M1 GPR MOTORCYCLE PACKAGE

MoTeC's M1 GPR Motorcycle Package is a versatile and adaptable platform primarily for the operation of port-injected motorcycle engines fitted with drive by wire systems. This single product can be configured over a huge range of complexities, from controlling a simple engine to a multi-throttle, quad cam boosted engine with two injectors per cylinder that may also include a sequential gearbox and many other features. Configurable engine synchronisation modes accommodate most modern engine triggering systems.

Included are numerous ancillary features common to race motorcycles, such as engine braking control, track splits for accelerating and braking, rider switches (pit switch, launch enable, traction trim etc.), gearbox control, knock control, launch control, rain light control, variable inlet control and traction control.

This Package seamlessly integrates with other MoTeC products and provides pre-defined CAN messaging for all current Display Loggers, Enclosed Loggers, Power Distribution Modules and other devices including E888, VCS, GPS, ADR, BR2 and SLM. Example wiring schematics are provided for basic operation.

This Package is supported by MoTeC Europe. For technical assistance please email: *support@moteceurope.co.uk*

ECU VARIANTS

This Package is available for use with MoTeC's port injection ECUs: M130, M150, M170 and M190.

MOTORCYCLE SPECIFIC FEATURES

The following features in GPR Motorcycle have been specifically designed to work with motorcycles:

- Onboard real time lean angle calculation from commonly available 3-axis IMUs (Bosch MM5.10, Yamaha R1, E Lean all currently supported).
- Ability to correct wheel speeds for variation in rolling tyre circumference due to lean angle.
- Wheelie detection by means of suspension position conditioning.
- Rider trim channels for traction control and engine braking.
- Engine braking strategy with open loop (throttle minimum position by gear and calculated engine speed) and closed loop (wheel speed differential with P controller) components. Utilises track sectors for enhanced performance.
- PID traction control by means of wheel speed differential and percentage slip. Multiple aim compensation and gain compensations available, including lean angle, longitudinal G, wheelie state and rider trim.
- Multiple throttle grip translation tables (engine speed v throttle grip position) selectable by gear position, rider switch and track sector.
- Gearbox shift request via up shift switch/down shift switch or gear lever force sensor.
- Gearbox shift control with ignition cut, fuel cut, ignition timing and throttle blipping.
- Launch control managing throttle limit and engine speed limit. Rider based entry with automatic exit based on gear position.

- Suspension Position Front and Rear.
- Rain light control strategy.
- Variable inlet length support (Yamaha R1, BMW S1000RR).

COMMON GPR FEATURES

- Operates port injected engines from 1 to 8 cylinders.
- Configurable engine synchronisation modes for many common engine types. Refer to the Supported Models section for current details.
- Configurable top dead centre for each cylinder allows for odd-fire engines.
- Configurable ignition output pin for each cylinder allows for coil-on-plug or wasted spark and distributor ignition systems.
- Configurable on-board knock for each cylinder with 2 assignable knock sensors and selectable centre frequencies.
- Configurable camshaft control from 1 to 4 cams, plus 1 switched camshaft.
- Dual bank lambda control supported; requires optional LTC with Bosch LSU4.9 sensor or LTCN with NTK sensor.
- Physical settings for engine displacement, fuel density + molar mass, stoichiometric ratio and injector characteristics allow for simplified engine start-up prior to tuning.
- Easy and fast engine tuning using engine efficiency map.
- Engine load modelling based on inlet manifold pressure and inlet manifold temperature. Alternatively, for example, when using individual throttle bodies, throttle position can be used.
- Control of 2 port injectors (peak&hold or saturated) per cylinder ('high/low' configuration) with tunable balance table.
- Control of one port injector (peak&hold or saturated) per cylinder.
- Fuel volume calculation considers delay effects resulting from the secondary (high) injector installation position.
- Sensor calibrations available for many common automotive sensors.
- Transient fuelling compensation using physical modelling of fuel film or throttle position rate of change.
- Nitrous system with two activation stages and additional fuel pumps, bottle heater control and pressure sensor.
- Transmission brake control ('bump') functionality for perfect positioning of motorcycles.
- Supports MoTeC devices: ADR, E8XX, PDM, SLM, VCS.
- Test settings for most outputs, including injection and ignition outputs, for easier setup.
- Turbocharger wastegate pressure control with pressure sensor and two PWM outputs.
- Configurable turbocharger boost control (using a normal and inverted solenoid output).
- Configurable anti-lag for single turbo with ignition timing limit, fuel volume trim, ignition cut, engine speed limit, boost aim and throttle aim tables.
- Supports turbocharger bypass valve control.
- Supports two coolant fan outputs (PWM controlled).
- Coolant temperature compensations for engine speed limit, ignition timing, fuel mixture and boost limit.
- Coolant pump output with PWM control.
- Coolant pump after-run functionality, optionally with additional pump output.
- Engine speed limiting with ignition cut and/or fuel cut.
- Fuel pump switched output.
- Fuel Flow Supply Sensor and Fuel Flow Return Sensor.
- Gearbox position detection via optional dual sensor or engine speed/wheel speed estimate.
- Gearbox shift request via Up Shift Switch/Down Shift Switch or Gear Lever Force sensor.
- Gearbox shift support with ignition cut, fuel cut, throttle blip and engine speed matching in forward gears.
- GPS acquisition and logging via CAN.
- Engine Charge Temperature calculation, allows for correction of Inlet Air Temperature (compensation of heat soak effect etc.).
- Lap distance, time and number via BR2, GPS or switched input, with split and sector options.
- Configurable launch control with tables for engine speed, throttle limit, boost aim and fuel volume trim.
- Race time system with trim tables for ignition timing compensation, fuel mixture aim, boost limit and throttle limit.
- Idle closed loop control system using ignition, drive by wire actuation or idle solenoid.
- Idle bypass control with stepper motor supported.
- Engine Load Average channel with tables for engine speed limit, ignition timing trim, fuel mixture aim, boost limit and throttle limit.
- Assisted engine start with dedicated fuel volume and idle compensations during crank and post start.
- Engine run time total for engine hour logging.
- Configurable security for multiple users.
- Configuration of brake state using a switch or a pressure sensor.
- Configuration of clutch state using a switch, a position sensor or a pressure sensor.
- Calculation of clutch slip.
- ECU-internal G-force (acceleration) – longitudinal, lateral, vertical.
- ECU CAN receive from a defined CAN ID for data reception from MoTeC devices. Supports 1 CAN bus.

- ECU CAN transmit of the most common channels using standard MoTeC CAN templates plus a GPR Motorcycle specific dataset (contact *support@moteceurope.co.uk* for more details).
- 8 configurable switches and 8 rotary switches (wired or CAN input) with each of 9 positions simultaneously mappable to all indexed rider switches.
- Analogue tachometer output with configurable output pin and scaling.
- Dual bank drive by wire throttle servo control.
- Throttle Grip sensor with multiple translation tables selectable according to gear and/or track position.
- Use of a Throttle Grip sensor or a Throttle Position sensor in case of a cable throttle.
- Traction control with tables for Aim Main, Aim Compensation and Control Range.
- Vehicle speed measurement using wheel speed sensors, estimation or GPS.
- Vehicle Speed Limit Control system (DBW-throttle based), which can also be used for pit speed limiting.
- Configurable warning system with light and CAN output.
- Auxiliary time system with tables for ignition timing compensation, fuel volume trim and fuel mixture aim.
- 4 auxiliary outputs for PWM control of added actuators:
  - Duty cycle tables using Engine Speed and Throttle or Manifold Pressure Axis'
  - Activation based on inlet manifold pressure or throttle position
  - Auxiliary Output 1 includes tables for Ignition Timing Compensation, Fuel Volume Trim and Fuel Mixture Aim
- Optional channels for additional sensors via input pin and/or CAN message, including:
  - Airbox Mass Flow, Pressure and Temperature
  - Ambient Pressure and Temperature
  - Boost Pressure
  - Brake Pressure Front and Rear
  - Brake Switch
  - Clutch Pressure and Position
  - Clutch Switch
  - Coolant Pressure and Temperature
  - Engine Oil Pressure and Temperature
  - Engine Crankcase Pressure
  - Exhaust Pressure Bank 1 and Bank 2
  - Exhaust Temperature (EGT) via TCA Thermocouple Amplifier, Generic CAN, or E888 for Collector, Bank 1 and 2 Collector, and Cylinders 1 to 8
  - Exhaust Lambda via LTC, LTCN, or PLM for Collector, Bank 1 and 2 Collector, and Cylinders 1 to 8
  - Fuel Pressure and Temperature
  - Fuel Tank Level
  - Gear Position
  - Gear Lever Force
  - Gear Neutral Switch
  - Gear Shift Request
  - Steering Angle
  - Suspension Position Front and Rear
  - Transmission Pressure and Temperature
  - Turbocharger Speed
  - Turbocharger Inlet/Outlet Temperature
  - Turbocharger Wastegate Position
  - G-Force (acceleration) – Longitudinal, Lateral, Vertical.
  - Wheel Speed sensors front/rear, wired or CAN input.
  - Gearbox shift request via up shift switch/down shift switch or gear lever force sensor.
  - Gearbox shift control with ignition cut, fuel cut, ignition timing and throttle blipping.
  - Launch control based on switch input and gear.
  - IMU supports Bosch MM5.10 and Yamaha R1 OE fitment.
  - Lean angle estimation via IMU input
  - Wheelie state determination

MOTORCYCLE ENGINE OPERATION ON M1

Engine Efficiency

The method of calculating Engine Efficiency has some differences when compared to the standard GPR firmware. The main change is that Engine Efficiency is calculated from two separate tables; Engine Efficiency Main and Engine Efficiency Secondary. These tables are added together and multiplied by the Inlet Manifold Pressure Engine Efficiency Compensation table to give the final Engine Efficiency value.

A typical configuration for a normally aspirated motorcycle engine would be to use Engine Efficiency Main only, with Engine Efficiency Secondary and Inlet Manifold Pressure Engine Efficiency Compensation both set to zero. However, it is very common for OE engine management systems to use both of these tables together, with lower load being managed by the Engine Efficiency Secondary table (inlet manifold pressure load) and higher load being managed by the Engine Efficiency Main table (throttle position load).

SUPPORTED MODELS

Make	Model	Years	Throttle
Aprilia	RSV4	All	DBW x 2
BMW	S1000RR	2015 on	DBW x 1
Honda	CBR1000	2017 on	DBW x 1
Kawasaki	ZX10R	2017 on	DBW x 1
MV Agusta	F3	All	DBW x 1
MV Agusta	F4	All	DBW x 1
Suzuki	GSXR1000	2017 on	DBW x 1
Yamaha	R6	2006 on	DBW x 1
Yamaha	R1	2007 on	DBW x 1

EXAMPLES GPR M130 PINOUT – YAMAHA YZF - R1 2012

M130 Connector A - 34 Way

Mating Connector: Tyco Superseal 34 Position Keying 1 – MoTeC #65044

Pin	Abbreviation	Name	Example Usage
A_1	OUT_HB2	Bridge Output 1.Positive	Throttle Servo Bank 1 Motor Output
A_2	SEN_5V0_A	Sensor 5.0V A	ECU Sensor 5V0 A Voltage
A_3	IGN_LS1	Low Side Ignition 1	Ignition Cylinder 1 Output
A_4	IGN_LS2	Low Side Ignition 2	Ignition Cylinder 2 Output
A_5	IGN_LS3	Low Side Ignition 3	Ignition Cylinder 3 Output
A_6	IGN_LS4	Low Side Ignition 4	Ignition Cylinder 4 Output
A_7	IGN_LS5	Low Side Ignition 5	Coolant Fan 1 Output
A_8	IGN_LS6	Low Side Ignition 6	
A_9	SEN_5V0_B	Sensor 5.0V B	ECU Sensor 5V0 B Voltage
A_10	BAT_NEG	Battery Negative	
A_11	BAT_NEG	Battery Negative	
A_12	IGN_LS7	Low Side Ignition 7	
A_13	IGN_LS8	Low Side Ignition 8	
A_14	AV1	Analogue Voltage Input 1	Throttle Grip Sensor Main Voltage
A_15	AV2	Analogue Voltage Input 2	Throttle Grip Sensor Tracking Voltage
A_16	AV3	Analogue Voltage Input 3	Throttle Servo Bank 1 Position Sensor Main Voltage
A_17	AV4	Analogue Voltage Input 4	Throttle Servo Bank 1 Position Sensor Tracking Voltage
A_18	OUT_HB1	Bridge Output 1.Negative	Throttle Servo Bank 1 Motor Output
A_19	INJ_PH1	Peak Hold Injector 1	Fuel Cylinder 1 Primary Output
A_20	INJ_PH2	Peak Hold Injector 2	Fuel Cylinder 2 Primary Output
A_21	INJ_PH3	Peak Hold Injector 3	Fuel Cylinder 3 Primary Output
A_22	INJ_PH4	Peak Hold Injector 4	Fuel Cylinder 4 Primary Output
A_23	INJ_LS1	Low Side Injector 1	
A_24	INJ_LS2	Low Side Injector 2	
A_25	AV5	Analogue Voltage Input 5	Gear Position Sensor Main Voltage
A_26	BAT_POS	Battery Positive	ECU Battery Voltage
A_27	INJ_PH5	Peak Hold Injector 5	Fuel Cylinder 1 Secondary Output
A_28	INJ_PH6	Peak Hold Injector 6	Fuel Cylinder 2 Secondary Output
A_29	INJ_PH7	Peak Hold Injector 7	Fuel Cylinder 3 Secondary Output
A_30	INJ_PH8	Peak Hold Injector 8	Fuel Cylinder 4 Secondary Output
A_31	OUT_HB3	Half Bridge Output 3	
A_32	OUT_HB4	Half Bridge Output 4	Fuel Pump Output
A_33	OUT_HB5	Half Bridge Output 5	Yamaha YZF R1 Inlet Actuator Inverting Output
A_34	OUT_HB6	Half Bridge Output 6	Yamaha YZF R1 Inlet Actuator Normal Output

M130 Connector B - 26 Way

Mating Connector: Tyco Superseal 26 Position Keying 1 – MoTeC #65045

Pin	Abbreviation	Name	Example Usage
B_1	UDIG1	Universal Digital Input 1	Engine Speed Reference
B_1	UDIG1	Universal Digital Input Pair 1.Phase A	
B_2	UDIG2	Universal Digital Input 2	Engine Synchronisation Position
B_2	UDIG2	Universal Digital Input Pair 1.Phase B	Engine Run Switch
B_3	AT1	Analogue Temperature Input 1	Airbox Temperature Sensor Voltage
B_4	AT2	Analogue Temperature Input 2	Coolant Temperature Sensor Voltage
B_5	AT3	Analogue Temperature Input 3	Rider Switch 1
B_6	AT4	Analogue Temperature Input 4	Rider Switch 2
B_7	KNOCK1	Knock Input 1	Suspension Position Front Sensor Voltage
B_8	UDIG3	Universal Digital Input 3	Wheel Speed Front Sensor Input
B_9	UDIG4	Universal Digital Input 4	Wheel Speed Rear Sensor Input
B_10	UDIG5	Universal Digital Input 5	Rider Switch 7
B_11	UDIG6	Universal Digital Input 6	Rider Switch 8
B_12	BAT_BAK	Battery Backup	ECU Battery Voltage
B_13	KNOCK2	Knock Input 2	Suspension Position Rear Sensor Voltage
B_14	UDIG7	Universal Digital Input 7	Rider Switch 3
B_15	SEN_0V_A	Sensor 0V A	
B_16	SEN_0V_B	Sensor 0V B	
B_17	CAN_HI	CAN Bus High	
B_18	CAN_LO	CAN Bus Low	
B_19	SEN_6V3	Sensor 6.3V	ECU Sensor 6V3 Voltage
B_20	AV6	Analogue Voltage Input 6	
B_21	AV7	Analogue Voltage Input 7	Airbox Pressure Sensor Voltage
B_22	AV8	Analogue Voltage Input 8	Gear Lever Force Sensor Voltage
B_23	ETH_TX+	Ethernet Transmit+	
B_24	ETH_TX-	Ethernet Transmit-	
B_25	ETH_RX+	Ethernet Receive+	
B_26	ETH_RX-	Ethernet Receive-	