid throttle signal which can lead to an unwanted acceleration and might cause an accident.
   If at least one of the signal wires breaks a safety shutdown by the module will be activated as described above.

3. Since all cable connectors are not water tight a safety issue could occur in case of flooding (driving through deep water) or high pressure water (cleaning). Electrical signals could appear that will lead to an unwanted acceleration and might cause an accident. Typically splash water is not that critical.

We therefore recommend using an additional emergency switch or connector with ripcord to interrupt the ignition circuit.

Installation of DMMD to OSET-Bikes

Disconnect the throttle sensor from the motor controller, connect module interfaces to the open ends and fix the module on the bike. If a change of module settings is required use the corresponding plug and connect the wires accordingly by switches or fixed connection.

Installation of DMMD to other e-bikes

Disconnect the throttle sensor from the motor controller, connect module interfaces to the open ends and fix the module on the bike. If a change of module settings is required use the corresponding plug and connect the wires accordingly by switches or fixed connection.

In case of a closed loop controller version is used the corresponding current sensor has to be installed and connected to the secod input connector.

Additionally the module might require a separate power supply via a corresponding plug. Two types of modules are available, DMMD-15 for supply voltages between 5V and 12V (max. 15V) and DMMD-120 for supply voltages between 5V and 120V.

Security issues for installation of the module

Any contact to the high current connectors and cables as well as to all other open contacts has to be avoided under all means. All cables and connectors have to be isolated adequately. All connections have to show good electrical contact.

All signaling cables from and to DMMD (e.g. from throttle, current sensor and to the motor controller) must not be placed and routed close to and in parallel to cables carrying switched currents. This is to avoid cross coupling and signal distortions that could cause malfunctions of the DMMD.
Cables with switched currents are e.g. all high power cables between battery, motor and controller as well as other cables of inductive switching circuits (relais).

Further security recommendations

http://www.automotive.picoamps.de/doc/safety_instructions_electrical_vehicles.pdf

NOTE: No general operating license available, yet.