Mectric Motorsport Electronics

µPDM4

The Micro PDM4 is a smart 4 channel power distribution module designed to replace mechanical relays and fuses in aftermarket automotive electrical circuits. Each of the 4 outputs can supply up to 15 amps continuous load current. Each output can be triggered by switch inputs or CAN messages. Outputs feature PWM soft start capabilities.

In applications where installers may need to add a small number of power circuits but don't require the size, cost or complexity of a full scale PDM. The Micro PDM4 is perfect for coupling with new engine harness builds or when adding a wide range of auxiliary circuits to a vehicle.

The uPDM4 is constructed from AEC-Q100 Automotive Grade components, ensuring its reliability in harsh environments.

Overview

- 4x Outputs, 15A Nominal, 24A Max
- 4x Digital Inputs
- 1x Analogue/Digital Input
- CAN 2.0B / FD Communications
- Overcurrent Protection
- Overtemperature Protection
- Short Circuit Protection
- Automotive Grade Device

Applications

- Resistive, Inductive and Capacitive Loads
- EFI relay
- ECU, DBW, Coil, Injector supplies
- Fuel pumps
- Water pumps
- Thermo fans
- Vehicle lighting

Mectric Motorsport Electronics

1/31 Ellemsea Circuit
Lonsdale SA 5160
Australia

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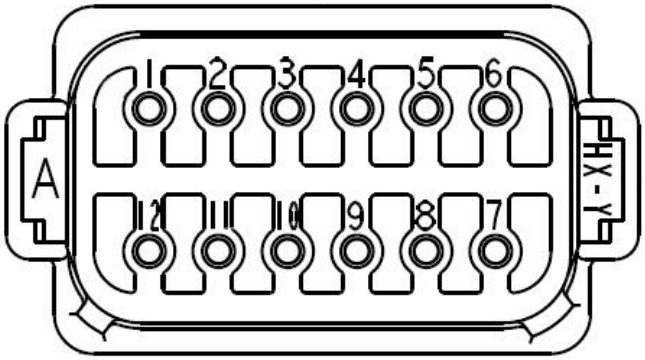
Contents

Wiring Pinout



Mating Connector: Deutsch DT06-12SA

Pin	Name	Description
1	OUT1	15A High side load output 1. PWM(1) up to 200Hz. Soft start capable.
2	OUT2	15A High side load output 2. PWM(1) up to 200Hz. Soft start capable.
3	OUT3	15A High side load output 3. PWM(1) up to 200Hz. Soft start capable.
4	OUT4	15A High side load output 4. PWM(1) up to 200Hz. Soft start capable.
5	IN5	Switch/Frequency/Analog input 5. Active high(2). 0-20V Measurement. Internal 10K pull down to 0V.
6	CANH	CAN High.
7	CANL	CAN Low.
8	GND	Chassis ground.
9	IN4	Switch/Frequency Input 4. Active low(3). Internal 10K pull up to 5V0.
10	IN3	Switch/Frequency Input 3. Active low(3). Internal 10K pull up to 5V0.
11	IN2	Switch/Frequency Input 2. Active low(3). Internal 10K pull up to 5V0.
12	IN1	Switch/Frequency Input 1. Active low(3). Internal 10K pull up to 5V0.
M6 Stud	BATT	Battery positive supply.

(1) Pins OUT1 & OUT2 as well as OUT3 & OUT4 share a common frequency register. The lowest of the two requested frequencies will drive the two outputs. Duty cycles remain independent to all channels.
(2) Active high inputs can be used as active low by installing an external 1K0 pullup resistor to the respective channel.
(3) Active low inputs can be used as active high by installing an external 1K0 pulldown resistor to the respective channel.

Software Configuration

Internal operations relay on three main components. Runtimes, Variables, and Functions.

- **Runtimes** are values generated at runtime and hold the results of function outputs, mathematical operations, inputs and output status's etc.
- **Variables** are user defined and editable constants that define how the device behaves.
- **Functions** are blocks of software that take inputs from both Runtimes and Variables and output a result.

Functions

Output Functions Can be configured to forward their results to drive an OUTn pin, or simply run virtually to have their outputs used by other functions. Their outputs can be used by other channels even if they are driving an OUTn pin.

Internal Functions Can't drive an OUTn pin directly, but their results can be used by any other functions.

Input Functions Take inputs from INn pins and convert the raw value to a usable result.

General Purpose Logic

Type: Output Function
Count: 8
Description: Takes the input from up to 3 Runtimes and compares them to the values of up to 3 Variables. Each input can be logically added to the next if they are required and used.

Logic:
If "Input Runtime 1" *is* (Greater than / Less than / Equal to / Not equal to) "Setting Variable 1", (And / Or / Don't Check),
If "Input Runtime 2" *is* (Greater than / Less than / Equal to / Not equal to) "Setting Variable 2", (And / Or / Don't Check),
If "Input Runtime 3" *is* (Greater than / Less than / Equal to / Not equal to) "Setting Variable 3",
Then: Output Runtime = 1,
Else: Output Runtime = 0.

Input Mirror

Type: Output Function
Count: 4
Description: Takes the input from an assigned INn pin and channels it's State, Frequency, and Duty Cycle to an OUTn pin. The function can accept another Runtime channel as an enabling condition.

Logic:
If "Enable Runtime" *is assigned* AND "Enable Runtime" *is* Greater Than 0, Or
"Enable Runtime" *is not assigned*,
Then: forward the assigned input pin's "Level, Frequency, Duty Cycle" to "Output Runtime",
Else "Output Runtime" = 0.

Counter

Type: Internal Function
Count: 8
Description: Takes the input from an input Runtime and increments or decrements a counter when the value changes. The change trigger can be set to the rise or fall of the input. Maximum and minimum values can be set. The counter can either stop at its limit or wrap to the opposing end. The counter can also be set to reset by the value of an assigned second input Runtime changing.

Timer
Type: Output Function
Count: 8
Description: A stopwatch like timer that counts in milliseconds, initiated by a configurable logic condition, similar to a single channel version of the General Purpose Logic function. The timer can be reset when it turns on or when it turns off. The timer's maximum value can be configured up to 32 seconds.

Switch
Type: Input Function
Count: 8
Description: Takes the input from an input Runtime and compares it to either an Active Level value or On/Off threshold values to give an on or off output. The Switch function can also be configured to toggle/latch.

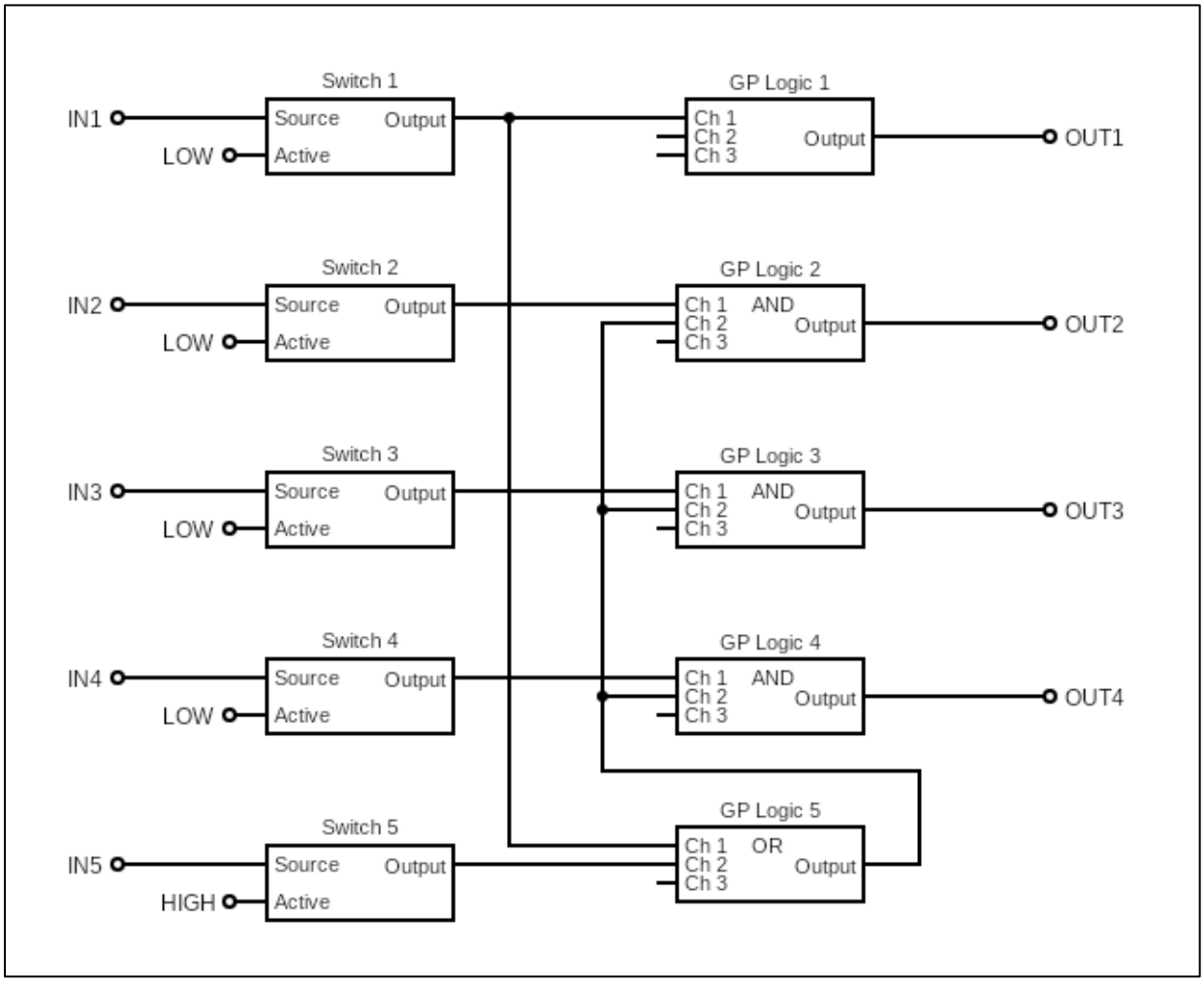
Default Configuration

By default, General Purpose Logic 1-4 are configured to drive OUT1-4 respectively.
IN1-5 drive Switch 1-5 respectively.
General Purpose Logic 1-4 are fed by Switch 1-4 respectively.
General Purpose Logic 5 is fed by Switch 1 OR Switch 5.
General Purpose Logic 2-4 require either Switch 1 or Switch 5 to be in some form of active state to enable.
This configuration makes OUT1 always switchable and acts like a master enable for the remaining OUTn pins.
All outputs are switchable if IN5 is high. This acts like a master ignition switch input.

This functionality has been chosen because some ECU's which may be driving the INn pins default to a low state when they are switched off. This can result in the output channels being enabled in error. OUT1 being always switchable makes it useful for EFI main relay duties.

All outputs can be controlled by CAN at any time, regardless of their driving function's.

Pin	Config	Fuse Current	Retries	Retry Delay
OUT1	GP Logic 1: IN1 Active	12.0 Amps	2	5.0 Seconds
OUT2	GP Logic 2: IN2 Active AND (IN1 Active OR IN5 Active)	12.0 Amps	2	5.0 Seconds
OUT3	GP Logic 3: IN3 Active AND (IN1 Active OR IN5 Active)	12.0 Amps	2	5.0 Seconds
OUT4	GP Logic 4: IN4 Active AND (IN1 Active OR IN5 Active)	12.0 Amps	2	5.0 Seconds
IN1	Active Low			
IN2	Active Low			
IN3	Active Low			
IN4	Active Low			
IN5	Active High			

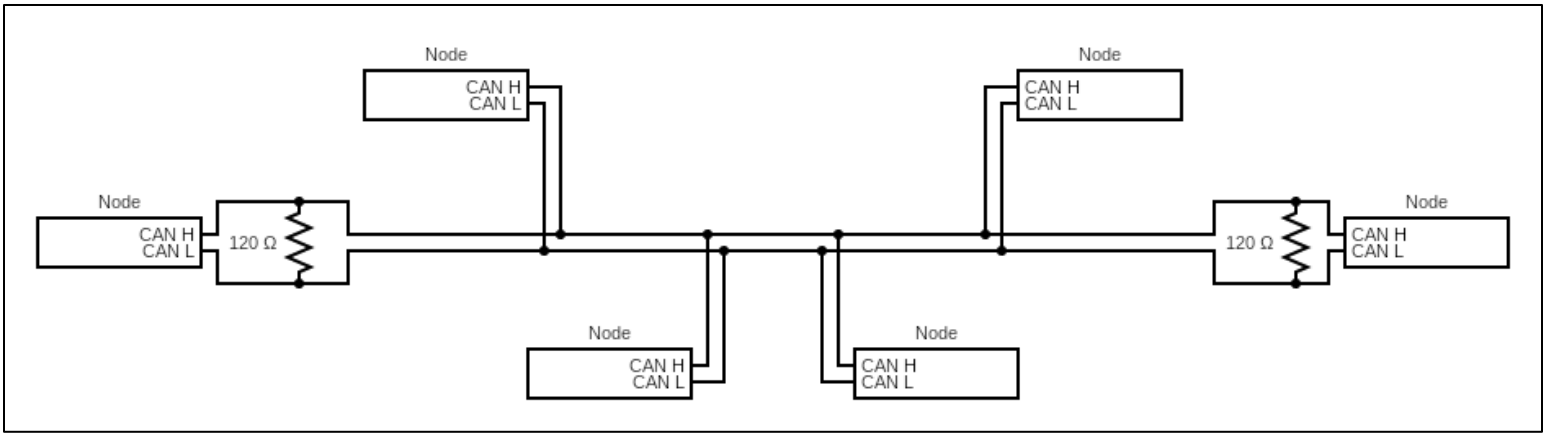


CAN

The µPDM4 is equipped with a single high speed Controller Area Network (CAN) transceiver able to communicate CAN2.0A/B & CAN Flexible Data rate (FD) messages at up to 4 Mbit/s. By default, the device accepts standard 11 bit frames at up to 1 Mbit/s (FD disabled).

Bus Wiring & Termination

The µPDM4 is **NOT** fitted with a CAN termination resistor. If the device is at either end of the bus, an external 120R termination resister should be installed.
CAN High and CAN Low wiring should be a twisted pair.
Maximum recommended stub lengths from the main bus to each node is 300mm.



Automatic Bus Speed Detection

On powerup the device will scan the CAN bus and attempt to establish communication. If this is unsuccessful, it will cycle through a range of preset speeds until a connection is achieved. It will then store the successful speed and use it as it's first attempt at next power up.
The cycled speed presets are: 1 Mbit/s, 500 Kbit/s, 250 Kbit/s, 125 Kbit/s.
This functionality can be disabled by the user if required.

Message Addressing

By default, the µPDM4's CAN base address is 416 (0x1A0).
Tx frames are transmitted at a base address offset of 0 through 15 (416-431 by default).
Rx frames are accepted from base address offset 16 through 31 (432-447 by default).
The base address can be changed by the user, but it must be a multiple of 32 (0x20).

IMPORTANT: When more than one µPDM4 are on the same bus, their base address's must be set independently and in multiples of at 32 (0x20).

Disconnect other devices which may be trying to use the same ID's while you configure each device.

CAN Protocol Frames

Default Base ID 416 (0x1A0)
Default Bitrate Auto detect (Up to 1Mbit/s, FD Disabled, 11 bit Standard ID's)
Tx Byte Order MSB First (Unless specified otherwise)

***Frame ID** = Device Base ID + Frame Base ID Offset. For example: By default, Rx Frame 5 will be accepted on ID 437 (0x1B5).*

Tx Data Stream

These frames are continually transmitted to the CAN bus. They contain lots of data about the device's operational status.

Tx Frame 0: Device ID — Base ID Offset: 0 (0x00) — DLC: 8 — Rate: 1 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Manufacturer ID	0	8	No	1	0	None	0	*Always = 222*
Device Type ID	1	8	No	1	0	None	0	*UPDM4 = 150*
Firmware Major	2	8	No	1	0	None	0	
Firmware Minor	3	8	No	1	0	None	0	
Firmware Revision	4	8	No	1	0	None	0	
Firmware Build	5	16	No	1	0	None	0	
Device Status	7	8	No	1	0	Status*	0	

** See Status Enumerations*

Tx Frame 1: Time & Device Critical Stats — Base ID Offset: 1 (0x01) — DLC: 8 — Rate: 1 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Uptime Days	0	8	No	1	0	Days	0	*12 = 12 Days*
Uptime Hours	1	8	No	1	0	Hours	0	*12 = 12 Hours*
Uptime Minutes	2	8	No	1	0	Minutes	0	*12 = 12 Minutes*
Uptime Seconds	3	8	No	1	0	Seconds	0	*12 = 12 Seconds*
CPU Temperature	4	8	No	1	-50	°C	0	*123 = 73 °C*
CPU Load	5	8	No	1	0	%	0	*12 = 12 %*
Internal 5V0 Supply	6	16	No	0.001	0	Volts	3	*1234 = 1.234 Volts*

Tx Frame 2: Output Status & Load — Base ID Offset: 2 (0x02) — DLC: 8 — Rate: 10 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Output 1 Status	0	8	No	1	0	Status*	0	
Output 2 Status	1	8	No	1	0	Status*	0	
Output 3 Status	2	8	No	1	0	Status*	0	
Output 4 Status	3	8	No	1	0	Status*	0	
Output 1 Load	4	8	No	1	0	%	0	*12 = 12%*
Output 1 Load	5	8	No	1	0	%	0	
Output 1 Load	6	8	No	1	0	%	0	
Output 1 Load	7	8	No	1	0	%	0	

** See Status Enumerations*

Tx Frame 3: Input Status — Base ID Offset: 3 (0x03) — DLC: 8 — Rate: 10 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Input 1 Status	0	8	No	1	0	Status*	0	
Input 2 Status	1	8	No	1	0	Status*	0	
Input 3 Status	2	8	No	1	0	Status*	0	
Input 4 Status	3	8	No	1	0	Status*	0	
Input 5 Status	4	8	No	1	0	Status*	0	
Input 5 Volts	5	16	No	0.001	0	Volts	3	*12345 = 12.345 Volts*
Input Level Flags	7	8	No	1	0	Bitfield**	0	*See Input Level Bitfield*

** See Status Enumerations*
*** See Bitfield Enumerations*

Tx Frame 4: Input Frequency — Base ID Offset: 4 (0x04) — DLC: 8 — Rate: 10 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Input 1 Frequency	0	16	No	0.1	0	Hz	1	*1234 = 123.4 Hz*
Input 2 Frequency	1	16	No	0.1	0	Hz	1	
Input 3 Frequency	2	16	No	0.1	0	Hz	1	
Input 4 Frequency	3	16	No	0.1	0	Hz	1	

Tx Frame 5: Device Totals Data — Base ID Offset: 4 (0x05) — DLC: 8 — Rate: 20 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Battery Voltage	0	16	No	0.001	0	Volts	3	*12345 = 12.345 Volts*
Total Current	2	16	No	0.01	0	Amps	2	*12345 = 12.34 Amps*
Total Power	4	16	No	0.1	0	Watts	1	*12345 = 123.4 Watts*
Total Load	6	16	No	0.01	0	%	1	*1234 = 12.34 %*

Tx Frame 6: Output Current Draw — Base ID Offset: 6 (0x06) — DLC: 8 — Rate: 20 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Output 1 Current	0	16	No	0.01	0	Amps	2	*1234 = 12.34 Amps*
Output 2 Current	2	16	No	0.01	0	Amps	2	
Output 3 Current	4	16	No	0.01	0	Amps	2	
Output 4 Current	6	16	No	0.01	0	Amps	2	

Tx Frame 7: Output Voltage — Base ID Offset: 7 (0x07) — DLC: 8 — Rate: 20 Hz

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Output 1 Volts	0	16	No	0.001	0	Volts	3	*12345 = 12.345 Volts*
Output 2 Volts	2	16	No	0.001	0	Volts	3	
Output 3 Volts	4	16	No	0.001	0	Volts	3	
Output 4 Volts	6	16	No	0.001	0	Volts	3	

Tx Frames 8-12: RESERVED

Rx Control Frames

Sending data to the device with these frames allows other devices to control the µPDM4's behavior.

Rx Frame 0: Control Frame 1 — Base ID Offset: 16 (0x10) — DLC: 8 — Timeout: 1.0 Seconds

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Output 1 Duty Override	0	8	No	1	1 or 100	% DC	0	*0 = No Change*
Output 2 Duty Override	1	8	No	1	1 or 100	% DC	0	*1 = Off (0 %DC)*
Output 3 Duty Override	2	8	No	1	1 or 100	% DC	0	*2 = On (100 %DC)*
Output 4 Duty Override	3	8	No	1	1 or 100	% DC	0	*100 - 200 = 0 - 100 %DC*
Output 1 & 2 Frequency Override	4	8	No	1	0	Hz	0	*0 = No Change*
Output 1 & 2 Frequency Override	5	8	No	1	0	Hz	0	*1 - 200 = 1 - 200 Hz*
Output 3 & 4 Frequency Override	6	8	No	1	0	Hz	0	
Output 3 & 4 Frequency Override	7	8	No	1	0	Hz	0	

Rx Frame 1: Control Frame 2 — Base ID Offset: 17 (0x11) — DLC: 8 — Timeout: 3.0 Seconds

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Output 1 Fuse Current Override	0	8	No	0.1	0	Amps	1	*0 = No Change*
Output 2 Fuse Current Override	1	8	No	0.1	0	Amps	1	*123 = 12.3 Amps*
Output 3 Fuse Current Override	2	8	No	0.1	0	Amps	1	
Output 4 Fuse Current Override	3	8	No	0.1	0	Amps	1	
Output 1 Retries Override	4	8	No	1	1	None	0	*0 = No Change*
Output 2 Retries Override	5	8	No	1	1	None	0	*1 - 254 = 0 - 253 Retires*
Output 2 Retries Override	6	8	No	1	1	None	0	*255 = Always Retry*
Output 4 Retries Override	7	8	No	1	1	None	0	

Rx Frame 2: Control Frame 3 (Emtron Friendly) — Base ID Offset: 18 (0x12) — DLC: 8 — Timeout: 3.0 Seconds

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Output 1 Enable Override	0	16 (LSB First)	No	1	0	None	0	*0 = No Change*
Output 1 Enable Override	2	16 (LSB First)	No	1	0	None	0	*1 = On (100% DC)*
Output 1 Enable Override	4	16 (LSB First)	No	1	0	None	0	
Output 1 Enable Override	6	16 (LSB First)	No	1	0	None	0	

Rx Frames 3-12: RESERVED

Device Config Frames

These frames allow the reading & writing of internal configuration data. They are mostly for use by configuration & tuning interfaces such as MectriCal & MectriCAN though any device capable of sending a single CAN frame can use them.

See Simplified CAN Programming for usage of the Special Command Frame

Rx Frame 13: Special Command Base ID Offset: 29 (0x1D) DLC: 8

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Command ID	0	8	No	1	0	None	0	*See Commands Table*
Data 0	1	**	**	**	**	**	**	
Data 1	2	**	**	**	**	**	**	
Data 2	3	**	**	**	**	**	**	
Data 3	4	**	**	**	**	**	**	
Data 4	5	**	**	**	**	**	**	
Checksum (where applicable)	6	16 (LSB First)	No	1	0	None	0	*Sum (Bytes 0:5) + 1*

The device will respond via Tx Frame 13.

Tx Frame 13: Special Command Response Base ID Offset: 13 (0x0D) DLC: 8 Rate: Once

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Command ID	0	8	No	1	0	None	0	*See Commands Table*
Data 0	1	**	**	**	**	**	**	
Data 1	2	**	**	**	**	**	**	
Data 2	3	**	**	**	**	**	**	
Data 3	4	**	**	**	**	**	**	
Data 4	5	**	**	**	**	**	**	
Checksum (where applicable)	6	16 (LSB First)	No	1	0	None	0	*Sum (Bytes 0:5) + 1*

Rx Frame 14: Configuration Read Request Base ID Offset: 40 (0x1E) DLC: 3

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Config Variable Type	0	8	No	1	0	None	0	
Config Variable ID	1	16 (LSB First)	No	1	0	None	0	

The device will respond via Tx Frame 14.

Tx Frame 14: Configuration Read Response Base ID Offset: 14 (0x0E) DLC: 8 Rate: Once

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Read Item Type	0	8	No	1	0	None	0	*255 = Invalid Request*
Read Item ID	1	16 (LSB First)	No	1	0	ID	0	*> 65500 = Error*
Data 0	3	8	**	**	**	**	**	*LSB First*
Data 1	4	8	**	**	**	**	**	
Data 2	5	8	**	**	**	**	**	
Data 3	6	8	**	**	**	**	**	
Data 4	7	8	**	**	**	**	**	

Rx Frame 15: Configuration Write Command Base ID Offset: 31 (0x1F) DLC: 8

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Config Variable Type	0	8	No	1	0	None	0	
Config Variable ID	1	16 (LSB First)	No	1	0	None	0	
Config New Value	3	32(LSB First)	**	**	**	**	**	
Store All Changes	7	8	No	1	0	None	0	*0 = No, 1 = Store All*

The device will respond via Tx Frame 15.

Tx Frame 15: Configuration Write Response Base ID Offset: 15 (0x0F) DLC: 8 Rate: Once

Data	Byte	Length (Bits)	Signed	Multiplier	Offset	Units	Decimals	Usage
Config Variable Type	0	8	No	1	0	None	0	*255 = Wrong Variable Type*
Config Variable ID	1	16 (LSB First)	No	1	0	ID	0	*> 65500 = Error*
Config New Value	3	32(LSB First)	**	**	**	**	**	*New value of the variable*
Store All Changes	7	8	No	1	0	None	0	*0 = No, 1 = Store Complete*

Simplified CAN Programming

In the absence of a MectriCAN interface, basic config changes can be made by any device capable of sending a CAN message. The following protocol is provided to simplify this process.

Configuration changes are written using **Rx Frame 13** (ID + 29) and responses will be transmitted on **Tx Frame 13** (ID + 13). For simplicity the requirement for a checksum has been omitted for these commands. Frames must be 8 bytes long or they will be ignored. Unused bytes can contain 0's.

Command ID is placed in Byte 0. Data is placed in Bytes 1-7 as required. If the configuration sent differs from the current data in memory, the response frame will contain a value of 1 in Byte 1. This means the new configuration has been changed and stored in permanent memory. If the same frame is sent again without new configuration changes, response Byte 1 will be 0.

Commands

10	Output Current Limits
11	Output Retries
12	Output Retry Delays
13	Output Soft Start Initial Duty Cycles
14	Output Soft Start Times
15	Output Max Duty Cycles
16	Output Frequencies
20	Input Pin Config
21	Switch Active Levels
30	Logic Conditions
31	CAN Config

Response Frame

The response frame will contain the following data:
Byte 0: Command ID (255 = Error).
Byte 1: 0 = No change to current config (data sent matches data stored), 1 = Change made and stored in memory.
Byte 2-7: Not used, will contain all 0's.

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 13	8	**Command ID**	O or 1	0	0	0	0	0	0

Output Current Limits

Sets the current limit for the outputs.
Command ID: 10
Data Units: Amps
Data Multiplier: 0.1
Data Usage: (123 = 1.23 Amps)

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**10**	Output 1 Max Current	Output 2 Max Current	Output 3 Max Current	Output 4 Max Current	0	0	0

Output Retries

Sets the maximum number of times each output will be retried after a fault is detected.
Command ID: 11
Data Units: None
Data Multiplier: 1
Data Usage: 0-254 = 0-254 Retries, 255 = Always Retry.

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**11**	Output 1 Max Retries	Output 2 Max Retries	Output 3 Max Retries	Output 4 Max Retries	0	0	0

Output Retry Delay

Sets the amount of time that the output must remain off after a fault is cleared before it will be retried.
Command ID: 12
Data Units: Seconds
Data Multiplier: 0.1
Data Usage: 123 = 12.3 Seconds

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**12**	Output 1 Retry Delay	Output 2 Retry Delay	Output 3 Retry Delay	Output 4 Retry Delay	0	0	0

Output Soft Start Initial Duty Cycle

Sets the initial duty cycle used when an output's Soft Start Time > 0.
Command ID: 13
Data Units: %DC
Data Multiplier: 1
Data Usage: 12 = 12 %DC

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**13**	Output 1 Start Duty	Output 2 Start Duty	Output 3 Start Duty	Output 4 Start Duty	0	0	0

Output Soft Start Time

Sets the amount of time taken to ramp from the output's Initial Duty Cycle value to the output's Maximum Duty value.
Command ID: 14
Data Units: Seconds
Data Multiplier: 0.1
Data Usage: 123 = 12.3 Seconds

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**14**	Output 1 Start Time	Output 2 Start Time	Output 3 Start Time	Output 4 Start Time	0	0	0

Output Max Duty Cycle

Sets the maximum duty cycle for the output. Be careful when using values less then 100% as external flywheel diodes may be required. See DC Motors.
Command ID: 15
Data Units: %DC
Data Multiplier: 1
Data Usage: 12 = 12 %DC

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**15**	Output 1 Max Duty	Output 2 Max Duty	Output 3 Max Duty	Output 4 Max Duty	0	0	0

Output Frequency

Sets the frequency used by the outputs during Soft Start or similar PWM mode.
Command ID: 16
Data Units: Hz
Data Multiplier: 1
Data Usage: 123 = 123 Hz (200 Hz Max)

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**16**	Output 1 Frequency	Output 2 Frequency	Output 3 Frequency	Output 4 Frequency	0	0	0

Input Pin Config

Sets the active level and edge of the input pin.
Command ID: 20
Data Units: Bitfield
Data Multiplier: 1
Data Usage:

Bit 0 = Active Level (0 = Low, 1 = High)
Bit 1:5 = Not Used
Bit 6:7 = Active Edge (0 = Low, 1 = High, 2 = Both)

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**20**	Input 1 Config	Input 2 Config	Input 3 Config	Input 4 Config	0	0	0

Input Switch Active Level

Sets the active level of the Input Switch functions. By default, these values represent Input Pin levels for the switches to be considered ON. Byte 6 contains a bitfield that sets the Switches toggle/latch functionality.
Command ID: 21
Data Units: None
Data Multiplier: 1
Data Usage:

Switch Active Level: 0 = Low, 1 = High.
Switch Toggle Flags: Bit 0:5 = Switch 1-5 Toggle/Latch (0 = Off, 1 = On).

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**21**	Switch 1 Active Level	Switch 2 Active Level	Switch 3 Active Level	Switch 4 Active Level	Switch 5 Active Level	Switch Toggle Flags	0

Logic Conditions

Sets the requirements for the output switch logic. This is an extremely simplified implementation of the internal logic.
Command ID: 30
Data Units: None
Data Multiplier: 1
Data Usage:

0 = Output# will turn on if: Switch# = ON.
1 = Output# will turn on if: Switch# = ON AND Switch5 = ON.
2 = Output# will turn on if: Switch# = ON AND Switch1 = ON.
3 = Output# will turn on if: Switch# = ON AND (Switch5 = ON OR Switch1 = ON). *This is the default configuration.*

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**30**	Logic 1 Mode	Logic 2 Mode	Logic 3 Mode	Logic 4 Mode	0	0	0

CAN Configuration

Sets the CAN Base Address, Bitrate, and Auto Speed Detection. ***Changes will take effect after a full power cycle.***
Command ID: 31
Data Units: None
Data Multiplier: 1
Data Usage:

Base Address (Bytes 1:4): 32-bit unsigned integer, LSB First, internally masked to multiples of 32.
Bitrate Mode (Byte 5): 1 = 125 Kbit/s, 2 = 250 Kbit/s, 3 = 500 Kbit/s, 4 = 1 Mbit/s.
Auto Speed Detection (Byte 6): 0 = Off, 1 = On.

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BASE + 29	8	**31**	Base Address [0]	Base Address [1]	Base Address [2]	Base Address [3]	Bitrate Mode	Auto Speed Detection	0

Data Enumerations

Device Status

Value	Status	Description
1	OK	The output channel is on and OK.
5	Over Current	The device's total maximum current draw fault has been triggered.
6	Over Voltage	The device's supply voltage has exceeded 18.0 Volts.
7	Overload	The device's total maximum load fault has been triggered.
8	Short Circuit or Over Temp	All output channel's driver IC's have detected either a short circuit or over heated.
10	Retry Limit	The device's retry limit has been reached. All outputs are Off.

Output Status

Value	Status	Description
0	Off	The output channel is switched off.
1	On	The output channel is on and OK.
2	RESERVED	-
3	Soft Start	Soft start is currently active on the output channel.
4	Override Active	The output is being commanded by a configuration override variable.
5	Over Current	The output channel's maximum current draw fault has been triggered.
6	Over Voltage	The output channel's voltage has exceeded 18.0 Volts.
7	Overload	The output channel's maximum load fault has been triggered.
8	Short Circuit or Over Temp	The output channel's driver IC has detected either a short circuit or over heated.
9	Open Circuit	The output channel is on but there is no current draw.
10	Retry Limit	The output channel's retry limit has been reached. The output is Off.

Input Status

Value	Status	Description
0	Off / Inactive	The input channel's voltage level IS NOT equal to its active level.
1	On / Active	The input channel's voltage level IS equal to its active level.
2	PWM Signal Lost	The input channel has transitioned from a PWM input to a static signal.
3	PWM Signal Active	The input channel is measuring an incoming waveform.

Input Level Bitfield

Bit	Input	Description
0	IN1	0 = Low, 1 = High
1	IN2	0 = Low, 1 = High
2	IN3	0 = Low, 1 = High
3	IN4	0 = Low, 1 = High
4	IN5	0 = Low, 1 = High

Wiring

Wiring configuration can vary greatly from application to application. Here are a few examples and notes to use as guides.

Example: EFI Relay w/ Drive by Wire

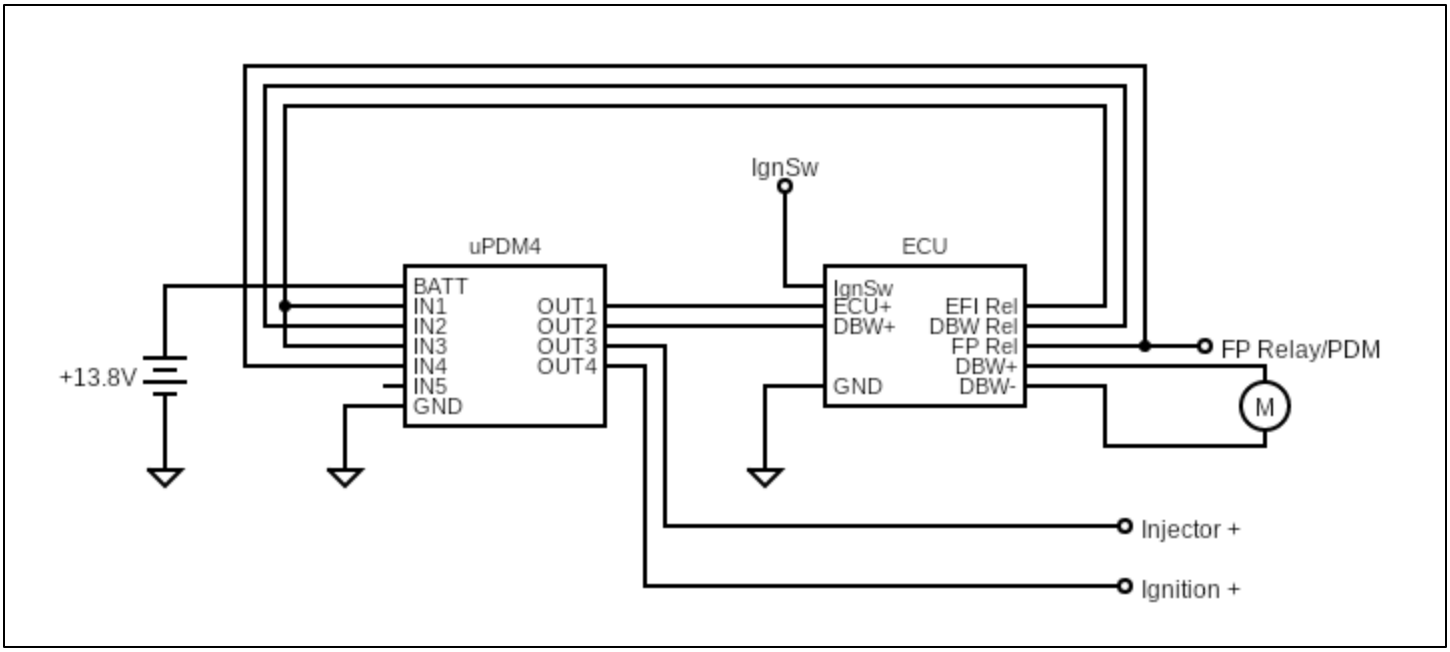


Figure 1 *EFI wiring implementation example: ECU controlled engine harness supplies with hold-power and DBW.*

Inputs

Input pins (INn) can be used as switch inputs or waveform inputs. Inputs 1-5 have Schmitt trigger circuits and will transition from a low to a high state with a small amount of hysteresis. The inputs are compatible with VR sensor AC waves as long as the voltage levels are high enough to trigger the input thresholds.

Each input can measure the frequency, duty cycle, and pulse width of an input waveform up to 1.0 KHz. These values can be used by any function and/or directed straight to control an output pin(s).

High input threshold: ~2.7 Volts.
Low input threshold: ~2.0 Volts.

Input 5 (IN5) can also measure in input voltage of 0-20V. This can be used by any logic function.

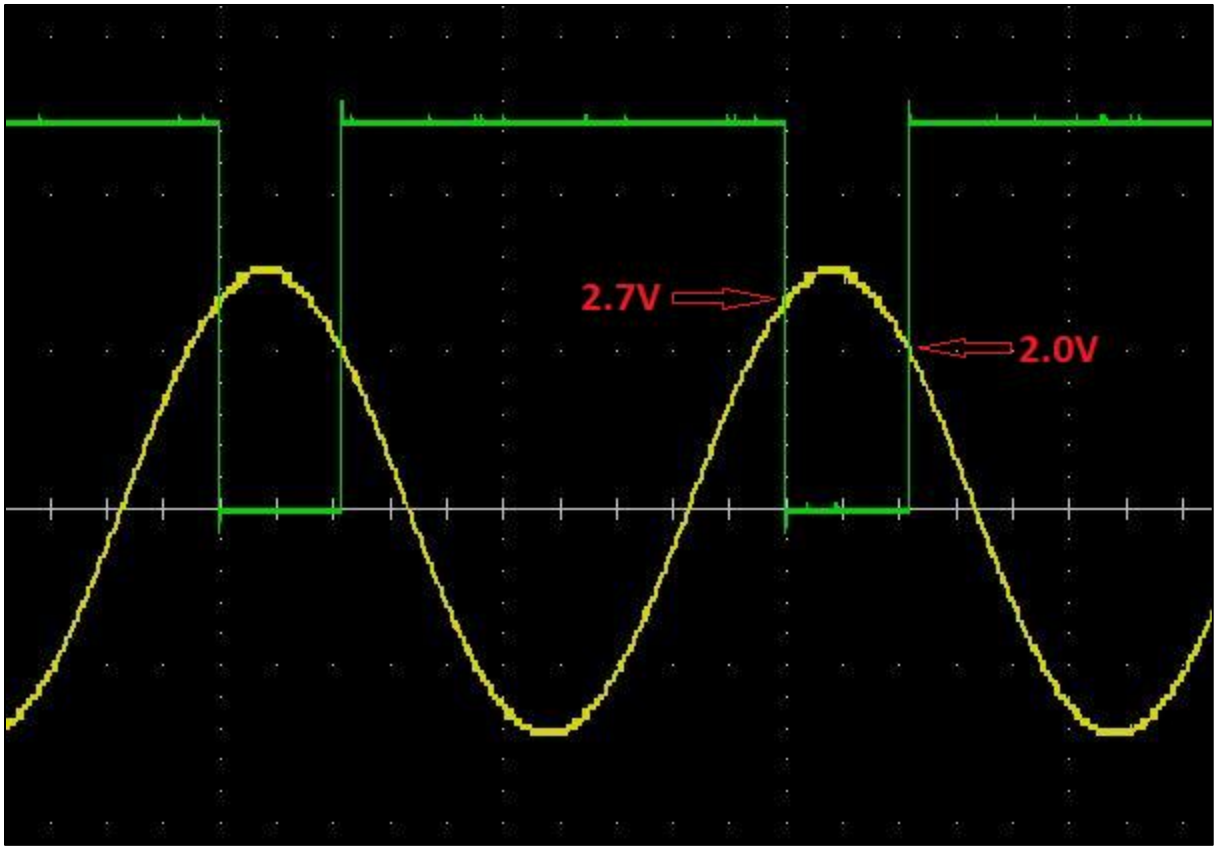


Figure 2 *Input Schmitt Trigger with a +- 3.0V AC waveform input (Yellow). Note the Green trace represents the output of the Schmitt trigger circuit which is inverse to the actual waveform input. The result is inverted by software to represent the true input level.*

Inputs 1-4 Active Low

Input's (INn) 1-4 have internal 10K pullups to 5V0 allowing them to be used as active low inputs without any additional external components.

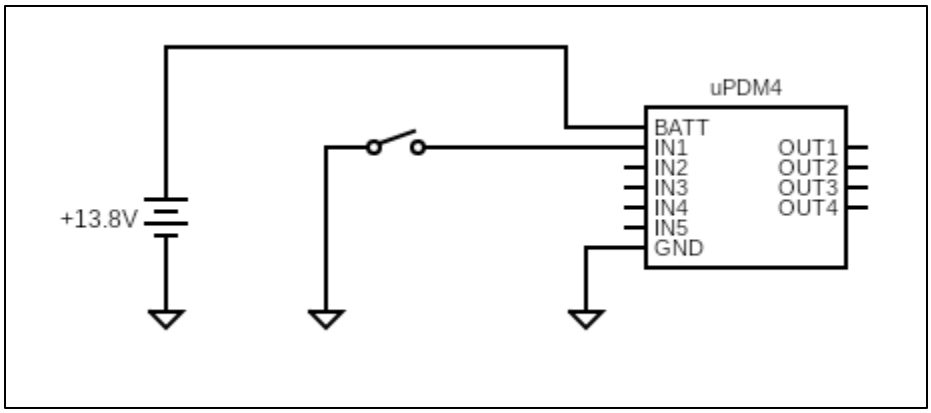


Figure 3 *Input 1-4 active Low with an external switch to ground.*

Inputs 1-4 Active High

Input's (INn) 1-4 have internal 10K pullups to 5V0. To use them as active high inputs, install an external 2K2 pulldown will pull the input's rest voltage below its low input threshold.

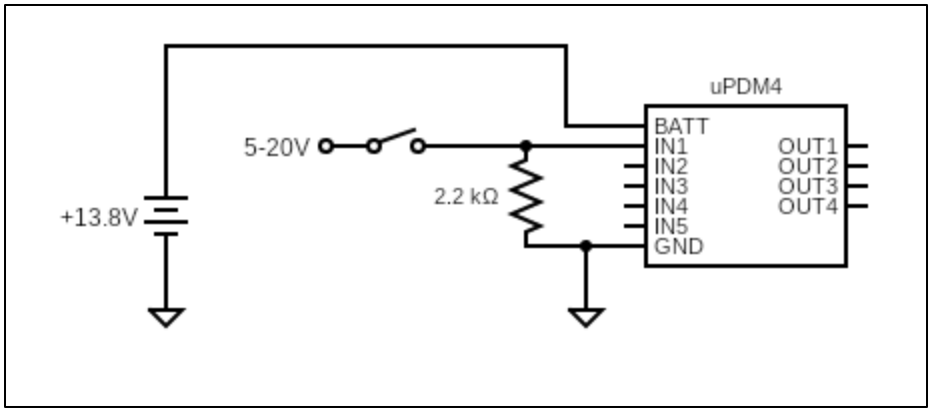


Figure 4 *Input 1-4 active high. External switch to a high source voltage and a pull down to ground.*

Input 5 Active High

Input 5 (IN5) has an internal 10K pulldown to 0V. It can be used as an active high input without any additional external components.

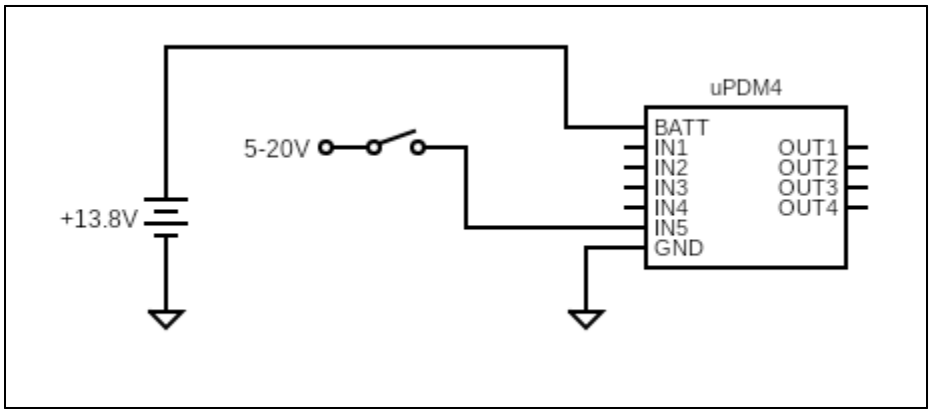


Figure 5 *Input 5 active high. External switch to a high source voltage.*

Input 5 Active Low

Input 5 (IN5) has an internal 10K pulldown to 0V. To use it as an active low input an external 1K0 – 4K7 pullup to 5-20V is required to pull the input's rest voltage above its high input threshold.

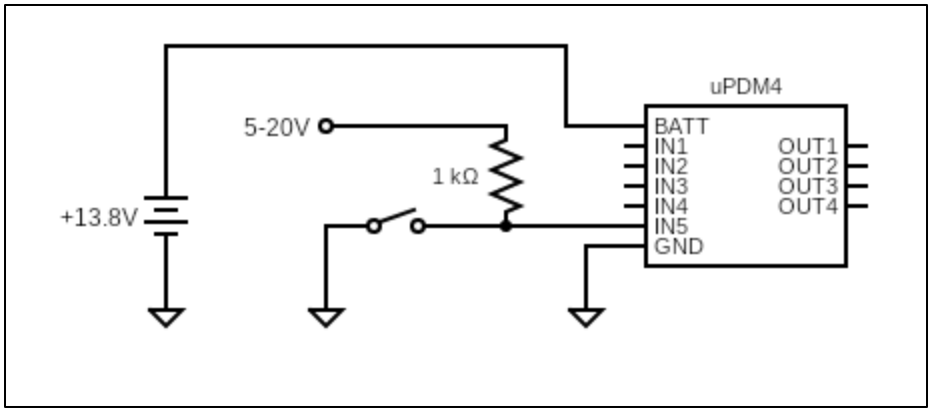


Figure 6 *Input 5 active low. External switch to ground and a pullup to a high source voltage.*

Outputs

Output Pins (OUTn) can supply external loads with a controlled and protected source voltage. Each output is protected against overload, short circuit, over voltage, and over temperature. Fuse current's can be configured along with retry delays and limits.

Each output driver is rated to capable of 15A continuous load, more in short burst and inrush conditions.

Each output can be PWM'd at up to 200Hz, allowing current/speed control of load devices such as globes, pumps, and fans. **Care must be taken when PWM controlling highly inductive loads and external flywheel diodes must be fitted.** See the section on DC Motors for details.

Frequencies are shared between OUT1 & OUT2 as well as between OUT3 & OUT4. The OUTn channel requesting the lowest frequency will gain control. Care should be taken to choose appropriate channels for certain tasks.
For example:
OUT1 = Left indicator lamps @ 1Hz.
OUT2 = Right Indicator lamps @ 1Hz.
OUT3 = Fuel pump @ 100 Hz.
OUT4 = Thermo Fan @ 100 Hz.
If you were to try to run OUT1 at 1Hz and OUT 2 at 100 Hz, both channels will operate at 1Hz.

The device maximum current limitation is 65A. If the current draw exceeds this value for more than 5 seconds, the device total current limit fault will be triggered, and all outputs will turn off.

Short Circuit Protection

In the event of a short circuit between a OUTn channel and GND, a very high current will flow through the device. This current will exceed the output's hardware over current threshold and the OUTn channel will be switched off.

Over Temp Protection

Any output channel (OUTn) supplying an excessive current load will cause the output driver to heat up. In the event of excessive IC temperature, OUTn will switch OFF. The output will remain off for the duration of the configured **Retry Delay** time. If the channel's configured **Retry Limit** has not been reached, the output will switch back on.

Reverse Battery Protection

Battery voltage is distributed to the µPDM4's internal circuitry through an array of high current P-Channel MOSFETs. These will block the flow of reverse current to the device itself as well as any load it is supplying.

Over Load Protection

Each output channel (OUTn) calculates a Load value represented in percent. Load is a function of accumulated current draw over time compared to the output's configured **Fuse Current**. If the Load figure reaches 100% for more that the output's configured **Fault Delay** time, OUTn will switch OFF. The output will remain off for the duration of the configured **Retry Delay** time. If the channel's configured **Retry Limit** has not been reached, the output will switch back on.

Over Current Protection

Each output channel (OUTn) measures a live current draw value represented in amps. If the current draw exceeds the configured **Fuse Current** by more than 2.0A for more longer than the output's configured **Fault Delay** time, OUTn will switch OFF. The output will remain off for the duration of the configured **Retry Delay** time. If the channel's configured **Retry Limit** has not been reached, the output will switch back on.

Soft Start

Outputs can be enabled to utilize a Soft Start function. When the configured OUTn **Soft Start Time** is non 0, the output will ramp up from its **Start Duty** value to its final duty cycle over the specified time period. This helps to reduce the inrush current of high draw loads and reduce effects like headlights dimming when fans turn on.

DC Motors (Fans, Pumps, etc.)

When driving high current inductive loads such as thermo fans and pumps it's **recommended to install a large external flywheel diode across the motor terminals**. This is particularly important if the motor is to be speed controlled by PWM. When the output switches off, the motor will induce a large negative voltage that the driver IC must try and dissipate. During PWM operation, this happens up to 200 times per second, causing excessive heat to build up in the IC. A diode rated for at least 3A and 50V should suffice. The test below was done with a 1N5404.

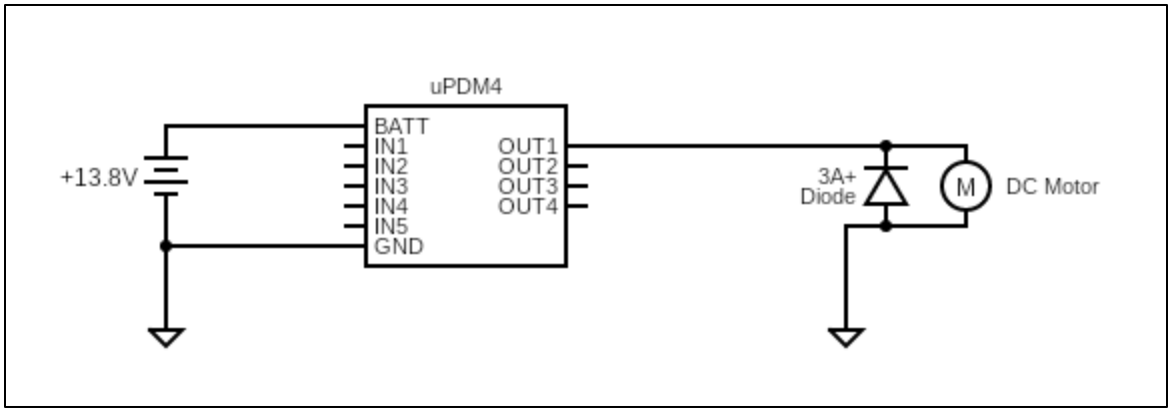


Figure 7 *Required external flywheel diode for DC motor PWM operation.*

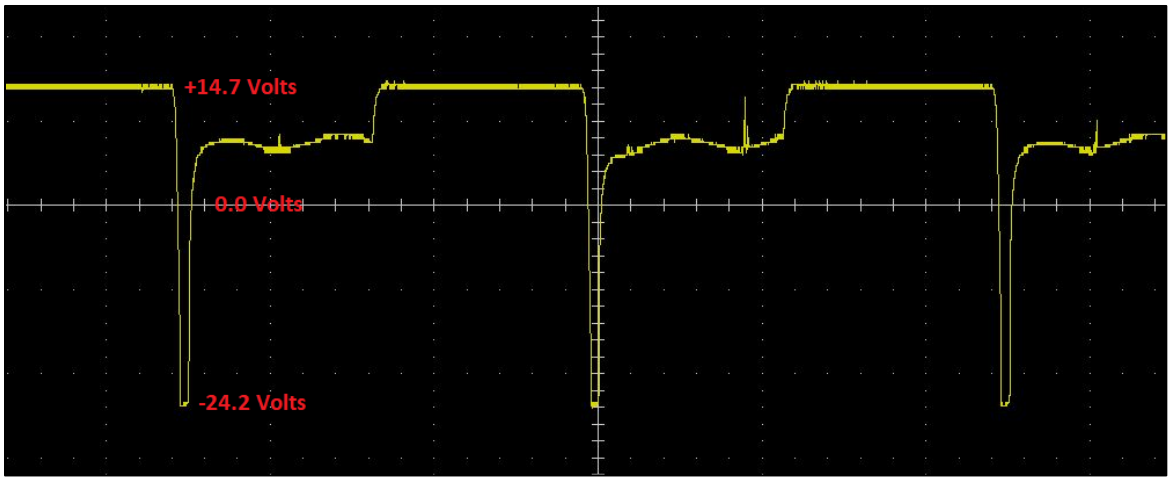


Figure 8 *100Hz, 50% Duty PWM, no diode fitted. Output channel voltage is subjected to a large negative voltage when the IC switches off.*

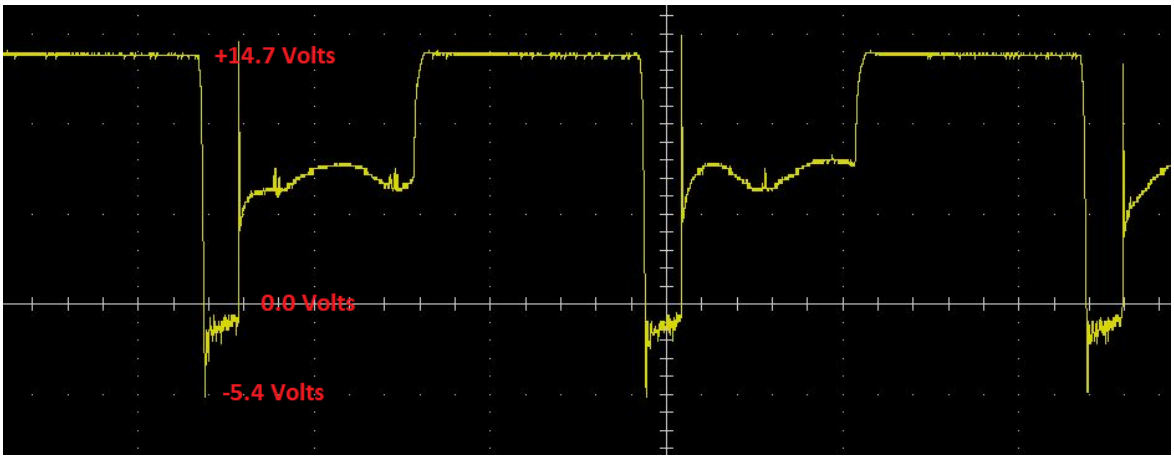
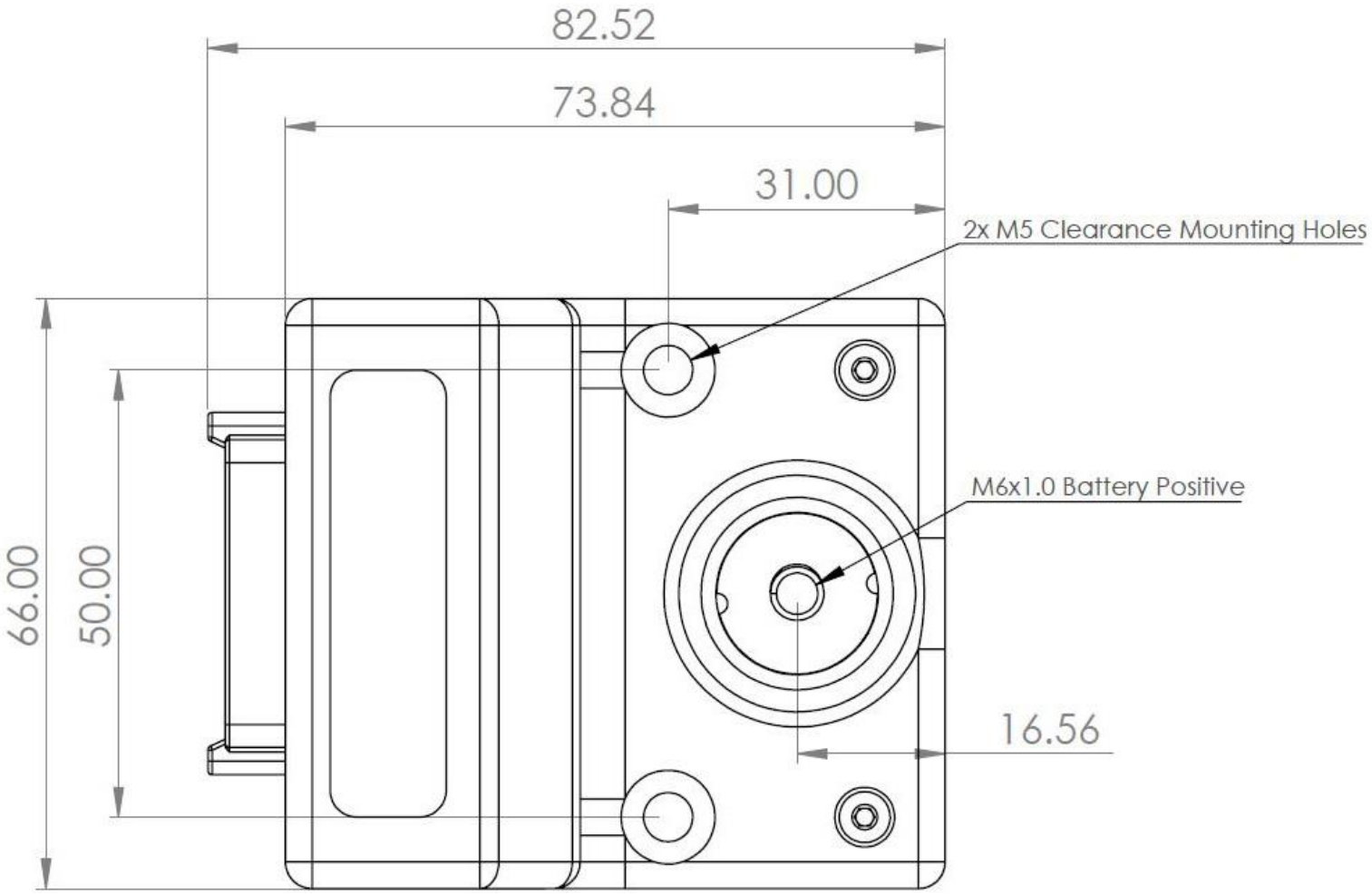


Figure 9 *100Hz, 50% Duty, Diode Installed. The negative voltage spike is largely absorbed.*

Device Ratings

Parameter	Value
Processor	48 MHz, 32 Bit, Cortex M0
CAN	1x 2.0A/2.0B/FD
Inputs	4x Digital, 1xAnalogue/Digital
Outputs	4x High Side
Minimum operating voltage	6.0 V
Minimum operating voltage (cranking)	6.0 V
Maximum operating voltage	27 V (Software limited to 18 V)
Maximum current draw in OFF state (all outputs OFF, CPU & CAN active)	40 mA
Input LOW threshold	~2.0 V
Input HIGH threshold	~3.0 V
Output typical ON-state resistance (T_J = 25 °C)	2.5 mΩ
Output maximum ON-state resistance (T_J = 150 °C)	5 mΩ
Output IC nominal rated load current (T_A = 85 °C)	24 A
Output IC minimum overload detection current	65 A
Device total current limit	65 A
Minimum operating temperature	-40 °C
Maximum operating temperature	105 °C
Minimum component automotive qualification	AEC-Q100 Grade 2

Dimensions


82.52
73.84
31.00
2x M5 Clearance Mounting Holes
M6x1.0 Battery Positive
66.00
50.00
16.56

Document History

09/09/2021 - Initial Release.
18/02/2022 – Updated to Rev 2B Hardware.
12/03/2022 – Updated default configuration.
20/03/2022 – Changed CAN addressing. Added simplified CAN Programming.