1 Purpose

The TM4 NEURO Vehicle Management Unit (**VMU**) – also referred to as **VCU** or **ECU** in the automotive industry – is typically the main controller of a vehicle. The VMU interfaces with all vehicle auxiliaries and manages torque commands using proven algorithms.

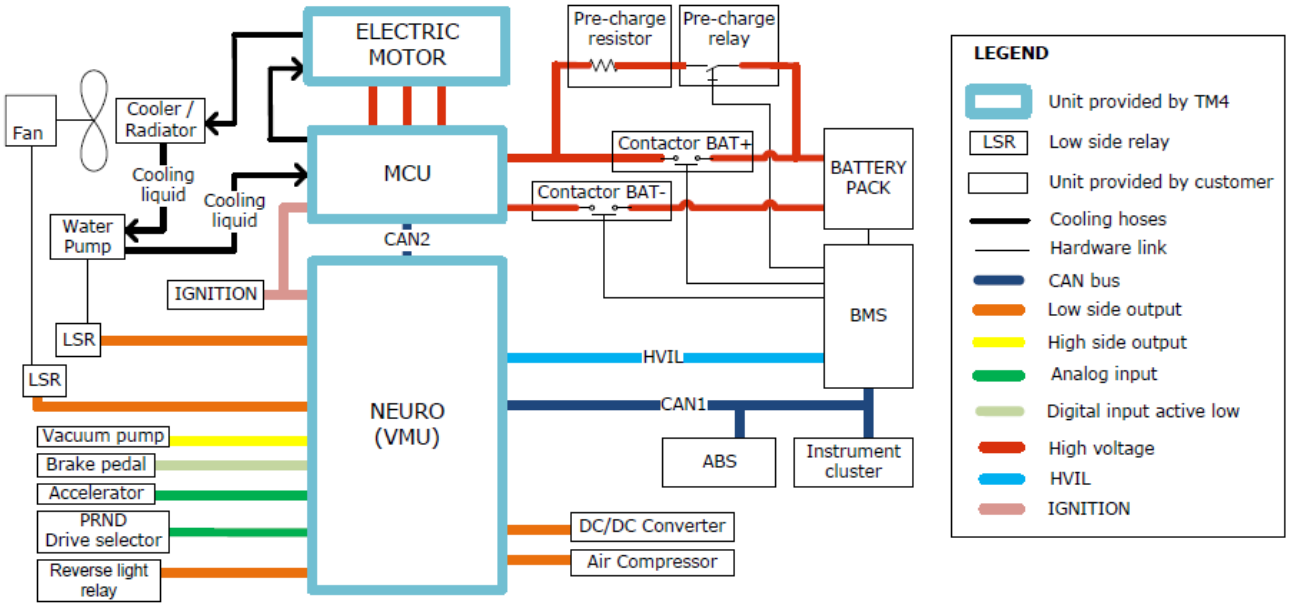
Each model of vehicle is built differently; therefore, the roles and functionality of NEURO depend greatly on the type of vehicle integration. This document is intended to help the customer to provide all necessary information prior to TM4 adapting the VMU software/hardware.

TM4 offers VMU software development services to its MOTIVE or SUMO electric traction system customers looking for a fully-compatible vehicle management system optimised for operation in conjunction with other TM4 products.

2 Typical vehicle integration

2.1 Vehicle architecture

The example of vehicle architecture below provides a general understanding of which hardware components are connected to NEURO. This type of plan allows TM4 to understand the overall system architecture as well as the interactions between the all the components and the NEURO VMU.



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2013-03-26
Issue number: 1

2.2 TM4 NEURO functionalities

The following functionalities are given as examples only as a vast array of software functionalities can be implemented within the NEURO VMU; the only limitations are the hardware interface (input/output) and the information on the CAN buses.

The VMU software integrates proven torque algorithms (hill holder, damping, creep and speed vs. accelerator position torque) with over 60 parameters that allow the customer to configure NEURO as required when calibrating the vehicle.

Here is a list of sample functionalities:

- **Accelerator management**: Reads the accelerator position and computes the torque command
- **Drive selector management (PRND)**: Reads the PRND position and computes its logical position according to the vehicle state
- **BMS communication**: Receives the permitted discharge/recharge current
- **Pre-charge management**: Manages the contactors to pre-charge the HV bus
- **DC/DC management**: Turns on/off the DC/DC based on the battery SOC
- **Cooling fans/pump**: Starts and stops the fans/pump according the level of cooling required
- **ABS/EPS management**: Reads the state of the ABS/EPS system and removes regenerative torque on event
- **Charger management**: Reads if the charge socket is connected and controls the charger commands until the battery is full
- **Range extender management**: Starts, controls and stops the range extender based on different states of the VMU and the battery
- **Instrument cluster**: Sends the appropriate messages to the vehicle instrument cluster
- **Cabin temperature management**: Manages the air conditioning compressor and the heating loop according to the commands received from the cabin cluster
- **Interlock management**: For safety purposes, manages any interlock of the vehicle and requests the battery contactor to open if an event is detected
- **Hybrid system management**: Manages the internal combustion engine and the electrical system to maximize vehicle efficiency
- **Others according to customer needs**

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3 TM4 NEURO development considerations

3.1 VMU input/output overview

For any VMU software development it is important to take into consideration all hardware limitations; the table below provides a list of NEURO inputs/outputs (12 volts and 24 volts).

Signal name	Quantity	12 V version	24 V version
Enable (Ignition signal)	1	Used to activate the VMU (On/Off)	
HVIL (only 24 V version)	1	NONE	High voltage interlock loop
CAN bus	3	CAN1: Termination of 2.6KΩ between CANH and CANL CAN2: Termination of 120Ω between CANH and CANL CAN3: Undefined	
PWM output	2	12V open drain	24V open drain
High side output	4	4A max continuous current per output	3A max continuous current per output
Low side output	13	12 O/P at 0.5A max sink current per output 1 O/P at 2A max sink current	
Active high input	2	*Hardware can be modified to convert active low input to active high input	
Active low input	16	-	
Analog input	12	-	
Analog alimentation	12	5.2V +/- 0.1V	5V +/- 0.1V
Speed sensor input (PWM input)	4	-	

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3.2 Information required by TM4 for customized VMU development

Information required for customized VMU software development:

1. **A schematic of the vehicle architecture**

2. **A full list of components to be connected to NEURO:**
   a. All technical specifications of the components connected to the VMU
   b. Electrical specifications: max current, continuous current, PWM frequency/duty-cycle, resistors, etc.(when applicable)

3. **CAN interface: CAN matrix and/or dbc file (when applicable)**

4. **Control strategy and architecture: how you intend NEURO to control this component:**
   a. Example 1: The charger shall be activated only when the socket is connected
   b. Example 2: The fans shall start when the battery temperature reaches 45°C and stop when it goes back to 35°C

5. **Technical Guides/Operational Manuals of the components**

6. **A list of functionalities with comprehensive descriptions requested by the customer, other than the basic torque algorithms:**
   a. Example 1: Simulated ABS Applies xNm of electrical braking with a frequency of xxHz and a duty cycle of xxx% when the brake is pressed, the accelerator is released and the deceleration is below xxxxRPM/m

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