Die Energiewende und das Smart Grid (1)

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English Abstract and Calculations

Abstract : DC-Power Hub for connection of 4-6 PV Strings(101) with Battery (102), Second Storage (103) and DC-Grid (104). Optional plugs for inverter (105) for AC-Grid (106) interactivity.

Best designed for 2S PV with 50Volt Battery. This means 2 panels serial (total of 8-12 PV-Panels) each string capable of 10-15 Amps.

50..60Volt*6Strings*10..15Amps = 3.000 …5.400Watt.

Single fault safety. Galvanic circuit breaker. Analog Intelligence. Micro Open Repair. Safety Voltage (below 60V). Super long life design (see details) for 50..83 years Dorfmüller Everlife. Completely Open Source. No Software.

Single Best Solution for Majorit of the people.

Efficiency @10Amps: >98% Efficiency @15Amps: >97%

Raw Material costs: below $200

Short Introduction

Replacing Coal takes about 10TW Solar + 10TWhBattery which is an increase of at least 100 times to actual Power and Capacity and it costs at least 10 Trillion Dollars which is about 2.5 times US Federal Budget or 28 times German Bundeshaushalt.

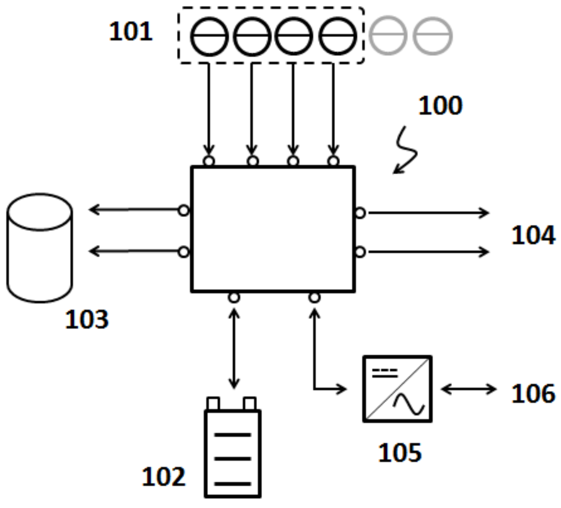
One option especially in regard of big cities, that we all love, are GIGA Projects that faciliate installation and maintenance significantly and thus can afford to run with comparetively short lived highvoltage inverters like SMA Tripower 10kW, $2.000.

Neither high voltage nor relatively short lifetime are an option if you want to achieve widspread swarm topology with hundreds of millions of small plants. There you need a concept like shown in this calculation: safety voltage, low cost, long life - like really long life- : we are aiming at 50-83 years Everlife Design, and simplicity including micro open repair for local maintenance and true empowerment.

DC-Source+DC-Store = DC-Comb

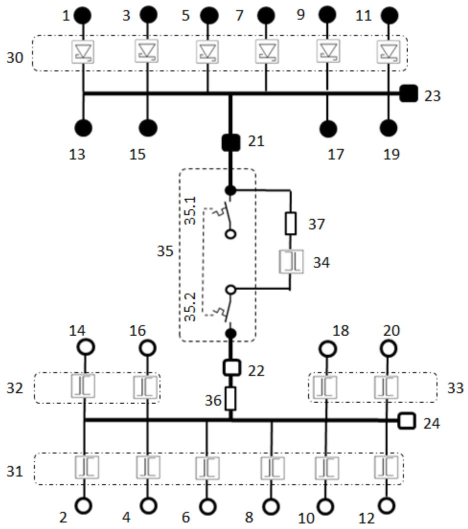
Most simple solution – Single Best Result for a 6TW Project.

Check it out – do the math – its completely open.



Part 1. Calculations Power Circuit

Components: Costs – Efficiency - Lifetime



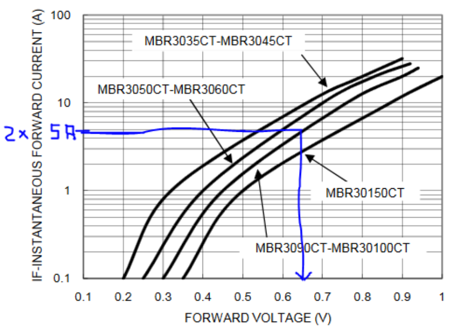
1.30 DIODES - SCHOTTKY

Double Diode used for *one* String of PV, 2x30Amp, 100Volt

☐	MBR30100 CT C0	2677441 Data Sheet RoHS	Schottky-Gleichrichterdiode, 100 V, 30 A, Zweifach, gemeinsame Kathode, TO-220AB, 3 Pin(s), 940 mV TAIWAN SEMICONDUCTOR Bestseller	224 auf Lager	Stück	1+ 1,68 € 10+ 1,18 € 100+ 0,901 € 500+ 0,797 € 1000+ 0,649 € Weitere Preise ...
☐	VS-30CTQ100-M3	2909628 Data Sheet RoHS	Schottky-Gleichrichterdiode, 100 V, 30 A, Zweifach, gemeinsame Kathode, TO-220AB, 3 Pin(s), 1.05 V VISHAY	241 auf Lager Weitere Artikel von Avnet	Stück	1+ 1,47 € 10+ 1,09 € 100+ 1,02 € 500+ 0,95 € 1000+ 0,88 €
☐	STPS30100ST	2353678 Data Sheet RoHS	Schottky-Gleichrichterdiode, 100 V, 30 A, Einfach, TO-220AB, 3 Pin(s), 800 mV STMICROELECTRONICS	739 auf Lager Weitere Artikel von Avnet	Stück	1+ 1,11 € 10+ 0,898 € 100+ 0,631 € 500+ 0,60 € 1000+ 0,567 € Weitere Preise ...

https://de.farnell.com/c/gleichrichter-transistoren-thyristoren-dioden/dioden/schottky-dioden/schottky-gleichrichterdioden?periodische-sperrspannung-vrrm-max-=100v&durchlassstrom-mittlerer-if-av-=30a

FIG. 3- TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS PER LEG



COST:	below 6*$1 = $6	
Efficiency:	6* 10Amps*0.65V=	6*6.5Watt
	6* 15Amps*0.70V=	6*10.5Watt
Rate of Loss:	40Watt/3.300Watt Total	-> 1.21%
	66Watt/4.950Watt Total	-> 1.33%

Calculation with 55Volt Battery Voltage @6*10Amps rated power and at 6*15Amps peak power.

Diodes are most sensitive device due to high power consumption. Need good cooling.

1.31-33 SWITCHES

N-Channel Mosfet, 80-100Volt, Rdson about 5-6mOhm possible

☐	IRL540NPBF	8651078 Data Sheet RoHS Date And Lot	Leistungs-MOSFET, n-Kanal, 100 V, 36 A, 0.044 ohm, TO-220AB, Durchsteckmontage INFINEON Bestseller	3.589 auf Lager	Stück	1+ 1,19 € 10+ 0,889 € 100+ 0,662 € 500+ 0,566 € 1000+ 0,455 € Weitere Preise ...
☐	PSMN5R6-100PS,127	1785632 Data Sheet RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 100 A, 0.0043 ohm, TO-220AB, Durchsteckmontage NEXPERIA Bestseller	3.493 auf Lager Weitere Artikel von Avnet	Stück	1+ 2,06 € 10+ 1,54 € 100+ 1,17 € 500+ 1,01 € 1000+ 0,886 €

https://de.farnell.com/c/gleichrichter-transistoren-thyristoren-dioden/leistungs-mosfet/einfache-mosfet?wandlerpolaritat=n-kanal&drain-source-spannung-vds=100v

NXP Semiconductors **PSMN5R6-100PS**

N-channel 100 V 5.6 mΩ standard level MOSFET in TO220

Symbol	Parameter	Conditions		Min	Max	Unit
I_{DM}	peak drain current	pulsed; $t_p \leq 10$ µs; $T_{mb} = 25$ °C; Fig. 3		-	539	A
P_{tot}	total power dissipation	$T_{mb} = 25$ °C; Fig. 2		-	306	W
T_{stg}	storage temperature			-55	175	°C
T_j	junction temperature			-55	175	°C
Source-drain diode						
I_S	source current	$T_{mb} = 25$ °C	[1]	-	100	A
I_{SM}	peak source current	pulsed; $t_p \leq 10$ µs; $T_{mb} = 25$ °C		-	539	A
Avalanche Ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$V_{GS} = 10$ V; $T_{j(init)} = 25$ °C; $I_D = 100$ A; $V_{sup} \leq 100$ V; $R_{GS} = 50$ Ω; unclamped		-	469	mJ

[1] Continious current limited by package.

COST:	about 6*$1 = $6	
Efficiency:	6* 10^2Amps^2*6mOhms=	6*0.6Watt
	6* 15^2Amps^2*7mOhms=	6*1.5Watt
Rate of Loss:	3.6Watt/3.300Watt Total	-> 0.11%
	9Watt/4.950Watt Total	-> 0.18%

Calculation with 55Volt Battery Voltage @6*10Amps rated power and at 6*15Amps peak power.

Way overrated in comparison to Diodes. No HF-Switching- no switching losses – no aging – Dorfmüller Everlife Design.

1.34 THE SWITCH

Normally you would use Smartmat as circuit breaker (35) in case of emergency. While this is not yet available still we do not want to use expensive and heavy relais with 5-8Watt standby losses – over decades! Just for that 1 moment where there is a fault that escapes the solid analog intelligence.

So we use a standard circuit breaker (35) and in the one case of emergency we shortcircuit the battery with a SWITCH (34) – and see what happens…

☐	CSD19536 KCS	3009677 RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 150 A, 0.0023 ohm, TO-220, Durchsteckmontage TEXAS INSTRUMENTS Bestseller	175 auf Lager	Stück	1+ 4,68 € 5+ 4,23 € 10+ 3,77 € 50+ 3,57 € 100+ 2,86 € Weitere Preise ...
☐	SUP70030 E-GE3	3019169 Data Sheet RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 150 A, 0.00265 ohm, TO-220AB, Durchsteckmontage VISHAY	369 auf Lager	Stück	1+ 2,89 € 10+ 2,17 € 100+ 1,68 € 500+ 1,54 € 1000+ 1,40 €
☐	SUP70040 E-GE3	2611272 Data Sheet RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 120 A, 0.0032 ohm, TO-220AB, Durchsteckmontage VISHAY	204 auf Lager	Stück	1+ 2,93 € 10+ 2,21 € 100+ 1,71 € 500+ 1,56 € 1000+ 1,33 €

https://de.farnell.com/w/c/gleichrichter-transistoren-thyristoren-dioden/leistungs-mosfet/einfache-mosfet?wandlerpolaritat=n-kanal&drain-source-spannung-vds=100v&verlustleistung-pd=375w

ABSOLUTE MAXIMUM RATINGS (T_C = 25 °C, unless otherwise noted)

PARAMETER		SYMBOL	LIMIT	UNIT
Drain-source voltage		V_{DS}	100	V
Gate-source voltage		V_{GS}	± 20	
Continuous drain current (T_J = 150 °C)	T_C = 25 °C	I_D	150 [d]	A
	T_C = 70 °C		150 [d]	
Pulsed drain current (t = 100 µs)		I_{DM}	500	
Avalanche current		I_{AS}	60	
Single avalanche energy [a]	L = 0.1 mH	E_{AS}	180	mJ
Maximum power dissipation [a]	T_C = 25 °C	P_D	375 [b]	W
	T_C = 125 °C		125 [b]	
Operating junction and storage temperature range		T_J, T_{stg}	-55 to +175	°C

☐	IPT015N10 N5ATMA1	2725874RL Data Sheet RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 300 A, 0.0013 ohm, HSOF, Oberflächenmontage INFINEON	48 auf Lager	Stück (Gurtabschnitt) Re-Reel Für dieses Produkte fällt eine Re-Reeling-Gebühr in Höhe von 5,00 € an	10+ 5,37 € 50+ 4,91 € 100+ 4,45 € 250+ 4,20 €
☐	IAUT300N 10S5N015 ATMA1	2888482RL Data Sheet RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 300 A, 0.0013 ohm, HSOF, Oberflächenmontage INFINEON	84 auf Lager	Stück (Gurtabschnitt) Re-Reel Für dieses Produkte fällt eine Re-Reeling-Gebühr in Höhe von 5,00 € an	10+ 5,60 € 50+ 5,12 € 100+ 4,64 € 250+ 4,36 €
☐	IPT020N10 N3ATMA1	2480869RL Data Sheet RoHS	Leistungs-MOSFET, n-Kanal, 100 V, 300 A, 0.0017 ohm, HSOF, Oberflächenmontage INFINEON	6.989 auf Lager	Stück (Gurtabschnitt) Re-Reel Verpackungsoptionen Für dieses Produkte	10+ 5,09 € 50+ 4,66 € 100+ 4,22 € 250+ 3,98 €

https://de.farnell.com/w/c/gleichrichter-transistoren-thyristoren-dioden/leistungs-mosfet/einfache-mosfet?wandlerpolaritat=n-kanal&drain-source-spannung-vds=100v&dauer-drainstrom-id=300a&verlustleistung-pd=375w

1 Maximum ratings

at T_A=25 °C, unless otherwise specified

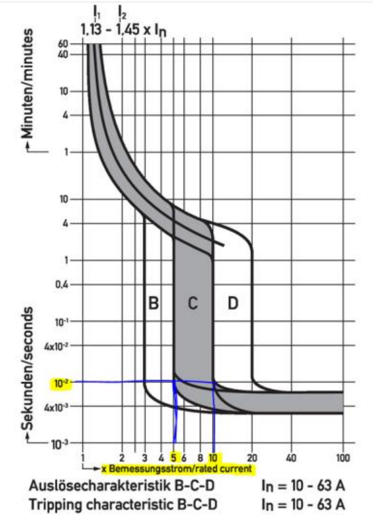
Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current	I_D	- - -	- - -	300 243 32	A	V_{GS}=10 V, T_C=25 °C V_{GS}=10 V, T_C=100 °C V_{GS}=10 V, T_C=25 °C, R_{thJA} =40 K/W[1)]
Pulsed drain current[2)]	$I_{D,pulse}$	-	-	1200	A	T_C=25 °C
Avalanche energy, single pulse[3)]	E_{AS}	-	-	775	mJ	I_D=150 A, R_{GS}=25 Ω
Gate source voltage	V_{GS}	-20	-	20	V	-
Power dissipation	P_{tot}	-	-	375	W	T_C=25 °C
Operating and storage temperature	T_j, T_{stg}	-55	-	175	°C	IEC climatic category; DIN IEC 68-1: 55/175/56

To trigger a circuit breaker of 63Amps you would need 300..600Amps. Total Power is: 60Volt*300..600Amps=18..36kWatt

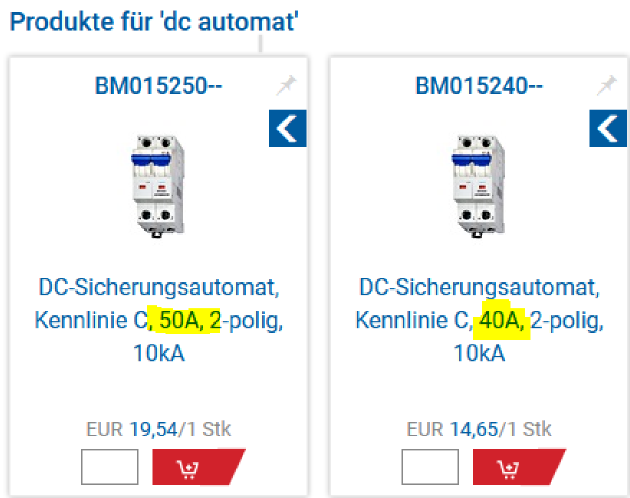
TO220 easier to replace after ‘onetime-switching’, when put into a connector.

Maybe putting a resistor in circuit who takes the load and controls current to 300..600Amps.



https://www.doepke.de/uploads/tx_doepkeproducts/diagramm/doepke_09917019_char_bcd_63a_dia_ml.jpg

1.35 CIRCUIT BREAKER



https://www.schrack-technik.de/shop/catalogsearch/result?q=dc+automat&cat=&fq=%7B%22facets%22%3A%7B%22schrack_stromstaerke%22%3A%5B%2240A%22%2C%2250A%22%5D%2C%22schrack_type%22%3A%5B%22DC-Sicherungsautomat%22%5D%2C%22schrack_pole%22%3A%5B%222%22%5D%7D%2C%22general_filters%22%3A%7B%7D%7D

Providing i> and i>> Protection – charge and discharge. Variation as Smartmat would add u>> and u<< redundancy at low extra cost and completely standalone.

COST: about $15 .. 20

(decreasing massively with increasing volume of future dc-applications. Down to $5 possible like ac circuit breaker 16Amp)

Efficiency: 50²Amps²*1mOhms= 2.5Watt

Rate of Loss: 2.5Watt/2.750Watt Total -> 0.09%

Estimated resistance of 1mOhm

Calculation with 55Volt Battery Voltage @50Amps max charge current. Remaining current – 25-40 Amps - is for second store (103) e.g. waterpumps, heating or solar fuels (still to be developped) or immidiate use in dc comb (104).

Solid Device. Extra longlife.

1.36 SHUNT

	Hersteller-Teilenr.	Bestellnummer	Beschreibung / Hersteller	Verfügbarkeit	Preiseinheit:	Preis
☐	OAR5 - R0 05FI	1200373 Data Sheet RoHS Date And Lot	Strommesswiderstand, 0.005 ohm, Baureihe OAR, 5 W, Met allband, Radial bedrahtet, ± 1% TT ELECTRONICS / WELWYN Bestseller	3.824 auf Lager	Stück	5+ 1,59 € 50+ 0,81 € 250+ 0,607 € 500+ 0,565 € 1000+ 0,554 € Weitere Preise ...
☐	FC4L110R0 05FER	2363983 Data Sheet RoHS Date And Lot	Strommesswiderstand, Oberfl ächenmontage, 0.005 ohm, B aureihe FC4L, 4319 Breit, 5 W, ± 1% OHMITE	847 auf Lager	Stück (Gurtabschnitt) Gurtabschnitte Verpackungsoptionen	1+ 3,31 € 50+ 1,80 € 100+ 1,62 € 250+ 1,61 € 500+ 1,54 € Weitere Preise ...
☐	FCSL110R0 05FER	2420537 Data Sheet RoHS	Strommesswiderstand, Oberfl ächenmontage, 0.005 ohm, B aureihe FCSL, 4320 Breit [Met risch 11050], 5 W OHMITE	973 auf Lager	Stück (Gurtabschnitt) Gurtabschnitte Verpackungsoptionen	1+ 2,27 € 50+ 1,58 € 100+ 1,37 € 250+ 1,19 € 500+ 0,978 €
☐	FCSL110R0 05FER	2420537RL Data Sheet RoHS	Strommesswiderstand, Oberfl ächenmontage, 0.005 ohm, B aureihe FCSL, 4320 Breit [Met risch 11050], 5 W OHMITE	973 auf Lager	Stück (Gurtabschnitt) Re-Reel Verpackungsoptionen Für dieses Produkte fällt eine Re-Reeling-Gebühr in Höhe von	50+ 1,58 € 100+ 1,37 € 250+ 1,19 € 500+ 0,978 €

https://de.farnell.com/w/search/prl/ergebnisse?st=widerstand%200.005ohm&nennleistung=5w

Measuring needs to be precise only near circuit breaker tripping current. We use 1Shunt per 10Amps: 10Amps*5mOhm=50mVolt

We do not have eny EMI – elektromagnetic interference – because we do have no hf-switching anywhere: neigher powerunit nor controlunit. The little switching that we do can be done very slow and emi free.

Thus our little 50mVolt Signal does not get interfered. The choice is between THT technology and SMD.

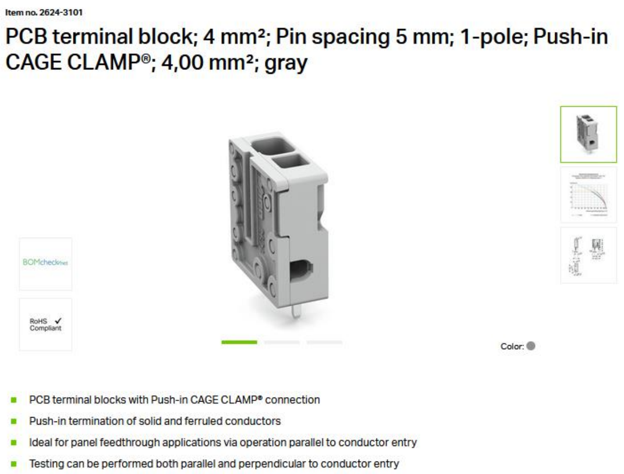
COST: about 5* $1 = $5

Efficiency: 5*10²Amps²*5mOhms= 2.5Watt

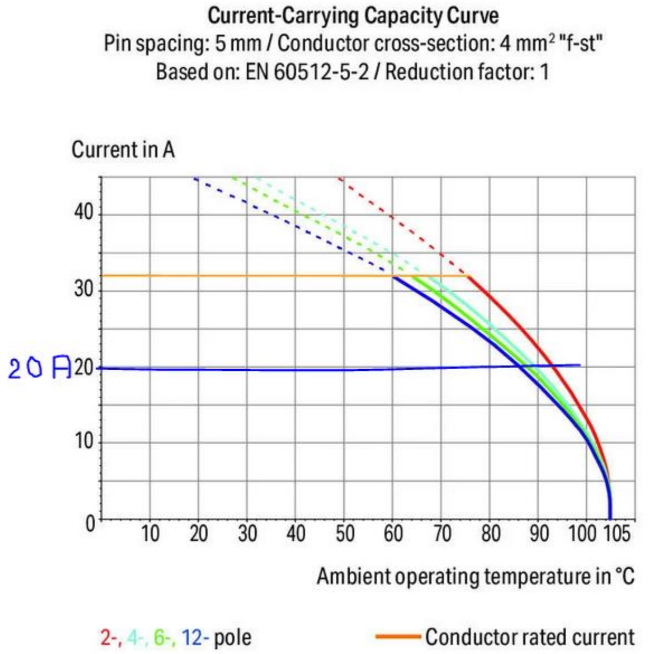
Rate of Loss: 2.5Watt/2.750Watt Total -> 0.09%

1.1-20 POWERPLUGS – max current 15..25Amps

The choice is between simple devices, which require more cable manufacturing or smart plug-in devices which are fine with simple isolated cables.



https://www.wago.com/us/pcb-interconnect/pcb-terminal-block/p/2624-3101



Plugs are well oversized for 15Amps and desired maximum Temperature of >72°C. Longlife Design

Cheaper variation. Usually designed for 15 Amps.

COST: about 20* $1 = $20

Efficiency: 20*10²Amps²*1.25mOhms= 2.5Watt

Rate of Loss: 2.5Watt/2.750Watt Total -> 0.09%

Estimated resistance of 1.25mOhm

Beispiel: Kontaktwiderstand von zwei ebenen Kupferscheiben mit $D = 1$ mm, die mit der Kraft 2,7 N aneinander gepresst werden. Für Kupfer ist bei Raumtemperatur:

$$\rho \approx 1{,}8 \cdot 10^{-8}\ \Omega\mathrm{m},\ E^* \approx 5{,}6 \cdot 10^{10}\ \mathrm{Pa}$$

und damit:

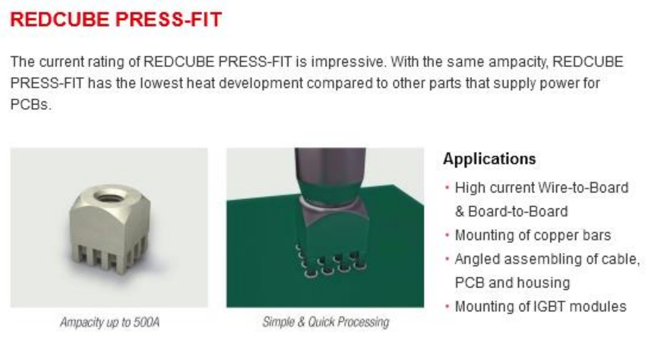
$$R = \frac{1}{\Lambda} = 0{,}1\ \mathrm{m\Omega}$$

Die Sättigungskraft ergibt sich zu 56 kN.

https://de.wikipedia.org/wiki/Kontaktwiderstand

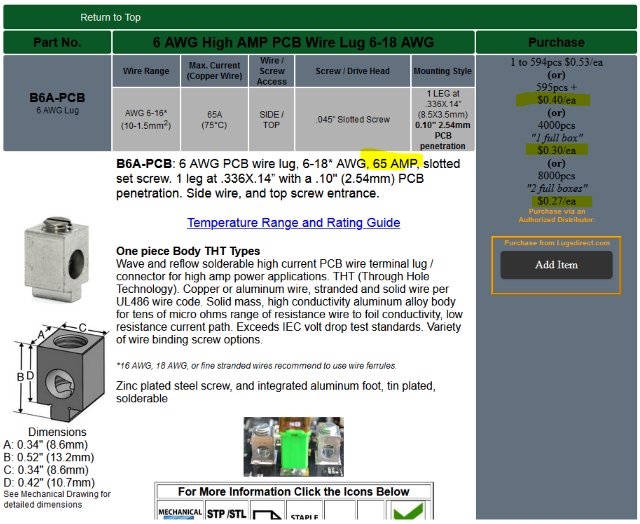
1.21-24 POWERCONNECTORS – max current 50-63Amps

One very powerful connector premium quality each.



https://www.we-online.com/web/en/electronic_components/produkte_pb/produktinnovationen/redcube.php

Or two moderate powerful connectors for each connection. Oversizing again 2times for long life performance (overheated connector is very bad for micro open repair: difficult to desolder and exchange, needs special equipment. Micro open repair shall be open to as much as possible)



https://ihiconnectors.com/IHI-THT-through-hole-technology-PCB-terminals.html

COST:	about $5 total	
Efficiency:	50²Amps²*1 mOhms=	2.5Watt
Rate of Loss:	2.5Watt/2.750Watt Total	-> 0.09%

Estimated resistance of 1mOhm

Calculation with 55Volt Battery Voltage @50Amps max charge current. Remaining current – 25-40 Amps - is for second store (103) e.g. waterpumps, heating or solar fuels (still to be developped) or immidiate use in dc comb (104).

Efficiency Total – above 98%

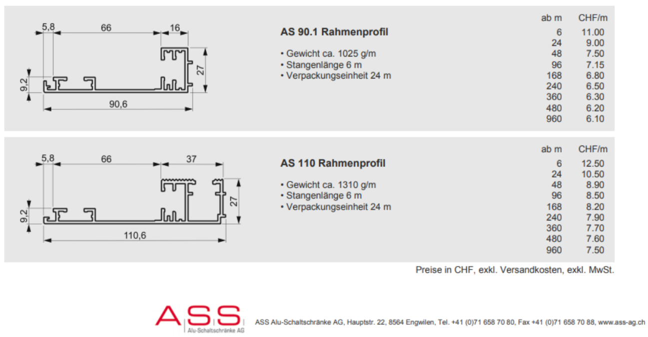
Diodes	**1.2 .. 1.4%**
Fet	**0.1.. 0.2%**
Contacts	**adding several 0.1%**

PCB Power Components Total – some $50 to $60

12 Diodes+Fet	**$12**
24 Connectors	**$24**
5 Shunt	**$5**
1 Circuit Breaker	**$15**

2. Additional cost: VISUALIZATION, CASING

Simple Voltmeter 60Volt	$20
Voltmeter 50mVolt, 2ways would be nice for current	$15
Additional 24 Clamps for easy installation	$24
Wires + Wireconnectors	$15
Aluminium Frame $8..10/m + Aluminium Plate +Screws	$24

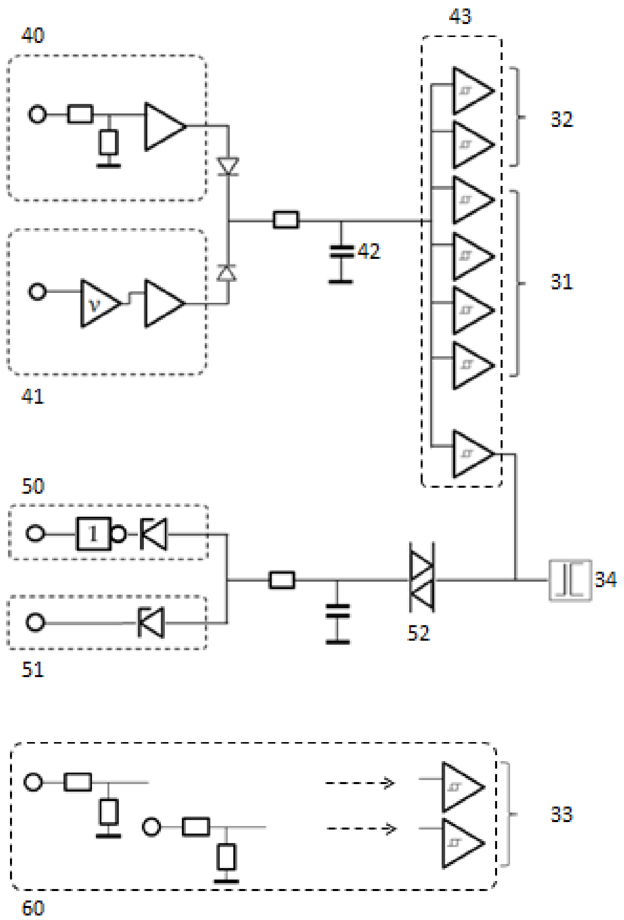


Adding another $100 cost up to $150 total so far.

Part 2. Calculations Control Circuitry

Simplicity

Lowest Tech has Longest Life



As you can see some comparator IC are all the logic we need. This is super low power consumption. This allows to renounce modern hf switching powerunit and to go back to simple resistor-zener diode powerunit with efficiency of below 20% - it simply does not matter. More important is simplicity and longlife and micro open repair for understanding and empowerment.

Of course we add a simple transistor to power unit – but it is still the same voltage divider principle with zenerdiode.

Not switching means not causing EMI electro magnetic interference. Only using comparator operating at 12..15 Volt but being strong enough for 30 Volt means we are not EMI sensitive – considering the solid BAT and PV voltage at the input.

We can drop all EMI circuitry.

We operate at 12..15 Volt generated from 60Volt which means our efficiency of powerunit ist below 25%.

But it does not matter, because our power consumption will be about some few multitudes of 10 mAmps.

(40) compares voltage: battery fully charged?

(41) compares current: too much?

The diodes provide simple OR-link and charge capacitor (42).

(43) sequentially switches secondary stores (32) – this usually stops events 40+41 voltage or current exceeded and capacitor (42) slowly – like very slowly – discharges. Minutes.

(43) sequentially switches OFF PV Panels (31) if second store cannot absorb the over-energy. Again this will stop event 40+41 at a certain step and stop the chain.

There is a hysteresis involved in (43). In a newer version this will be achieved in adding a second resistor-capacitor unit after (42). This reduces number of components.

See KICAD Schematic as soon as ready or in the appendix if already finished.

(43) finally would trigger switch (34) but why should this happen? Voltage (40) and Current (41) are the control values and with full disconnection of PV (31) everything should be fine – the events 40+41 would be set to zero and the required sequentially climbing voltage to trigger the final comparator would never be reached.

(50) detects undervoltage – deepcharge protection

(51) detects overvoltage – overcharge protection

The schematic here shows very simple methods of comparison with zenerdiodes and trigger with diac (52). This might be good for backup and single fault safety with values of 44Volt and 62 Volt. Additional comparators might do the more precise job at 46 and 60 Volt. Its just showing how little and simple components might be used.

(60) is for DC-Channels (33). They stop at undervoltage, say 48 Volt.

* * *

Q: Can you patent circuitry as simple as that?

A: if it is possible to prove that this approach is the single best energy solution with PV and BAT in cost*life*aftermath– by factor 3..10 - in comparison with all existing solutions available on market – with global players of billion dollar calibre –

Then: *yes*. They all could have done it – easily. It’s simple as child. But as they didn’t they are best proof that this approach is ingenious.

2.1 Components and Power Consumption

Comparator – we use one type several times: e.g. 2902D

	Hersteller-Teilenr.	Bestellnummer	Beschreibung / Hersteller	Verfügbarkeit	Preiseinheit:	Preis	Menge
	LM2902DT	2382608 Data Sheet RoHS	Operationsverstärker, vierfach, 4 Verstärker, 1.3 MHz, 0.4 V/µs, 3V bis 30V, SOIC, 14 Pin(s) STMICROELECTRONICS Bestseller	8.353 auf Lager Weitere Artikel von Avnet	Stück (Gurtabschnitt) Gurtabschnitte Verpackungsoptionen	5+ 0,281 € 50+ 0,208 € 100+ 0,133 € 500+ 0,114 € 1000+ 0,0958 €	5 Hinzufügen Min: 5 Mult: 5
	LM2902D	3117016 RoHS Date And Lot	Operationsverstärker, 4 Verstärker, 1.2 MHz, 0.5 V/µs, ± 1.5 V bis ± 13V, SOIC, 14 Pin(s) TEXAS INSTRUMENTS	5.303 auf Lager	Stück	5+ 0,401 € 10+ 0,252 € 100+ 0,145 € 500+ 0,129 € 1000+ 0,0896 € Weitere Preise ...	5 Hinzufügen Min: 5 Mult: 5

Low Power: <1mA * 4-5 comparators   **= 4-5mAmps**

Wide Tolerance: 3V..32 Volt (EMI Tolerance)

Product Folder | Sample & Buy | Technical Documents | Tools & Software | Support & Community

TEXAS INSTRUMENTS

LM224K, LM224KA, LM324, LM324A, LM324K, LM324KA, LM2902
LM124, LM124A, LM224, LM224A, LM2902V, LM2902K, LM2902KV, LM2902KAV
SLOS066W – SEPTEMBER 1975 – REVISED MARCH 2015

LMx24, LMx24x, LMx24xx, LM2902, LM2902x, LM2902xx, LM2902xxx Quadruple Operational Amplifiers

1 Features

- 2-kV ESD Protection for:
  - LM224K, LM224KA
  - LM324K, LM324KA
  - LM2902K, LM2902KV, LM2902KAV
- Wide Supply Ranges
  - Single Supply: 3 V to 32 V (26 V for LM2902)
  - Dual Supplies: ±1.5 V to ±16 V (±13 V for LM2902)
- Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA Typical
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters
  - Input Offset Voltage: 3 mV Typical
    A Versions: 2 mV Typical
  - Input Offset Current: 2 nA Typical
  - Input Bias Current: 20 nA Typical
    A Versions: 15 nA Typical

2 Applications

- Blu-ray Players and Home Theaters
- Chemical and Gas Sensors
- DVD Recorders and Players
- Digital Multimeter: Bench and Systems
- Digital Multimeter: Handhelds
- Field Transmitter: Temperature Sensors
- Motor Control: AC Induction, Brushed DC, Brushless DC, High-Voltage, Low-Voltage, Permanent Magnet, and Stepper Motor
- Oscilloscopes
- TV: LCD and Digital
- Temperature Sensors or Controllers Using Modbus
- Weigh Scales

3 Description

These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply or split supply over a wide range of voltages.

Optocoupler – to switch off PV – there is a potential trouble because the FETs are with Drain on GND and Source on PV-minus.

So we have to shortcircuit Gate-Source with Optocouplers to cut off PV current. These use up most of our power unit current – ironically this plays exactly into our hand: because then obviously battery is fully charged, and we have plenty energy to spare, a slight discharge 1..2Watt is welcome and we have no heat issues since our main source of heat (diodes (30) power circuit) are cut off at the same time as pv panels.

	ACPL-214-500E	1602610 Data Sheet RoHS Date And Lot	Optokoppler, Transistorausgang, 1 Kanal, SOIC, 4 Pin(s), 50 mA, 3 kV, 20 % BROADCOM Bestseller	Mit Nachbestellung lieferbar. Lieferung wird erwartet bis 17.05.21 Weitere Artikel von Avnet	Stück (Gurtabschnitt) Gurtabschnitte	5+ 0,39 € 50+ 0,255 € 250+ 0,227 € 1000+ 0,198 € 9000+ 0,194 €
	ACPL-217-50AE	1602616 Data Sheet RoHS Date And Lot	Optokoppler, Transistorausgang, 1 Kanal, SOIC, 4 Pin(s), 50 mA, 3 kV, 80 % BROADCOM Bestseller	12.302 auf Lager Weitere Artikel von Avnet	Stück (Gurtabschnitt) Gurtabschnitte Verpackungsoptionen	5+ 0,379 € 50+ 0,315 € 100+ 0,251 € 500+ 0,187 € 1500+ 0,184 €
	ACPL-217-50BE	1602617 Data Sheet RoHS Date And Lot	Optokoppler, Transistorausgang, 1 Kanal, SOIC, 4 Pin(s), 50 mA, 3 kV, 130 % BROADCOM Bestseller	34.038 auf Lager Weitere Artikel von Avnet	Stück (Gurtabschnitt) Gurtabschnitte Verpackungsoptionen	5+ 0,359 € 50+ 0,299 € 100+ 0,238 € 500+ 0,177 € 1500+ 0,174 €

Some 1..2mA should do to shut down Mosfet

Electrical Specifications (DC)

Over recommended ambient temperature at 25°C unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Note
Forward Voltage	V_F	-	1.2	1.4	V	$I_F = 20mA$	Fig.6
Reverse Current	I_R	-	-	10	µA	$V_R = 5V$	
Terminal Capacitance	C_t	-	30	-	pF	V = 0, f = 1MHz	
Collector Dark Current	I_{CEO}	-	-	100	nA	$V_{CE} = 48V$, $I_F = 0$ mA	Fig.12
Collector-Emitter Breakdown Voltage	BV_{CEO}	80	-	-	V	$I_C = 0.5$ mA, $I_F = 0$ mA	
Emitter-Collector Breakdown Voltage	BV_{ECO}	7	-	-	V	$I_E = 100$ µA, $I_F = 0$ mA	
Current Transfer Ratio	CTR	50	-	600	%	$I_F = 5$ mA, $V_{CE} = 5V$	CTR=(I_C/IF)* 100%
Saturated CTR	CTR(sat)	-	100	-	%	I_F=1mA, $V_{CE} = 0.4V$	
Collector-Emitter Saturation Voltage	V_{CE}(sat)	-	-	0.4	V	$I_F = 8mA$, $I_C = 2.4mA$	Fig.14
Isolation Resistance	R_{ISO}	$5x10^{10}$	$1x10^{11}$	-	Ω	DC500V, R.H. 40~60%	
Floating Capacitance	C_F	-	0.6	1	pF	V = 0, f = 1MHz	
Cut-off Frequency (-3dB)	F_C	-	80	-	kHz	$V_{CC} = 5V$, $I_C = 2$ mA, $R_L = 100Ω$	Fig. 2,19
Response Time (Rise)	t_r	-	2	-	µs	$V_{CC} = 10V$, $I_C = 2$ mA, $R_L = 100Ω$	Fig. 1
Response Time (Fall)	t_f	-	3	-	µs		
Turn-on Time	t_{on}	-	3	-	µs		
Turn-off Time	t_{off}	-	3	-	µs		
Turn-ON Time	t_{ON}	-	2	-	µs	$V_{CC} = 5V$, $I_F = 16$ mA, $R_L = 1.9kΩ$	Fig. 1, 17
Storage Time	T_S	-	25	-	µs		
Turn-OFF Time	t_{OFF}	-	40	-	µs		
Common Mode Rejection Voltage	CMR	-	10	-	kV/µs	Ta=25°C, R_L=470Ω, V_{CM}=1.5kV(peak), I_F=0mA, V_{CC}=9V, V_{np}=100mV	Fig.20

Visualization – takes energy directly from DC Power Circuit: pointer instruments for voltage 0..60Volt or 0..15 Volt with zenerdiode 45Volt inline. Ideal would be pointer instrument two ways for current directly at shunt (36) measuring some 50mVolt both ways.

* * *

Will be updated with KICAD Schematic.

Its still all calcualtions – not tested. Even if buggy the concept is clear, straightforward and shows how to design 50..83 years longlived technology in BASICS.

Electricity is BASIC – the plugins are **SPECIAL**.

https://www.paypal.com/paypalme/StefanMATH?locale.x=

Thank you so much .1

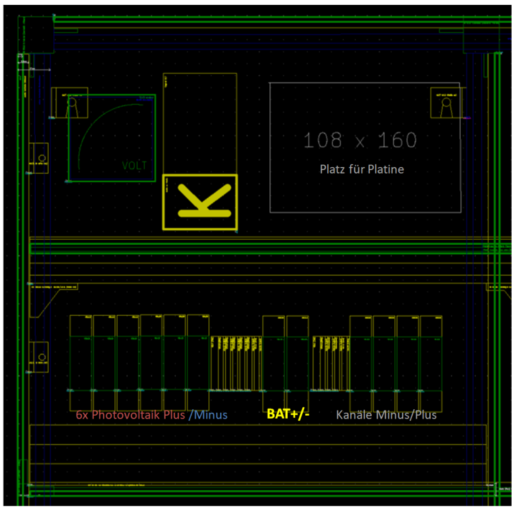
Update July 2021

Kicked out Diodes and replaced with circuit breakers to secure reverse current into pv panels. Also eliminates main source of power loss! **Efficiency now probably 99%!**

Schematic – done. Only needs some details calculations.

Board – placement and choice of components almost done.

CASE – concept done.



Gehäuse Konzept nach Installations art

Plugbox

400x400

Unterer Teil für Elektriker zum Anschließen

Oberer Teil bleibt verschlossen mit Platine

Abbildung 1 - case drawing with eagle. Board, Volmeter and Relais in top row. Circuit Breakers and Connectors in bottom row and accessible for electrician.

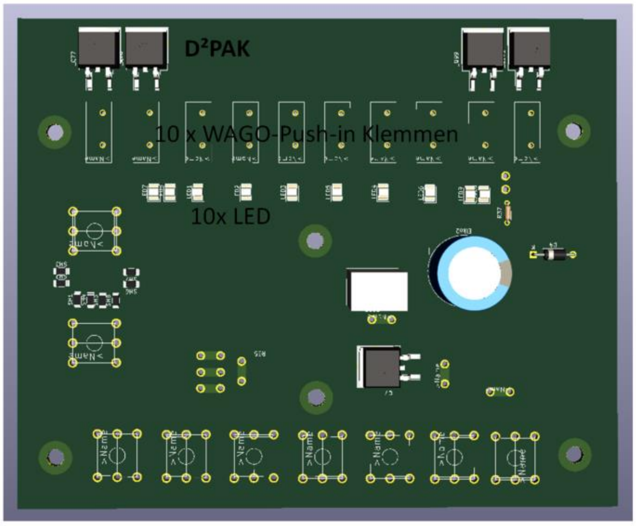


Abbildung 2THT Top Side of Board

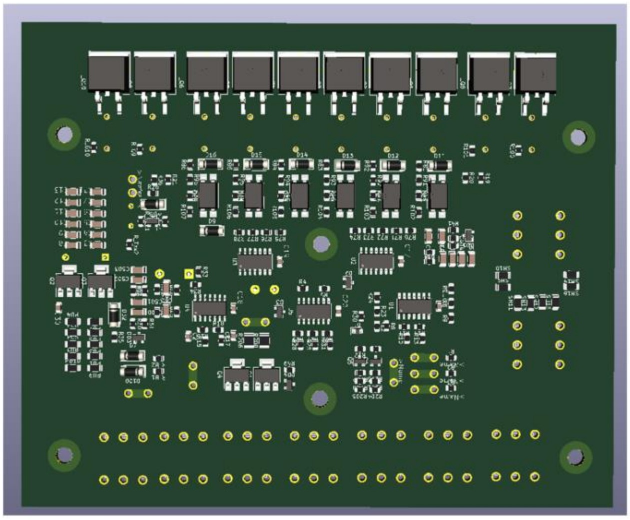


Abbildung 3 - SMD Bottom Side of Board

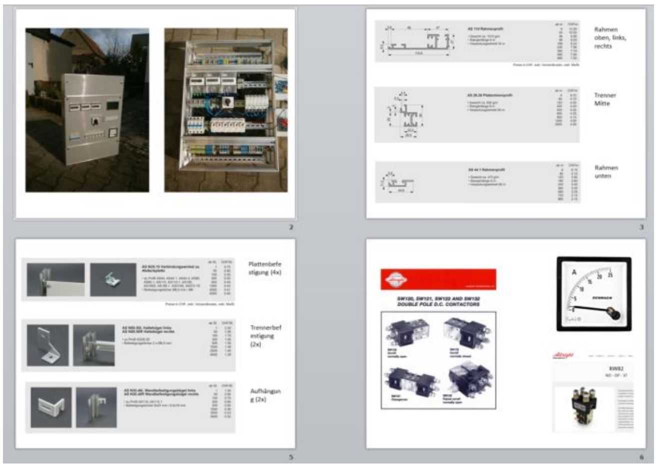


Abbildung 4 Example of Case Material (way larger and for different application)