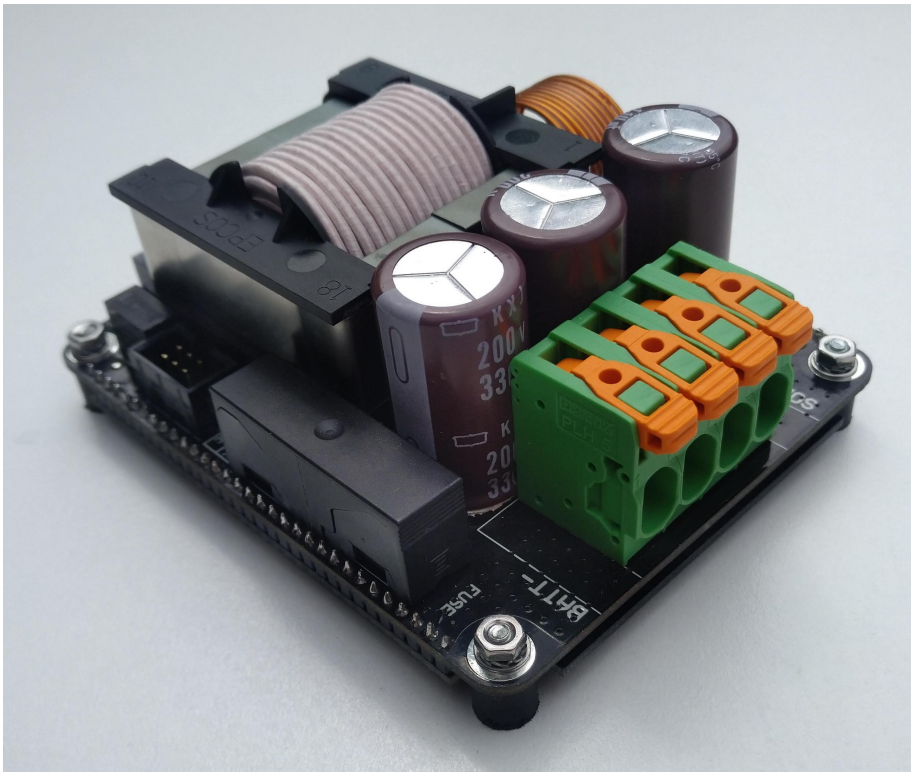
Elmar Solar MPPT Datasheet
3A input current (2019 stock)

October 6, 2020



1 Introduction

This document describes the specifications, performance and properties of the Elmar Solar MPPT. With it's record breaking 99.6% peak efficiency it is currently the most efficient MPPT available for solar car racing teams.

This document describes the default configuration of the MPPT optimized for lower current Multi-junction or diced silicon solar arrays and a $> 100V$ li-ion battery. Different versions of the MPPT are available to accompany for full silicon solar cells and Lower voltage battery systems.

During WSC 2019 this MPPT version was used by all the teams that used multi junction gaas arrays: Kogakuin, Delft, Leuven, Twente, Western Sydney, Aachen and Michigan. It's also very suitable for use with cut silicon arrays.

2 Features

- Extremely high electrical conversion efficiency up to 99.6%
- Tracking algorithm optimized for solar cars
- Data transmission via CAN Bus
- End of charge current control for safe and optimal battery charging

3 Specifications

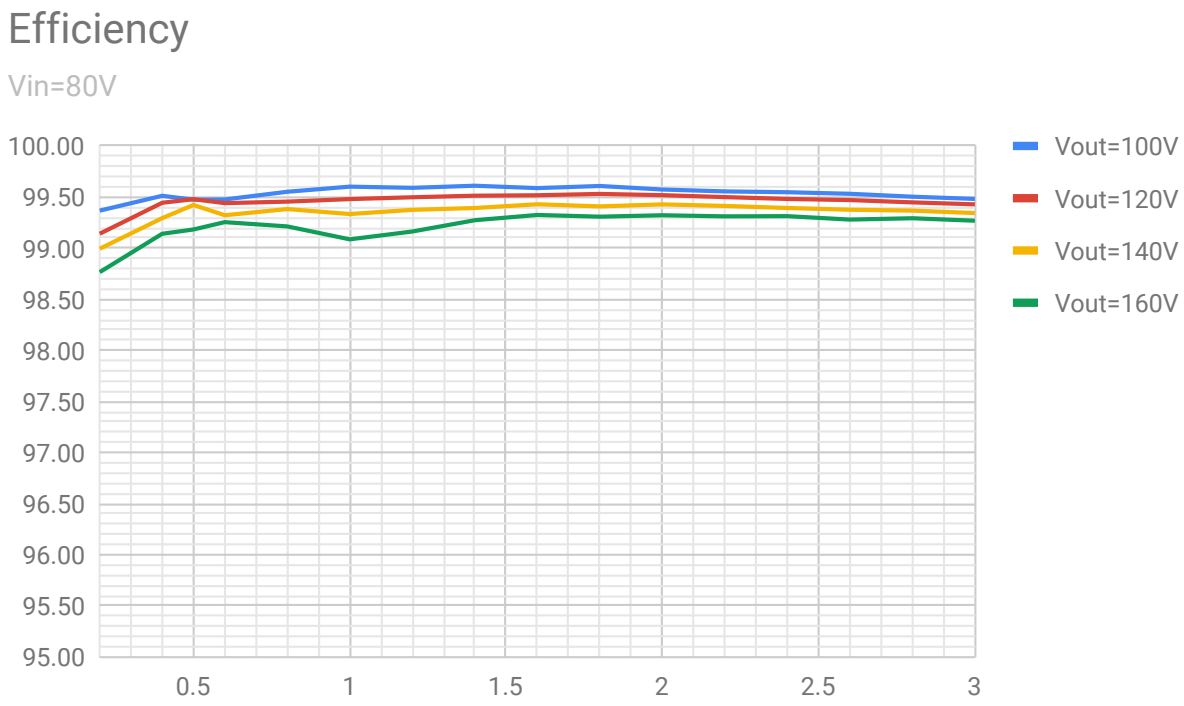
Parameter	**Minimal**	**Nominal**	**Maximal**	**Unit**
Array Voltage *1	20		150	Volt
Array Current *2			3.0	Ampere
Output Voltage *1 *2	22		165	Volt
Output Shutdown Voltage			175	Volt
Boost ratio	1.1		8	
Efficiency		99.2	99.6	%
Off state current draw ($V_{out} = 140V$)		84		uA
Operating Temperature	0		55	Celsius
CAN Interface Specification				
Supply Voltage	10.8	12	13.2	Volt
Supply Current		20		mA
Transmission rate *3	125	125	1000	kB/s
Dimensions				
Length		100		mm
Width		80		mm
Height		42		mm
Weight		311		gram

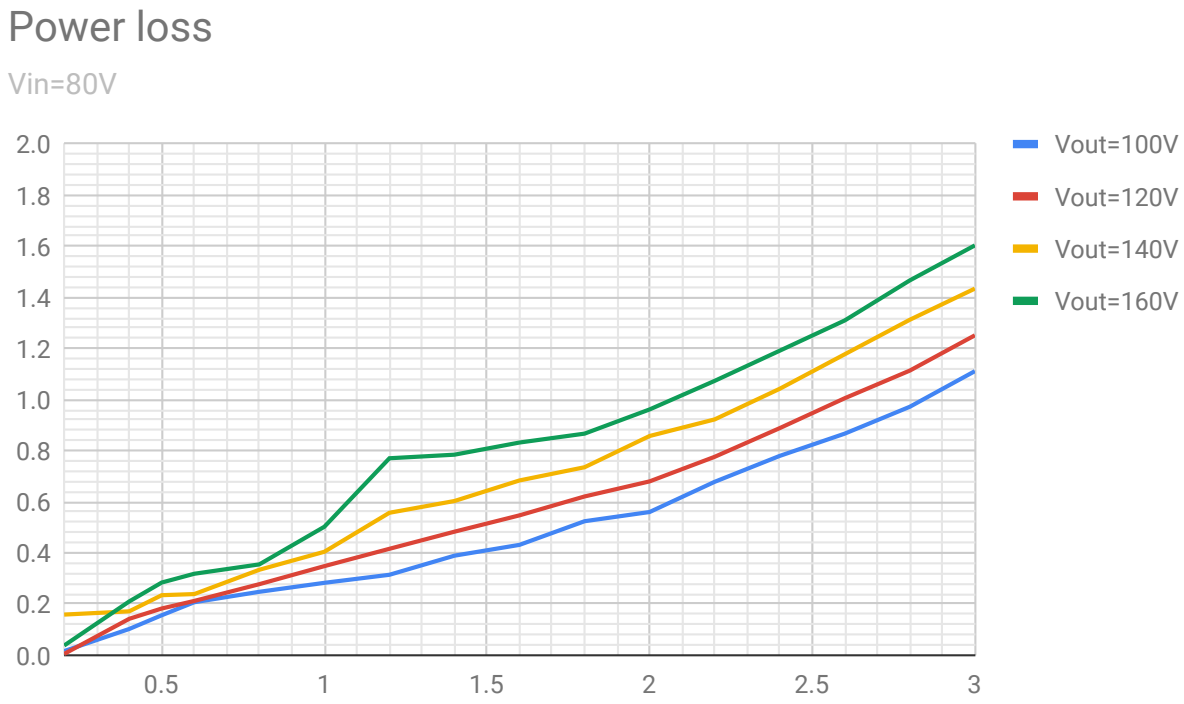
*1 The input voltage must be less than the output voltage for the MPPT to track the maximum power point

*2 The input current and output voltage will be limited to a value required by the customer.

*3 Transmission rate will be configured to the rate required by the customer.

4 Electrical conversion





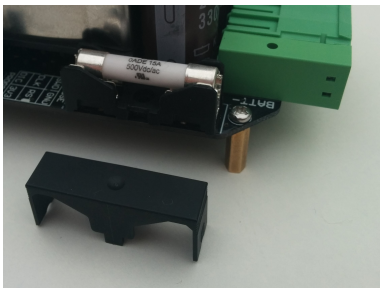
5 Fusing

5.1 CAN

The 12V Can supply voltage rail is protected with a resettable 200mA PTC fuse of the type Bourns MF-MSMF020-2 mounted on the PCB of the MPPT.

5.2 Power

The $V_{out}+$ voltage rail is protected with a fuse of the type Bel Fuse 0ADEC9150-BE mounted mounted on the PCB of the MPPT. This fuse is user replaceable, however it is recommended to send in the MPPT for service whenever this fuse is blown as there is a very high change of damage to the MPPT.



6 Precharge

6.1 Output

The Elmar Solar MPPT has 660uF of low-impedance capacitance across the DC bus output connections. Destructive high currents can flow when connecting capacitors or low impedance sources like a battery with different voltages in parallel. An external precharge circuit is mandatory when connecting the MPPT output to a battery.

When the MPPT is in off state there is still a diode from the input to the output connection, allowing the array to charge the output capacitors of the MPPT. Whenever connecting the output of MPPT's in parallel or paralleling the MPPT output to other devices such as a motor controller special care has to be taken to discharge all capacitors prior to making connections to avoid damage.

6.2 Input

The Elmar Solar MPPT has 330uF of low-impedance capacitance across the input connections. A solar array is current limited and thereby a precharge circuit on the input is not necessary when connecting solar arrays that have a short circuit current of less than 8A.

7 Led signaling

A single LED indicator is available next to the canbus connectors. Use CAN to get more detailed information about the MPPT state.

Led color	**state**
Off	off-state
orange	standby-state
green	active-state
red	error-state

8 Can Bus Interface

The canbus van be used to monitor the operation of the MPPT and to limit the input current of the MPPT. The use of CAN communication is recommended but optional, the 12V can supply is required for the MPPT to turn on.

8.1 Galvanic isolation

A galvanic isolation barrier is present between the CAN circuitry and the power circuit.

Parameter	**Value**
Isolation Voltage	1kVDC
Isolation Resistance	10GOhm
Isolation Capacitance	20-75pF
Insulation Grade	Basic

8.2 CAN Bus Speed

The general device identifier is hard coded into the device and can be specified when ordering the MPPT. Available options are 125kB/s, 250kB/s, 500kB/s and 1Mbit/s, by default it is set to 125 kB/s.

8.3 Identifier

The identifier field has been split in three sections for Elmar Solar MPPT's. Bits 10-8 contain the general device identifier, bits 7-4 contain the specific device identifier and bits 3-0 contain the message identifier.

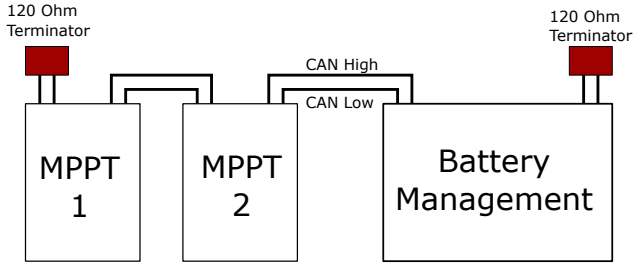
The general device identifier is hard coded into the device and is 0x600.

The specific device identifier can be selected using the rotary encoder on the MPPT and is equal to the number displayed on the rotary switch multiplied by 0x010.

With the default setting for the general device identifier of 0x600, and the rotary switch on position A, the MPPT base address becomes 0x6A0, with the rotary switch positioned on 3 the MPPT base address becomes 0x630.

8.4 CAN Termination

The CAN bus is structured as a linear network. The CAN bus data lines must be terminated at each end of the main bus with 120 ohm resistors between the CAN-H and CAN-L signals.



8.5 Limits

Input current limit is limited to 3A by default, this can be configured to a lower value, every time the MPPT restarts it will be reset to it's default value.

The output voltage limit can be specified when ordering the MPPT, normally it is limited to 165V. During operation the output voltage limit can be configured to any value between 22V and 165V, every time the MPPT restarts it will be reset to it's default value.

8.6 CAN broadcast Messages

8.6.1 Input measurements

ID: MPPT base Address + 0

Variable	Byte	Type	Unit
Input Voltage	0-3	FLOAT	Volt
Input Current	4-7	FLOAT	Ampere

8.6.2 Output measurements

ID: MPPT base Address + 1

Variable	Byte	Type	Unit
Output Voltage	0-3	FLOAT	Volt
Output Current	4-7	FLOAT	Ampere

8.6.3 Temperature

ID: MPPT base Address + 2

Variable	Byte	Type	Unit
Mosfet Temperature	0-3	FLOAT	Degree Celsius
Controller Temperature	4-7	FLOAT	Degree Celsius

8.6.4 Auxiliary power supply

ID: MPPT base Address + 3

Variable	Byte	Type	Unit
12V	0-3	FLOAT	Volt
3V	4-7	FLOAT	Volt

8.6.5 Limits

ID: MPPT base Address + 4

Variable	Byte	Type	Unit
Max. Output Voltage	0-3	FLOAT	Volt
Max. Input Current	4-7	FLOAT	Ampere

8.6.6 Status

ID: MPPT base Address + 5

Variable	Byte	Type	Unit
CAN RX error counter	0	UINT8	
CAN TX error counter	1	UINT8	
CAN TX overfow counter	2	UINT8	
error flags	3	8 bits	bit0: low array power bit1: mosfet overheat bit2: battery low bit3: battery full bit4: 12V undervoltage bit5: reserved bit6: HW overcurrent bit7: HW overvoltage
limit flags	4	8 bits	bit0: Input current min. bit1: Input current max. bit2: Output voltage max bit3: Mosfet temperature bit4: Duty cycle min. bit5: Duty cycle max. bit6: Local MPPT bit7: Global MPPT
mode	5	UINT8	0 = standby 1 = on
test counter	7	UINT8	+1 every second

8.6.7 Power connector

ID: MPPT base Address + 6

Variable	Byte	Type	Unit
Output Voltage (Battery side of fuse)	0-3	FLOAT	Volt
Power connector Temperature	4-7	FLOAT	Degree Celsius

8.7 CAN receive Messages

8.7.1 Mode

ID: MPPT base Address + 8

Variable	Byte	Type	Unit
mode	0	UINT8	0 = standby 1 = on

8.7.2 Sweep period

ID: MPPT base Address + 9

Variable	Byte	Type	Unit
sweep period	0	UINT8	seconds

8.7.3 Maximum output voltage

ID: MPPT base Address + A

Variable	Byte	Type	Unit
Max. Output Voltage	0-3	FLOAT	Volt

8.7.4 Maximum input current

ID: MPPT base Address + B

Variable	Byte	Type	Unit
Max. Input Current	0-3	FLOAT	Ampere

8.7.5 reserved

ID: MPPT base Address + C..F

9 Connectors

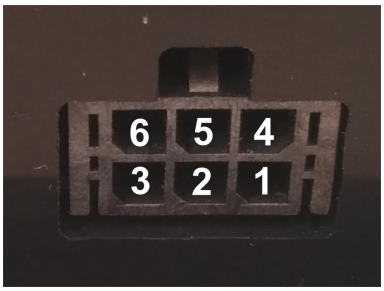
9.1 Can Bus

All 6 pins on the two canbus connectors are interconnected, pin 1 is connected to pin 1, pin 2 is connected to pin 2 etc. The connector used for the canbus on the MPPT is Wurth Electronics 66200621022.

Mating parts for this connector can be either:

- Wurth Electronics 662006113322
- Micro-Fit 3.0 430250600 / 430250608 / 430250610

1	+12V	Can Supply voltage, 10.8-13.2V
2	GND	Can Ground
3	NC	Not connected
4	CAN-H	Can High
5	CAN-L	Can Low
6	NC	Not connected



9.2 Power

The Power connector used on the MPPT is Phoenix 1792122 (PLH 5/ 4-7,5-ZF)

1	$V_{in}-$	Array -
2	$V_{in}+$	Array +
3	$V_{out}+$	Battery +
4	$V_{out}-$	Battery -

10 Dimensions