The design of a Solar Home System series.
Appendices

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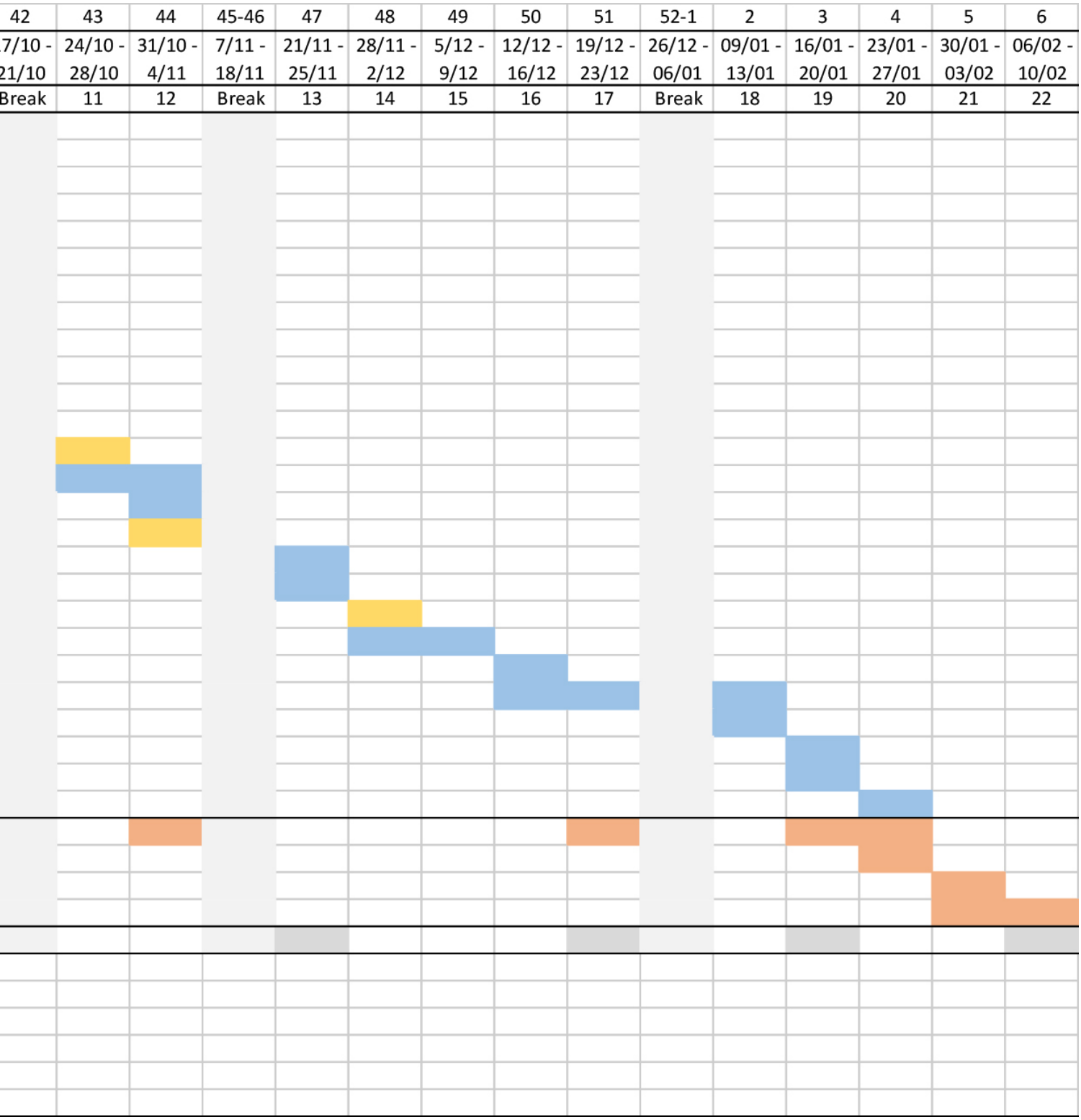
A Project Planning

Calendar week	32	33	34	35	36	37	38	39	40	41
Dates	8/08 - 12/08	15/08 - 19/08	22/08 - 26/08	29/08 - 02/09	05/09 - 09/09	12/09 - 16/09	19/09 - 23/09	26/09 - 30/09	3/10 - 7/10	10/10 - 14/10
Project week	1	2	3	4	5	6	7	8	9	10
Company analysis										
Literature research										
Solar Home System principle										
Market & Competitors										
Explorative field research										
Project goal										
Assembly analysis old box										
Comparison old & new electronics										
Analysis small box proposal										
List of requirements										
Concept development boxes										
Prototype plan										
Prototype boxes										
Assembly analysis mounting system										
Workshop visits										
Design details boxes										
Transportation & Installation visits										
List of requirements										
Assembly test battery boxes										
Concept development boxes										
Prototype plan										
Prototype mounting system										
Installation test										
Optimization mounting system										
Align component designs										
Total system transport										
Documentation										
Recommendations										
Presentation poster										
Final presentation										
Supervisory meetings										

	Analysis		Box	
	Concept development		Mount	
	Optimization		Both	
	Report & Presentation		Other	

42	43	44	45-46	47	48	49	50	51	52-1	2	3	4	5	6
7/10 - 21/10	24/10 - 28/10	31/10 - 4/11	7/11 - 18/11	21/11 - 25/11	28/11 - 2/12	5/12 - 9/12	12/12 - 16/12	19/12 - 23/12	26/12 - 06/01	09/01 - 13/01	16/01 - 20/01	23/01 - 27/01	30/01 - 03/02	06/02 - 10/02
Break	11	12	Break	13	14	15	16	17	Break	18	19	20	21	22



B Cost price SHS

In the box on this page an overview of the cost price for both the regular and large SHS is visualized. The prices are derived from Kamworks' most recent unit cost (right page) and assembly list records (September 2016).

Materials	**USD**
Battery box:	
Box front	$4,5 / $7
Box back	$1,5 / $5
PCBs	$35
Charge controller	$7 / $35,5
Circuit breaker	$2,5
3x Cigarette plug	$2
Cigarette plug box	$5 / -
IEC Connector	$0,2
4-Wire connector	$1,5
Battery	$69 / $96
Fasteners & wiring	$15
Accessoires	$6
Contracts & Manuals	$4
Bags and Boxes	$3
Stickers	$0,5
Solar panel:	
Solar panel	$39 / $36
Mounting system	$6 / $15
Electric cable	$12 / $18
Lampkit:	
4x 9W LED	$16
4x Lamp holder	$2
3x Light switch	$2
Electric cable	$10
Transport	
Sre Ampil to Kampong Chhnang	$3
Installation	$5
Labour	
Assembly	$4,5
Installation (2 installers)	$10

Materials	**$243,7 / $313,2**
Transport & installation	**$ 8**
Labour:	**$14,5**

Production costs (including risk margin 2% for theft, loss, damage):

$270,8 / $342,4

Regular SHS Large SHS

Sub Assembly	Sub Assembl	Code	name	Pcs	unit	cost/unit	Total cost	KW60W-V2	KW100W-V2
0.1 Display Ass	AS011	GE004	Display board	1	pcs	0	0	1	1
0.2 Sim ass	AS022	GE011	SIM board	1	pcs	0	0	1	1
0.6 LampKit4	FP003	AS014	fastners Lampkit	1	pcs	0	0	1	1
1.1 Powerb_100Ass	AS020	GE010	Power board	1	pcs	0	0	0	1
1.1 Powerb_100Ass	AS020	GE030	Resistor	4	pcs	0	0	0	1
1.3 Electronics_100_Ass	AS012	AS011	Display Ass	1	pcs	0	0	0	1
1.3 Electronics_100_Ass	AS012	AS017	Flat cable ass 100	1	pcs	0	0	0	1
1.3 Electronics_100_Ass	AS012	AS020	Powerb_100Ass	1	pcs	0	0	0	1
1.3 Electronics_100_Ass	AS012	AS022	Sim Ass	1	pcs	0	0	0	1
1.3 Electronics_100_Ass	AS012	IF026	Test form electronics	1	pcs	0	0	0	1
1.4 Batterybox_100	AS008	AS012	Electronics_100_Ass	1	pcs	0	0	0	1
1.4 Batterybox_100	AS008	AS023	solarin	1	pcs	0	0	0	1
1.4 Batterybox_100	AS008	IF017	Sticker good solar brown	1	pcs	0	0	0	1
1.4 Batterybox_100	AS008	IF018	Sticker good solar gold	1	pcs	0	0	0	1
1.6 Box Assembly 100W - v2.0	AS001	AS019	Phone charger ass	1	pcs	0	0	0	1
1.6 Box Assembly 100W - v2.0	AS001	AS008	Batterybox_100	1	pcs	0	0	0	1
1.6 Box Assembly 100W - v2.0	AS001	AS015	Fastners_100_Ass	1	pcs	0	0	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF016	Sticker Good Loar	1	pcs	0	0	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF034	Solar loar certificate	1	pcs	0	0	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF028	Wing card	1	pcs	0	0	0	1
1.8 Support Structure Assembly	AS003	MT001	Pole top 100W	1	pcs	0	0	0	1
1.8 Support Structure Assembly	AS003	MT002	Sheet steel leg 101 degree	2	pcs	0	0	0	1
1.8 Support Structure Assembly	AS003	MT003	Sheet steel leg 98 degree	2	pcs	0	0	0	1
1.8 Support Structure Assembly	AS003	MT007	Pipe clamp 100W	1	pcs	0	0	0	1
1.8 Support Structure Assembly	AS003	MT004	Steel pipe 1.5m	1	pcs	0	0	0	1
1.9 100W SHS	FP001	AS001	Box Assembly 100W - v2.0	1	pcs	0	0	0	1
1.9 100W SHS	FP001	AS002	Solar Assembly 100W	1	pcs	0	0	0	1
1.9 100W SHS	FP001	AS003	Support Structure Assembly 1	1	pcs	0	0	0	1
1.9 100W SHS	FP001	FP003	LampKit4	1	pcs	0	0	0	1
2.10 SHS 60W - v2.0	FP002	AS004	Box Assembly 60W - v2.0	1	pcs	0	0	1	0
2.10 SHS 60W - v2.0	FP002	AS006	Support Structure Assembly 6	1	pcs	0	0	1	0
2.10 SHS 60W - v2.0	FP002	FP003	LampKit4	1	pcs	0	0	1	0
2.6 Fastners_60_Ass	AS016	MT005	Mounting bracket	2	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	IF023	Sticker SHS60 box serial	1	pcs	0	0	1	0
2.6 Fastners_60_Ass	AS016	MT006	Pipe clamp 60W	2	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	IF024	Sticker SHS60 Install form	1	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	IF025	Sticker SHS60 Warrantee	1	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	IF026	Test form electronics	1	pcs	0	0	1	0
2.7 Box Assembly 60W - v2.0	AS004	AS009	Batterybox_60	1	pcs	0	0	1	0
0.1 Display Ass	AS011	IF030	Serial sticker display	1	pcs	0,0005	0,0005	1	1
2.4 Batterybox_60	AS009	AS023	solarin	1	pcs	0	0	1	0
0.2 Sim ass	AS022	IF029	Serial sticker SIM	1	pcs	0,0005	0,0005	1	1
2.4 Batterybox_60	AS009	AS013	Electronics_60_Ass	1	pcs	0	0	1	0
2.4 Batterybox_60	AS009	IF009	Sticker KW 60W	1	pcs	0	0	1	0
2.4 Batterybox_60	AS009	IF010	Sticker display 60W	1	pcs	0	0	1	0
2.7 Box Assembly 60W - v2.0	AS004	AS010	connection box	1	pcs	0	0	1	0
2.4 Batterybox_60	AS009	IF017	Sticker good solar brown	1	pcs	0	0	1	0
0.1 Display Ass	AS011	GE028	Header strip Male	3	pin	0,0005	0,0015	1	1
0.1 Display Ass	AS011	GE028	Header strip Male	3	pin	0,0005	0,0015	1	1
2.4 Batterybox_60	AS009	IF018	Sticker good solar gold	1	pcs	0	0	1	0
2.7 Box Assembly 60W - v2.0	AS004	AS016	Fastners_60_Ass	1	pcs	0	0	1	0
0.1 Display Ass	AS011	GE028	Header strip Male	5	pin	0,0005	0,0025	1	1
0.1 Display Ass	AS011	GE028	Header strip Male	5	pin	0,0005	0,0025	1	1
0.2 Sim ass	AS022	GE028	Header strip Male	8	pin	0,0005	0,004	1	1
1.4 Batterybox_100	AS008	IF006	Sticker KW 100W	1	pcs	0,015	0,015	0	1
1.1 Powerb_100Ass	AS020	GE028	Header strip Male	10	pin	0,0005	0,005	0	1
1.1 Powerb_100Ass	AS020	GE028	Header strip Male	10	pin	0,0005	0,005	0	1
0.1 Display Ass	AS011	GE028	Header strip Male	10	pin	0,0005	0,005	1	1
0.1 Display Ass	AS011	GE028	Header strip Male	10	pin	0,0005	0,005	1	1
1.3 Electronics_100_Ass	AS012	IF021	Sticker SHS100 Install form	1	pcs	0,05	0,05	0	1
1.3 Electronics_100_Ass	AS012	IF022	Sticker SHS100 Warrantee	1	pcs	0,05	0,05	0	1
0.2 Sim ass	AS022	GE028	Header strip Male	10	pin	0,0005	0,005	1	1
0.5 fastners Lampkit	AS014	CM012	Plastic bag 5x5	1	pcs	0,005	0,005	1	1
0.1 Display Ass	AS011	GE027	Header strip female	8	pin	0,00083	0,0066	1	1
0.1 Display Ass	AS011	GE027	Header strip female	10	pin	0,00083	0,00825	1	1
1.3 Electronics_100_Ass	AS012	CM010	plastic bag	1	pcs	0,01	0,01	0	1
1.5 Fastners_100_Ass	AS015	CM011	Plastic bag 10x10	1	pcs	0,01	0,01	0	1
0.4 Phone charger ass	AS019	CM011	Plastic bag 10x10	1	pcs	0,01	0,01	1	1
1.4 Batterybox_100	AS008	CB007	Wire black flexible 2.5mm2	4	cm	0,0027	0,0108	0	1
1.4 Batterybox_100	AS008	CB008	Wire red flexible 2.5mm2	4	cm	0,0027	0,0108	0	1
2.7 Box Assembly 60W - v2.0	AS004	AS019	Phone charger ass	1	pcs	0	0	1	0
2.9 Support Structure Assembly (	AS006	MT008	Aluminium angle bracket 28,	1	pcs	0	0	1	0
2.9 Support Structure Assembly (	AS006	MT009	Sheet steel rectangular 2x4x6	2	pcs	0	0	1	0
1.4 Batterybox_100	AS008	IF005	Sticker display 100W	1	pcs	0,015	0,015	0	1
1.4 Batterybox_100	AS008	IF014	Sticker Cellcard	1	pcs	0,02	0,02	0	1
1.4 Batterybox_100	AS008	MT011	Aluminium antenna holder 2	1	pcs	0,02	0,02	0	1
2.9 Support Structure Assembly (	AS006	MT010	Sheet steel square 3x3x33.5c	2	pcs	0	0	1	0
2.9 Support Structure Assembly (	AS006	MT012	Steel pipe diameter 3.5cm - 1	1	pcs	0	0	1	0
2.7 Box Assembly 60W - v2.0	AS004	IF034	Solar loar certificate	1	pcs	0	0	1	0
2.7 Box Assembly 60W - v2.0	AS004	IF028	Wing card	1	pcs	0	0	1	0
2.7 Box Assembly 60W - v2.0	AS004	IF016	Sticker Good Loar	1	pcs	0	0	1	0
2.1 Powerb_60Ass	AS021	GE010	Power board	1	pcs	0	0	1	0
2.1 Powerb_60Ass	AS021	GE030	Resistor	4	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	AS011	Display Ass	1	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	AS018	FlatCable ass 60	1	pcs	0	0	1	0
2.3 Electronics_60_Ass	AS013	AS021	Powerb_60Ass	1	pcs	0	0	1	0
1.4 Batterybox_100	AS008	FN010	Galvanized ring M4	4	pcs	0,01	0,04	0	1
2.3 Electronics_60_Ass	AS013	AS022	Sim Ass	1	pcs	0	0	1	0
1.3 Electronics_100_Ass	AS012	IF020	Sticker SHS100 box serial	1	pcs	0,05	0,05	0	1
1.7 Solar Assembly 100W	AS002	IF019	Sticker High Voltage warning	1	pcs	0,15	0,15	0	1
1.3 Electronics_100_Ass	AS012	IF032	serial sticker Charge controlle	1	pcs	0,05	0,05	0	1
1.3 Electronics_100_Ass	AS012	IF033	Sticker electronic assembly	1	pcs	0,05	0,05	0	1
1.4 Batterybox_100	AS008	IF004	Sticker ++--	1	pcs	0,05	0,05	0	1
1.5 Fastners_100_Ass	AS015	FN016	Ring M8 big	4	pcs	0,0175	0,07	0	1
1.2 FlatCable ass 100	AS017	CB002	Flat cable	30	cm	0,0025	0,075	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF008	Warranty certificate	1	pcs	0,15	0,15	0	1
1.1 Powerb_100Ass	AS020	FS001	Faston receptacle female blue	8	pcs	0,01	0,08	0	1
1.4 Batterybox_100	AS008	FN008	Galvanized bolt M4x20	9	pcs	0,01	0,09	0	1
1.4 Batterybox_100	AS008	FN009	Galvanized nut M4	9	pcs	0,01	0,09	0	1
1.7 Solar Assembly 100W	AS002	GE006	IEC female plug	1	pcs	0,19	0,19	0	1
1.1 Powerb_100Ass	AS020	GE025	Microswitch	1	pcs	0,1	0,1	0	1
1.1 Powerb_100Ass	AS020	FS007	Faston ring 8mm blue	2	pcs	0,05	0,1	0	1
1.1 Powerb_100Ass	AS020	MC007	Shrink tube 10mm²	2	cm	0,05	0,1	0	1
2.1 Powerb_60Ass	AS021	GE028	Header strip Male	10	pin	0,0005	0,005	1	0
1.5 Fastners_100_Ass	AS015	MC002	Seal lead	2	pcs	0,05	0,1	0	1
2.1 Powerb_60Ass	AS021	GE028	Header strip Male	10	pin	0,0005	0,005	1	0
0.5 fastners Lampkit	AS014	FN021	Woodscrew 25x3	20	pcs	0,006	0,12	1	1
0.3 solarin	AS023	CB007	Wire black flexible 2.5mm2	45	cm	0,0027	0,1215	1	1
0.3 solarin	AS023	CB008	Wire red flexible 2.5mm2	45	cm	0,0027	0,1215	1	1
1.5 Fastners_100_Ass	AS015	FN017	Ring M8 small	28	pcs	0,00438	0,1225	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF002	Installation form	1	pcs	0,3	0,3	0	1
1.1 Powerb_100Ass	AS020	IF031	serial sticker Power	1	pcs	0,15	0,15	0	1
0.5 fastners Lampkit	AS014	GE017	Wire connector small (red)	3	pcs	0,06	0,18	1	1
0.5 fastners Lampkit	AS014	GE018	Wire connector big (yellow o	3	pcs	0,06	0,18	1	1
2.6 Fastners_60_Ass	AS016	CM010	plastic bag	1	pcs	0,01	0,01	1	0
2.3 Electronics_60_Ass	AS013	CM010	plastic bag	1	pcs	0,01	0,01	1	0
2.6 Fastners_60_Ass	AS016	FN018	Woodscrew 6x80	2	pcs	0,01	0,02	1	0
2.4 Batterybox_60	AS009	IF014	Sticker Cellcard	1	pcs	0,02	0,02	1	0
2.4 Batterybox_60	AS009	MT011	Aluminium antenna holder 2	1	pcs	0,02	0,02	1	0
1.5 Fastners_100_Ass	AS015	FN014	Nut M8	20	pcs	0,0095	0,19	0	1
0.3 solarin	AS023	GE009	IEC male connector (solar in)	1	pcs	0,19	0,19	1	1
2.1 Powerb_60Ass	AS021	FS001	Faston receptacle female blue	2	pcs	0,01	0,02	1	0
2.1 Powerb_60Ass	AS021	FS005	Faston ring 6mm blue	2	pcs	0,01	0,02	1	0
2.6 Fastners_60_Ass	AS016	FN006	Bolt M8x50	1	pcs	0,03	0,03	1	0
2.6 Fastners_60_Ass	AS016	FN004	Bolt M8x30	4	pcs	0,01	0,04	1	0
1.5 Fastners_100_Ass	AS015	MC003	Seal wire	10	cm	0,02	0,2	0	1
2.1 Powerb_60Ass	AS021	GE008	IEC female connector (solar o	1	pcs	0,04	0,04	1	0
2.6 Fastners_60_Ass	AS016	FN001	Bolt M8x100	1	pcs	0,05	0,05	1	0
2.3 Electronics_60_Ass	AS013	IF032	serial sticker Charge controlle	1	pcs	0,05	0,05	1	0
2.5 connection box	AS010	CB007	Wire black flexible 2.5mm2	20	cm	0,0027	0,054	1	0
2.2 FlatCable ass 60	AS018	CB002	Flat cable	25	cm	0,0025	0,0625	1	0
1.7 Solar Assembly 100W	AS002	GE006	IEC female plug	1	pcs	0,19	0,19	0	1
1.1 Powerb_100Ass	AS020	GE025	Microswitch	1	pcs	0,1	0,1	0	1
1.1 Powerb_100Ass	AS020	FS007	Faston ring 8mm blue	2	pcs	0,05	0,1	0	1
1.1 Powerb_100Ass	AS020	MC007	Shrink tube 10mm²	2	cm	0,05	0,1	0	1
2.1 Powerb_60Ass	AS021	GE028	Header strip Male	10	pin	0,0005	0,005	1	0
1.5 Fastners_100_Ass	AS015	MC002	Seal lead	2	pcs	0,05	0,1	0	1
2.1 Powerb_60Ass	AS021	GE028	Header strip Male	10	pin	0,0005	0,005	1	0
0.5 fastners Lampkit	AS014	FN021	Woodscrew 25x3	20	pcs	0,006	0,12	1	1
0.3 solarin	AS023	CB007	Wire black flexible 2.5mm2	45	cm	0,0027	0,1215	1	1
0.3 solarin	AS023	CB008	Wire red flexible 2.5mm2	45	cm	0,0027	0,1215	1	1
1.5 Fastners_100_Ass	AS015	FN017	Ring M8 small	28	pcs	0,00438	0,1225	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF002	Installation form	1	pcs	0,3	0,3	0	1
1.1 Powerb_100Ass	AS020	IF031	serial sticker Power	1	pcs	0,15	0,15	0	1
0.5 fastners Lampkit	AS014	GE017	Wire connector small (red)	3	pcs	0,06	0,18	1	1
0.5 fastners Lampkit	AS014	GE018	Wire connector big (yellow o	3	pcs	0,06	0,18	1	1
2.6 Fastners_60_Ass	AS016	CM010	plastic bag	1	pcs	0,01	0,01	1	0
2.3 Electronics_60_Ass	AS013	CM010	plastic bag	1	pcs	0,01	0,01	1	0
2.6 Fastners_60_Ass	AS016	FN018	Woodscrew 6x80	2	pcs	0,01	0,02	1	0
2.4 Batterybox_60	AS009	IF014	Sticker Cellcard	1	pcs	0,02	0,02	1	0
2.4 Batterybox_60	AS009	MT011	Aluminium antenna holder 2	1	pcs	0,02	0,02	1	0
1.5 Fastners_100_Ass	AS015	FN014	Nut M8	20	pcs	0,0095	0,19	0	1
0.3 solarin	AS023	GE009	IEC male connector (solar in)	1	pcs	0,19	0,19	1	1
2.1 Powerb_60Ass	AS021	FS001	Faston receptacle female blue	2	pcs	0,01	0,02	1	0
2.1 Powerb_60Ass	AS021	FS005	Faston ring 6mm blue	2	pcs	0,01	0,02	1	0
2.6 Fastners_60_Ass	AS016	FN006	Bolt M8x50	1	pcs	0,03	0,03	1	0
2.6 Fastners_60_Ass	AS016	FN004	Bolt M8x30	4	pcs	0,01	0,04	1	0
1.5 Fastners_100_Ass	AS015	MC003	Seal wire	10	cm	0,02	0,2	0	1
2.1 Powerb_60Ass	AS021	GE008	IEC female connector (solar o	1	pcs	0,04	0,04	1	0
2.6 Fastners_60_Ass	AS016	FN001	Bolt M8x100	1	pcs	0,05	0,05	1	0
2.3 Electronics_60_Ass	AS013	IF032	serial sticker Charge controlle	1	pcs	0,05	0,05	1	0
2.5 connection box	AS010	CB007	Wire black flexible 2.5mm2	20	cm	0,0027	0,054	1	0
2.2 FlatCable ass 60	AS018	CB002	Flat cable	25	cm	0,0025	0,0625	1	0
2.5 connection box	AS010	CB008	Wire red flexible 2.5mm2	25	cm	0,0027	0,0675	1	0
2.4 Batterybox_60	AS009	FN025	Screw PT4x20 (close 60W box	8	pcs	0,01	0,08	1	0
2.6 Fastners_60_Ass	AS016	MC002	Seal lead	2		0,05	0,1	1	0
1.5 Fastners_100_Ass	AS015	FN002	Bolt M8x120	4	pcs	0,07	0,28	0	1
1.1 Powerb_100Ass	AS020	CB011	Wire Red flexible 0.75mm2	30	cm	0,01	0,3	0	1
0.6 LampKit4	FP003	GE024	Box cover	1	pcs	0,3	0,3	1	1
2.6 Fastners_60_Ass	AS016	FN017	Ring M8 small	30	pcs	0,00438	0,13125	1	0
2.6 Fastners_60_Ass	AS016	FN014	Nut M8	15	pcs	0,0095	0,1425	1	0
2.6 Fastners_60_Ass	AS016	FN005	Bolt M8x40	5	pcs	0,03	0,15	1	0
2.1 Powerb_60Ass	AS021	IF031	serial sticker Power	1	pcs	0,15	0,15	1	0
2.7 Box Assembly 60W - v2.0	AS004	IF008	Warranty certificate	1	pcs	0,15	0,15	1	0
1.6 Box Assembly 100W - v2.0	AS001	IF001	End user manual	1	pcs	0,4	0,4	0	1
2.10 SHS 60W - v2.0	FP002	AS005	Solar Assembly 60W	1	pcs	0	0	1	0
0.6 LampKit4	FP003	BX008	Carton box Lamp	1	pcs	0,4	0,4	1	1
1.1 Powerb_100Ass	AS020	CB007	Wire black flexible 2.5mm2	###	cm	0,0027	0,4185	0	1
1.5 Fastners_100_Ass	AS015	FN003	Bolt M8x20	16	pcs	0,03	0,48	0	1
0.4 Phone charger ass	AS019	GE029	Phone charger cable	1	pcs	0,57	0,57	1	1
2.1 Powerb_60Ass	AS021	MC007	Shrink tube 10mm²	4	cm	0,05	0,2	1	0
2.6 Fastners_60_Ass	AS016	MC003	Seal wire	10	cm	0,02	0,2	1	0
1.1 Powerb_100Ass	AS020	CB010	Wire Black flexible 0.75mm2	60	cm	0,01	0,6	0	1
0.6 LampKit4	FP003	FN019	Cable clip small (1box of 100	1	pcs	0,6	0,6	1	1
2.6 Fastners_60_Ass	AS016	FN007	Bolt M8x60	4	pcs	0,05	0,2	1	0
2.1 Powerb_60Ass	AS021	CB007	Wire black flexible 2.5mm2	###	cm	0,0027	0,27	1	0
0.6 LampKit4	FP003	GE014	Double switch	1	pcs	0,6	0,6	1	1
2.7 Box Assembly 60W - v2.0	AS004	IF002	Installation form	1	pcs	0,3	0,3	1	0
2.1 Powerb_60Ass	AS021	CB010	Wire Black flexible 0.75mm2	33	cm	0,01	0,33	1	0
2.1 Powerb_60Ass	AS021	CB011	Wire Red flexible 0.75mm2	33	cm	0,01	0,33	1	0
2.9 Support Structure Assembly (	AS006	FN002	Bolt M8x120	5	pcs	0,07	0,35	1	0
2.1 Powerb_60Ass	AS021	CB008	Wire red flexible 2.5mm2	###	cm	0,0027	0,3645	1	0
1.3 Electronics_100_Ass	AS012	GE020	Antenna cable (plus ring & bo	1	pcs	0,65	0,65	0	1
1.4 Batterybox_100	AS008	MC001	Rubber tube	6	pcs	0,11	0,66	0	1
2.7 Box Assembly 60W - v2.0	AS004	IF001	End user manual	1	pcs	0,4	0,4	1	0
2.5 connection box	AS010	GE001	Cigarette lighter socket	2	pcs	0,28	0,56	1	0
1.1 Powerb_100Ass	AS020	CB008	Wire red flexible 2.5mm2	250	cm	0,0027	0,675	0	1
1.6 Box Assembly 100W - v2.0	AS001	BX006	Carton box 100W	1	pcs	0,7	0,7	0	1
1.3 Electronics_100_Ass	AS012	GE019	Antenna	1	pcs	0,75	0,75	0	1
2.7 Box Assembly 60W - v2.0	AS004	BX007	Carton box 60W	1	pcs	0,6	0,6	1	0
2.3 Electronics_60_Ass	AS013	GE020	Antenna cable (plus ring & bo	1	pcs	0,65	0,65	1	0
2.4 Batterybox_60	AS009	MC001	Rubber tube	6	pcs	0,11	0,66	1	0
2.3 Electronics_60_Ass	AS013	GE019	Antenna	1	pcs	0,75	0,75	1	0
0.4 Phone charger ass	AS019	GE021	SHS phone charger	1	pcs	0,8	0,8	1	1
0.6 LampKit4	FP003	GE023	Base box	4	pcs	0,2	0,8	1	1
0.3 solarin	AS023	FS010	Faston wire end pipe red	2	pcs	0,42	0,84	1	1
1.4 Batterybox_100	AS008	GE001	Cigarette lighter socket	3	pcs	0,28	0,84	0	1
1.4 Batterybox_100	AS008	FN011	Nickelized bolt M3x20	12	pcs	0,08	0,96	0	1
1.7 Solar Assembly 100W	AS002	MC007	Shrink tube 10mm²	20	cm	0,05	1	0	1
1.2 FlatCable ass 100	AS017	GE026	box connector (for flat cable)	2	pcs	0,5	1	0	1
1.4 Batterybox_100	AS008	FN026	Screw PT3x15 (Microswitch)	2	pcs	0,5	1	0	1
2.2 FlatCable ass 60	AS018	GE026	box connector (for flat cable)	2	pcs	0,5	1	1	0
2.5 connection box	AS010	BX005	Connection box 10cmx10cm	1	pcs	1,1	1,1	1	0
2.4 Batterybox_60	AS009	FN011	Nickelized bolt M3x20	14	pcs	0,08	1,12	1	0
1.4 Batterybox_100	AS008	FN012	Nickelized nut M3	12	pcs	0,09	1,08	0	1
0.6 LampKit4	FP003	GE013	Single switch	2	pcs	0,6	1,2	1	1
2.4 Batterybox_60	AS009	FN012	Nickelized nut M3	14	pcs	0,09	1,26	1	0
0.6 LampKit4	FP003	GE015	Lamp holder E27	4	pcs	0,3	1,2	1	1
2.7 Box Assembly 60W - v2.0	AS004	GE002	Cigarette plug	2	pcs	0,71	1,42	1	0
2.5 connection box	AS010	GE012	Terminal connector block 4 s	1	pcs	1,5	1,5	1	0
2.7 Box Assembly 60W - v2.0	AS004	IF003	Sign installed by KW	1	pcs	1,5	1,5	1	0
2.4 Batterybox_60	AS009	BX003	Battery box 60W back	1	pcs	1,67	1,67	1	0
2.1 Powerb_60Ass	AS021	FS010	Faston wire end pipe red	4	pcs	0,42	1,68	1	0
2.4 Batterybox_60	AS009	GE007	Circuit breaker 10A	1	pcs	2,26	2,26	1	0
1.6 Box Assembly 100W - v2.0	AS001	GE002	Cigarette plug	2	pcs	0,71	1,42	0	1
1.4 Batterybox_100	AS008	GE012	Terminal connector block 4 s	1	pcs	1,5	1,5	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF003	Sign installed by KW	1	pcs	1,5	1,5	0	1
1.4 Batterybox_100	AS008	FS010	Faston wire end pipe red	4	pcs	0,42	1,68	0	1
1.4 Batterybox_100	AS008	GE007	Circuit breaker 10A	1	pcs	2,26	2,26	0	1
1.6 Box Assembly 100W - v2.0	AS001	IF035	Solar folder	1	pcs	2,45	2,45	1	1
2.7 Box Assembly 60W - v2.0	AS004	IF035	Solar folder	1	pcs	2,45	2,45	1	0
1.1 Powerb_100Ass	AS020	FS010	Faston wire end pipe red	6	pcs	0,42	2,52	0	1
2.5 connection box	AS010	FS010	Faston wire end pipe red	8	pcs	0,42	3,36	1	0
2.5 connection box	AS010	CB001	Connection cable 2x2.5mm2	1	pcs	3,72	3,72	1	0
1.3 Electronics_100_Ass	AS012	GE022	Sim card	1	pcs	5,95	5,95	0	1
1.4 Batterybox_100	AS008	BX001	Battery box 100W back	1	pcs	6	6	0	1
1.6 Box Assembly 100W - v2.0	AS001	MC006	Solar fan cap	1	pcs	4	4	1	1
1.4 Batterybox_100	AS008	BX002	Battery box 100W front	1	pcs	6	6	0	1
2.7 Box Assembly 60W - v2.0	AS004	MC006	Solar fan cap	1	pcs	4	4	1	0
2.4 Batterybox_60	AS009	BX004	Battery box 60W front	1	pcs	4,15	4,15	1	0
1.7 Solar Assembly 100W	AS002	CB003	Solar cable flexible 2x1.5mm	1	pcs	12	12	0	1
2.3 Electronics_60_Ass	AS013	GE022	Sim card	1	pcs	5,95	5,95	1	0
2.3 Electronics_60_Ass	AS013	CC001	Charge controller 60W v2	1	pcs	7	7	1	0
3.1 new version		CB013	cable sp 70W	1	pcs	10,274	10,274	0	0
2.3 Electronics_60_Ass	AS013	CC004	Charge controller SR-HM for E	1	pcs	12	12	0	0
2.8 Solar Assembly 60W	AS005	MC007	Shrink tube 10mm²	20	cm	0,05	1	1	0
2.8 Solar Assembly 60W	AS005	FS011	Faston connection tube blue	2	pcs	0,05	0,1	1	0
2.8 Solar Assembly 60W	AS005	CB004	Solar cable flexible 2x4 mm2	1	pcs	18,6	18,6	1	0
2.8 Solar Assembly 60W	AS005	SP002	Solar panel 60Wp	1	pcs	39	39	1	0
0.6 LampKit4	FP003	CB009	Cable 2x1.5mm2	40	m	0,26	10,4	1	1
3.1 new version		BX009	Battery box 70W new design	1	pcs	6	6	0	0
4 Sub assembly price		GC002	Mounting	1	pcs	15	15	1	1
0.6 LampKit4	FP003	GE016	Led lamp 9W/12V	4	pcs	3,97	15,88	1	1
3.1 new version		CB012	cable sp 130w	1	pcs	17,17	17,17	0	0
4 Sub assembly price		GC001	PB+DB+SB+assembly+shippin	1	pcs	28,56	28,56	1	1
1.3 Electronics_100_Ass	AS012	CC003	Charge controller 100W v2	1	pcs	35,5	35,5	0	1
3.1 new version		GC003	New electronics v3	1	pcs	30	30	0	0
3.1 new version		SP004	sp 70W	1	pcs	33,88	33,88	0	0
3.1 new version		SP003	sp 130w	1	pcs	60,06	60,06	0	0
2.10 SHS 60W - v2.0	FP002	BT002	BATTERY 12V 55AH	1	pcs	69	69	1	0
1.7 Solar Assembly 100W	AS002	SP001	Dupont 95Wp panel	1	pcs	36,19	36,19	0	1
1.9 100W SHS	FP001	BT001	BATTERY 12V 100AH	1	pcs	96,14	96,14	0	1

C Calculation MFI payments

The average monthly payment for a large SHS with a 2-year loan (right bottom)

វិសិនហ៊ុន	2,00%	
តំលៃ SHS 100W	595	$
បង់រំលៃ២ឆ្នាំ	24	(ខែ)

	បុរាក់ដើមនៅដំពាក់	បុរាក់ដើមតួរបង់	ការបុរាក់	បុរាក់សរុបដែលតួរបង់	
ខែទី1	595,00	24,79	11,90	**36,69**	
ខែទី2	570,21	24,79	11,40	**36,20**	
ខែទី3	545,42	24,79	10,91	**35,70**	
ខែទី4	520,63	24,79	10,41	**35,20**	
ខែទី5	495,83	24,79	9,92	**34,71**	
ខែទី6	471,04	24,79	9,42	**34,21**	
ខែទី7	446,25	24,79	8,93	**33,72**	
ខែទី8	421,46	24,79	8,43	**33,22**	
ខែទី9	396,67	24,79	7,93	**32,73**	
ខែទី10	371,88	24,79	7,44	**32,23**	
ខែទី11	347,08	24,79	6,94	**31,73**	
ខែទី12	322,29	24,79	6,45	**31,24**	
ខែទី13	297,50	24,79	5,95	**30,74**	
ខែទី14	272,71	24,79	5,45	**30,25**	
ខែទី15	247,92	24,79	4,96	**29,75**	
ខែទី16	223,13	24,79	4,46	**29,25**	
ខែទី17	198,33	24,79	3,97	**28,76**	
ខែទី18	173,54	24,79	3,47	**28,26**	
ខែទី19	148,75	24,79	2,98	**27,77**	
ខែទី20	123,96	24,79	2,48	**27,27**	
ខែទី21	99,17	24,79	1,98	**26,78**	
ខែទី22	74,38	24,79	1,49	**26,28**	
ខែទី23	49,58	24,79	0,99	**25,78**	
ខែទី24	24,79	24,79	0,50	**25,29**	30,99
	សរុប	**595**	**148,75**	**743,75**	

The average monthly payment for a regular SHS with a 2-year loan (right bottom)

វិសិនហ៊ុន	2,00%	
តំលៃ SHS 60W	450	$
បង់រំលៃ២ឆ្នាំ	24	(ខែ)

	បុរាក់ដើមនៅដំពាក់	បុរាក់ដើមតួរបង់	ការបុរាក់	បុរាក់សរុបដែលតួរបង់	
ខែទី1	450,00	18,75	9,00	**27,75**	
ខែទី2	431,25	18,75	8,63	**27,38**	
ខែទី3	412,50	18,75	8,25	**27,00**	
ខែទី4	393,75	18,75	7,88	**26,63**	
ខែទី5	375,00	18,75	7,50	**26,25**	
ខែទី6	356,25	18,75	7,13	**25,88**	
ខែទី7	337,50	18,75	6,75	**25,50**	
ខែទី8	318,75	18,75	6,38	**25,13**	
ខែទី9	300,00	18,75	6,00	**24,75**	
ខែទី10	281,25	18,75	5,63	**24,38**	
ខែទី11	262,50	18,75	5,25	**24,00**	
ខែទី12	243,75	18,75	4,88	**23,63**	
ខែទី13	225,00	18,75	4,50	**23,25**	
ខែទី14	206,25	18,75	4,13	**22,88**	
ខែទី15	187,50	18,75	3,75	**22,50**	
ខែទី16	168,75	18,75	3,38	**22,13**	
ខែទី17	150,00	18,75	3,00	**21,75**	
ខែទី18	131,25	18,75	2,63	**21,38**	
ខែទី19	112,50	18,75	2,25	**21,00**	
ខែទី20	93,75	18,75	1,88	**20,63**	
ខែទី21	75,00	18,75	1,50	**20,25**	
ខែទី22	56,25	18,75	1,13	**19,88**	
ខែទី23	37,50	18,75	0,75	**19,50**	
ខែទី24	18,75	18,75	0,38	**19,13**	23,44
	សរុប	**450**	**112,50**	**562,50**	

D Calculation solar panel position

Month	Sun angle[1]:	Hours sun/day[2]:	Consistency factor:
January	62˚ (61-63)	4,99	1,004
February	70˚ (69-71)	5,48	0,914
March	78˚ (77-79)	5,77	0,868
April	86˚ (85-87)	5,84	0,858
May	94˚ (93-95)	5,31	0,944
June	101˚ (100-102)	4,93	1,016
July	94˚ (93-95)	4,81	1,042
August	86˚ (85-87)	4,61	1,087
September	78˚ (77-79)	4,60	1,089
October	70˚ (69-71)	4,53	1,106
November	62˚ (61-63)	4,58	1,094
December	55˚ (54-56)	4,56	1,099
Average:	78˚	5,01	-
Total:	-	60.01	12,121

Solar data of Cambodia. [1] Solar Electricity Handbook 2016. [2] NASA Langley atmospheric science data center, 2017

Average sun angle
› SUM([Sun angle]) / 12 = 936 / 12 = 78˚

Annual consistent power production
› SUM([Sun angle] x [consistency factor]) / 12,121 =
› (62,248+63,98+67,704+73,788+88,735+102,616+97,948+93,482+84,942+77,42+67,828+60,445) / 12,121 =
› 941,136 / 12,121 = 77,6450788
› Angle = 90 - 77,65 = 12,35 ˚

Maximal yearly power production
› SUM([Sun angle] x [optimal annual output factor]) / [Total optimal annual output factor] = 78,35˚
› Angle solar panel: 90 - 78,35 = 11,65˚

Consistency factor
› [Average Hours sun/day] / [Hours sun/day] = 5,01 / [Hours sun/day]

Optimal annual output factor
› [Hours sun/day] / [Average Hours sun/day] = [Hours sun/day] / 5,01

E Understanding expandability (field research)

Goal of the research
To verify the focus topic that is most depending to the customer's understanding–Expandability–, a research was conducted. For this research three main goals were determined:

› Do customers understand the concept of expanding a SHS?
› Is there a demand for an expandable SHS?
› Are multiple system sizes desired?

Since this research was performed with T. Den Heeten, at that time performing research in the same topic with a different focus, several additional questions emerged. For the clarity of this part of the research they are not included here. Before the execution of the research, a booklet and game were designed. A pilot was performed with an employee of Kamworks.

Method
Seven participants were involved in the research. They are persons/households who already own a SHS. They were located in several villages in the Kampong Chhnang province. They were asked to fill in a booklet and to play a game. A translator speaking both English and Khmer joined the three-day trip to translate everything.

The booklet with questions regarding their current situation was filled in partially before and partially after the game. This booklet gave insights in the households' current situations. The game represents a simplified version of the potential future portfolio of Kamworks. The gameplay and questionnaire helped to gain insight in the understanding of, and attitude towards, expandability of different system sizes.

The research was observed and captured through voice recording, notes and pictures. In the end the results were discussed and linked to the participant's real situation.

Results
The progress of the game is shown on page 12 and 13. It gives insight in the participants' attitudes towards dealing with money. Some results are more relevant to the research goals than others.
› Participants understood the concept of expanding a system.
› All participants were more confident in their actions in the second round (e.g. a participant mentioned she wanted to save money for three months to buy a certain appliance).
› Two (out of 7) participants needed to expand their large SHS in the second round. These were village chief with an income higher than other participants.
› Six out of seven participants would prefer buying a big system in the first place.
› Grid is expanding, but participants still have a positive attitude towards solar energy as addition to reduce the grid costs.
› Three participants complained that they wanted to expand their system already, but do not know how. They were owners of a large SHS.
› All customers experienced a lack of after sales & service.

Discussion
The game was not only useful for the research, but also for the participants. Some indicated they liked the game because it is a fun way to learn how to manage income. In general there is little knowledge about the income of a household. During the game, the two village chiefs bought more appliances. This is possibly related to their actual income: their attitude towards buying products / saving money may be different than the other participants with an actual lower income.

Two participants had access to both a SHS and the grid. One of them mentioned he used the SHS for light and charging phone, while he used the grid as less as possible due to the (high) costs. Grid is a competitor, but it can also stimulate selling smaller systems if it is sold as a solution to reduce grid costs.

When participants were asked what system they would buy first, they mentioned it depended mostly on the price. However, looking at Kamworks experiences, customers would most of the times go for an as large system as possible. One participant mentioning she would buy a small system first was because she wanted to test the new technology first before investing. Also the way participants would expand 'their' systems differed: some would expand with the same system size, others would like to expand with a smaller system. This implies that multiple system sizes are desired and the system sizes should be combinable. Moreover, giving the user the choice of multiple products may stimulate sales.

In the last place the complaints regarding after sales and services should be a thing for Kamworks to keep in mind. In the first place, keeping in touch with the customers could stimulate the demand for accessories, if they would offer them. Currently this is not the case. Offering the right appliances could reduce the misuse of the SHS by unsuitable appliances, but more importantly it may indirectly

Expandable Solar Home System Game
The materials of the game can be divided in four groups: The playing board, Solar Home Systems, Appliances and Money. Additionaly there are 'future objects' like a scooter or a car (that cannot be bought) to give the player the choise between investing directly or saving for the future. An overview of prices for the Solar Home Systems and appliances is provided.

› **The playground** - The playing board shows 12 steps. Each step represents a month. Every turn the player can buy a SHS, Appliances, or save money.
› **Solar Home Systems** - Three sizes are available: small, normal and large. A SHS is payed through a monthly fee of respectively $20, $30 or $50. These fees represent the monthly fees for a loan. The sizes differ in the amount of boxes, representing the capacity.
› **Appliances** - There are several appliances (TV, iron, rice cooker, electric kettle, etcetera) available that can be purchased. The size of the card stands for the power consumption for 4 hours. If a player indicates he/she uses an appliance for longer than 4 hours, additional space is taken from the SHS boxes.
› **Money** - A player recieves $100 in fake dollar bills each turn. They can be spent on expanding their SHS capacity or buy additional appliances. It is also possible to safe money.

One player (1 person or 1 household) plays the game 2 rounds: one starting with a small SHS and one starting with the large SHS. In addition to that a player recieves 50$, 4 lights and a phone.

There is no winning or losing in the game, it is only about learning how the players would deal with their money in real life.

Rules:
› Each turn the player recieves 100$ and has the possibility of buying a SHS or appliances.
› Purchased appliances need to stay on the SHS card(s).
› You cannot have more appliances (in size) than the boxes of the owned SHS provide. In that case an additional SHS should be bought first.
› After each round the game will be evaluated, the amount of SHS, appliances and money possesed by the player will be noted. A round will be concluded with a questionnaire about the progress of the game (How did it go? What did you like/dislike? etc.)

stimulate the expansion of a SHS.

Conclusions
After the conducted research it can be concluded that customers do understand the concept of expanding. In fact some participants mentioned this demand themselves. It makes more sense to them that it is possible than explaining the system is fixed. Most of T. Den Heeten's research goals were related to the use of appliances. It turns out that people will buy 'luxury' products like a TV, iron or electric kettle as soon as they can afford it. With this attitude in a growing economy, the demand for an expandable SHS will be definitely there.

Siebinga's design proposal offers a single sized, expandable SHS. However, participants indicated they would expand their SHS in different ways. Offering two system sizes that are expandable and interchangeable should suit the market's demand.

Additional note
In addition to the conclusions relevant for this project, an issue occurred that may be good to know for future research. Participating in the game was initially perceived tricky to some participants. Apparently there are salesmen trying to 'play a game' with these people and then force them to buy things. After explaining clearly we were students doing research only made them feel comfortable with it.

Expandable Solar Home System Game

After the game questions were asked. The questions mentioned below were meant as a guideline.

› What did you think of the game?
› What did you like/dislike?
› Did you find things hard to understand during the game?
› Which round did you liked the most? [ask while showing the results]
› Imagine you were a new customer: which system would you buy? Why?
› Are you aware that the total investment is lower when you buy a big system in the first place?
› Would you prefer a small system that you can expand or a big system? Why?

Results SHS game

User	Appliances round 1	Amount of appliances		Appliances round 2	Amount of appliances
1	Radio, ricecooker, TV, Water kettle, 2nd fan	5		Radio, water kettle, rice cooker, TV.	4
2	TV, ricecooker, iron, radio, water kettle.	6		**Fridge**	1
3	TV, fan, ricecooker, iron, radio, kettle	6		TV, radio, fan, ricecooker, iron, water kettle, **fridge**	7
4	Fan, radio, ricecooker, **fridge**, *washing machine* , TV.	6		TV, radio, washing machine, **fridge**.	4
5	Ricecooker. TV, Radio, Iron	4		TV, water kettle, **fridge**, radio.	4
6	TV, Iron, Fan	3		Lamp, Fan, TV, Water kettle, Radio, Speaker	6
7	TV, Radio, Ricecooker, kettle	4		Ricecooker, TV, radio, water kettle, stereo set, iron, **fridge**	7

Participant 1

Round 1 Small System			Round 2 Big System		
Step	**Bought**	**Comments**	**Step**	**Purchases**	**Comments**
1	Wants to save for a TV		1	-	Wants to earn money, than buy appliances
2	Buys a Radio		2	-	
3	-		3	-	
4	Wants a rice cooker and a TV		4	Radio	
5	Buys a 2nd SHS and a ricecooker		5	Thinks about buying a fridge. Doesn't do it. Buys a water kettle	Fridge takes a lot of eneryg. Does she understands?
6	-		6	Buys rice cooker	Yes she understands, but then she doesn't want it.
7	-		7	Buys a TV (5-8 hours)	
8	Buys a TV (8 hours)	Starts counting the steps till the end	8	-	
9	-		9	-	
10	-		10	-	
11	Buys a 3rd SHS and a water kettle		11	-	
12	Wants an Iron. This doesn't fit. Buys a 2nd fan.		12	-	
Total	420$		**Total**	400$	
With the money leftover, I would buy:	Kobuta. Wants a boat also, but can't afford it		**With the money leftover, I would buy:**	She wants to have a house as she has now, but then with closed walls.	
Appliances	Radio, ricecooker, TV, Water kettle, 2nd fan			Radio, water kettle, rice cooker, TV.	

Participant 2

Round 1 Small System			Round 2 Big System		
Step	**Bought**	**Comments**	**Step**	**Purchases**	**Comments**
1			1	Wants to buy a fridge.	
2	Wants to buy a TV, but she can't afford it yet		2		
3	Buys TV and a 2nd SHS.		3		
4	Buys ricecooker.		4	Buys a fridge.	
5	Buys iron and 3rd	Daughter takes over.	5	save money first	
6	Wants a fridge? Maybe at the end of the game.		6	save money first	
7			7	-	
8			8	-	
9	Father wants a radio.		9	-	
10			10	-	
11	Kettle + 4th system.		11	-	
12			12	-	
				-	
Total	310$		**Total**	400$	
With the money leftover, I would buy:			**With the money leftover, I would buy:**	Would like to have a car.	
Appliances	TV, ricecooker, iron, radio, water kettle.		**Appliances**	Fridge	

Participant 3

Round 1 Small System			Round 2 Big System		
Step	**Bought**	**Comments**	**Step**	**Purchases**	**Comments**
1			1	-	
2	She wants a TV, but can't afford it yet		2	-	
3	TV (4hours)		3	Buys TV.	
4	Buys a fan and 2nd SHS		4	Buys Radio.	
5	-		5	Buys Fan.	
6	Buys a ricecooker. Understands it costs a lot of energy.		6	Buys Ricecooker.	
7	Wants an iron, but doesn't buy it because she would need an extra system (=expensive)		7	Buys Iron.	
8	-		8	Buys Water kettle.	
9	Buys iron + 3rd SHS		9	Wants to buy a fridge, but she has no more space left.	
10	Wants a fridge, but this does not fit.		10	Buys Fridge.	
11	Buys radio. Wants a water kettle, because she does not have to pay for the 4th system.		11	Buys SHS to power the fridge.	
12	Buys ketle & 4th system.		12		
Total	370$		**Total**	70$	
With the money leftover, I would buy:			**With the money leftover, I would buy:**		
Appliances	TV, fan, ricecooker, iron, radio, kettle		**Appliances**	TV, radio, fan, ricecooker, iron, water kettle, fridge	

Round 1 Small System			Round 2 Big System		
Step	Bought	Comments	Step	Purchases	Comments
1	-		1	Saves for TV	
2	Wants to buy a laptop. Buys fan.		2	Saves for TV	
3	Radio To listen to the news		3	Buys TV.	
4	Wants a washing machine. Buys ricecooker and 2nd SHS.		4	Buys Radio	
5	Wants a fridge.		5		
6	Buys a washing m Pays 150$ for washing machine		6		
7	Wants a PC for his kids.		7	Buys Washing machine.	
8	TV + 4th SHS. Bu System full		8		
9			9		
10			10		
11			11	Buys Fridge + 130Wp system	
12			12		
Total	80$		Total		
With the money leftover, I would buy:	Wants a car (has one already)		With the money leftover, I would buy:		
Appliances	Fan, radio, ricecooker, fridge, washing machine, TV.		Appliances	TV, radio, washing machine, fridge.	

Participant 4

Round 1 Small System			Round 2 Big System		
Step	Bought	Comments	Step	Purchases	Comments
1	Wants ricecooker. Saves money		1	Wants to save for a fridge.	
2	Wants DVD player. Decides to save money		2	-	
3	Buys TV.		3	-	
4	Wants Fridge. Doe Doesn't want a ricecooker, because she has an alternative.		4	Buys TV.	
5	Radio for her husband.		5	Buys Kettle.	We tell her the fridge does not fit anymore. Is okay with her.
6	Wants to have a phone. Wants to have an iron. Buys an iron.		6	Still wants a fridge	
7	Is willing to pay 100$ for SHS pump.		7		
8	-		8		
9	-		9	Buys Fridge and 7 Not sure if this is correctly noted down.	
10	-		10	Radio.	
11	-		11		
12	-		12	Wants fridge. Needs another system.	
	-				
Total	360$		Total		
With the money leftover, I would buy:			With the money leftover, I would buy:		
Appliances	Ricecooker, TV, Radio, Iron		Appliances	TV, water kettle, fridge, radio.	

Participant 5

Round 1 Small System			Round 2 Big System		
Step	Bought	Comments	Step	Purchases	Comments
1			1	-	
2	Wants to have a ricecooker. Decides to save money		2	Buys lamps & seco Second fan for guests.	
3	Buys TV (2-3 hours)		3	Wants a TV but has no money	
4	Buys iron and 2nd Iron for special events only.		4	Buys TV	
5	-		5	Buys Water kettle & radio	
6	Wants to have frid She wants to have a fridge to cool fo		6	Wants speaker. Discount to 100$	
7	-		7		
8	-		8		
9	-		9		
10	-		10		
11	-		11		
12	-		12		
Total	550$		Total		
With the money leftover, I would buy:	A kobuta for her farm. She can earn more money than.		With the money leftover, I would buy:		
Appliances	TV, Iron, Fan		Appliances	Lamp, Fan, TV, Water kettle, Radio, Speaker	

Participant 6

Round 1 Small System			Round 2 Big System		
Step	Bought	Comments	Step	Purchases	Comments
1	PRefers to save. Wants to have a TV, this is a priority.		1	Save for TV	
2			2		
3	TV (5 hours). Has to buy a second SHS.		3	Buys ricecooker	
4	Radio		4	Buys TV, buys radio.	
5	Buys ricecooker		5	Buys water kettle.	
6	Water kettle		6	Buys stereo	For 50$. Will do karaoke.
7	Doesn't want more After suggestive question by translat		7	Wants solar pump	To water crops and plants. She would get it if she could get a loan for this.
8	-		8	Buys iron.	20 years loan, low interest rate, 2000$
9	-		9	Wants fridge	
10	-		10		
11	-		11	Buys fridge.	
12	-		12		
Total			Total		
With the money leftover, I would buy:			With the money leftover, I would buy:		
Appliances	TV, Radio, Ricecooker, kettle		Appliances	Ricecooker, TV, radio, water kettle, stereo set, iron, fridge	

Participant 7

F Current battery boxes

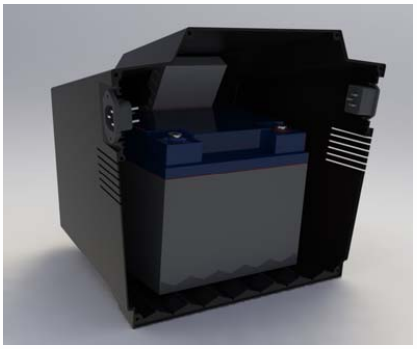
KAM WORKS

Adress:
Sré Ampil village
Kien Svay district
Kandal province
Cambodia

Mailing adress:
PO Box 2497
Phnom Penh

T +855 (0)92 962 162
T +855 (0)23 351 454
I www.kamworks.com
E info@kamworks.com

Solar Home Box



Specification

Compatible with RA12-33, RA12-40, and RA12-55 batteries

Weight: 1088 grams

Dimensions: 354mm x 247mm x 298mm

Material: Recycled ABS

Compatible with Phocos CML and CA series charge controllers

Stackable for ease of transport

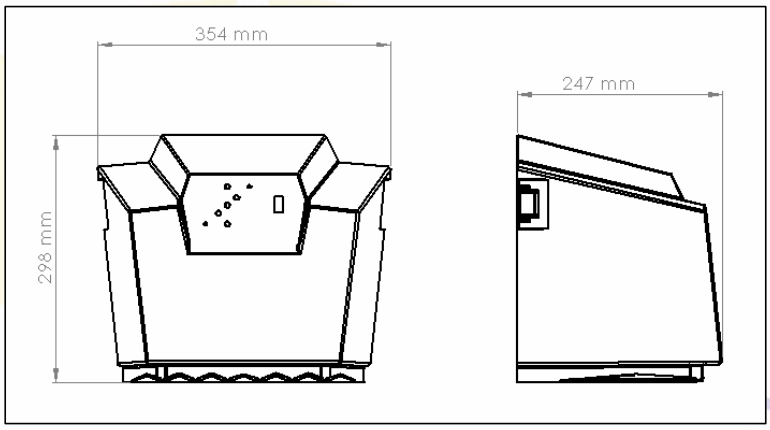
Non-reversible ports for power IN and OUT

Integrated over-current circuit breaker port

Strong flex resistant base

Small form factor

Power display easily visible when box is placed on floor



KAM WORKS

Adress:
Sré Ampil village
Kien Svay district
Kandal province
Cambodia

Mailing adress:
PO Box 2497
Phnom Penh

T +855 (0)92 962 162
T +855 (0)23 351 454
I www.kamworks.com
E info@kamworks.com

Solar Home Box 100

Specification

Compatible with RA12-100 batteries

Weight: 3000 grams

Dimensions: 495mm x 365mm x 270mm

Material: fiberglass

Compatible with Phocos CML and CA series charge controllers and SNRE SR-MT2410 charge controllers

Stackable for ease of transport

Small form factor

Power display easily visible when box is placed on floor

G Battery specifications

RA12-55 (12V55Ah)

RA series is a general purpose battery with 10 years design life in float service. It meets with IEC, JIS and BS standards .With up-dated AGM valve regulated technology and high purity raw materials, the RA series battery maintains high consistency for better performance and reliable standby service life. It is suitable for UPS/EPS, medical equipment, emergency light and security system applications.

RITAR®

Specification

Cells Per Unit	6
Voltage Per Unit	12
Capacity	55Ah@10hr-rate to 1.80V per cell @25℃
Weight	Approx. 18.0 Kg (Tolerance ±3%)
Max. Discharge Current	550A (5 sec)
Internal Resistance	Approx. 6 mΩ
Operating Temperature Range	Discharge: -20℃~60℃ Charge: 0℃~50℃ Storage: -20℃~60℃
Normal Operating Temperature Range	25℃±5℃
Float charging Voltage	13.6 to 13.8 VDC/unit Average at 25℃
Recommended Maximum Charging Current	16.5 A
Equalization and Cycle Service	14.6 to 14.8 VDC/unit Average at 25℃
Self Discharge	RITAR Valve Regulated Lead Acid (VRLA) batteries can be stored for more than 6 months at 25℃. Self-discharge ratio less than 3% per month at 25℃. Please charge batteries before using.
Terminal	Terminal F11/F15
Container Material	A.B.S. UL94-HB, UL94-V0 Optional.

MH28539

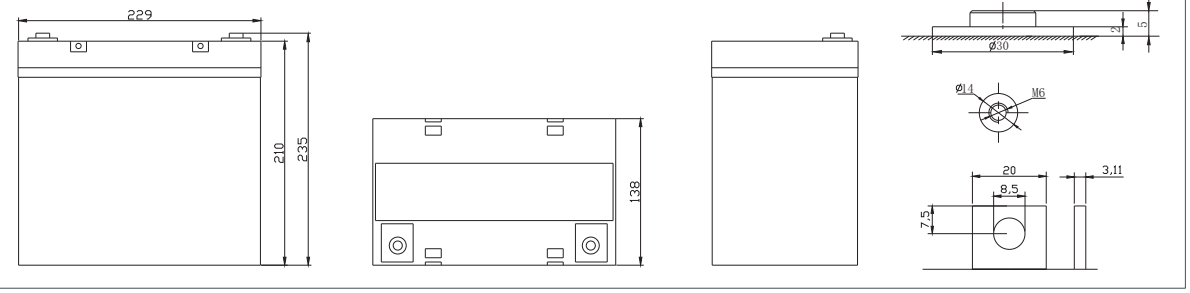
G4M20206-0910-E-16

IQNet THE INTERNATIONAL CERTIFICATION NETWORK
CERTIFICATE
Postcode.:421001 is in conformity with ISO 14001:2004 Standard

IQNet THE INTERNATIONAL CERTIFICATION NETWORK
CERTIFICATE
Postcode.:421001 is in conformity with OHSAS 18001:1999 Standard

Dimensions

Unit: mm Dimension: 229(L) ×138(W) ×235(H)



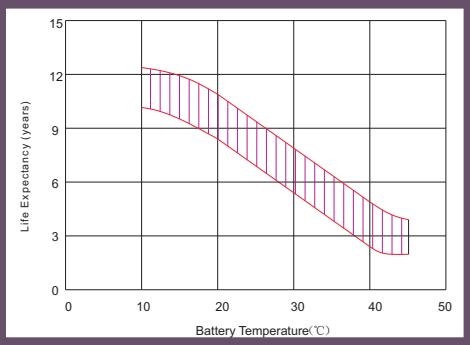
Constant Current Discharge Characteristics: A (25℃)

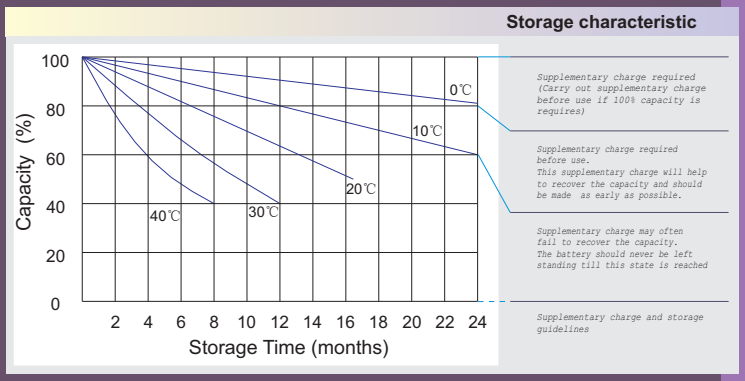
F.V/Time	5MIN	10MIN	15MIN	30MIN	1HR	2HR	3HR	4HR	5HR	8HR	10HR	20HR
9.60V	192.6	141.8	105.8	55.26	34.33	21.20	14.40	11.61	9.64	6.35	5.72	3.03
10.0V	187.0	134.9	103.6	54.55	33.87	20.77	14.14	11.45	9.56	6.33	5.67	2.97
10.2V	181.5	130.1	101.97	53.72	33.55	20.55	14.01	11.34	9.49	6.27	5.61	2.92
10.5V	162.9	120.1	97.09	52.24	33.14	20.28	13.89	11.17	9.41	6.21	5.56	2.86
10.8V	147.1	109.5	89.50	50.51	32.68	20.11	13.73	10.79	9.37	6.19	5.50	2.83
11.1V	125.6	97.9	80.28	48.59	31.90	19.30	13.46	10.63	9.30	6.14	5.44	2.72

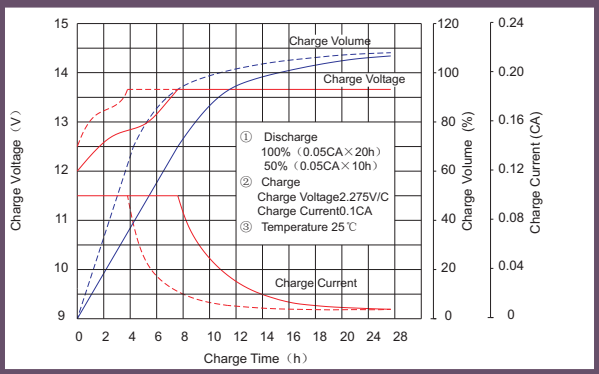
Constant Power Discharge Characteristics: W(25℃)

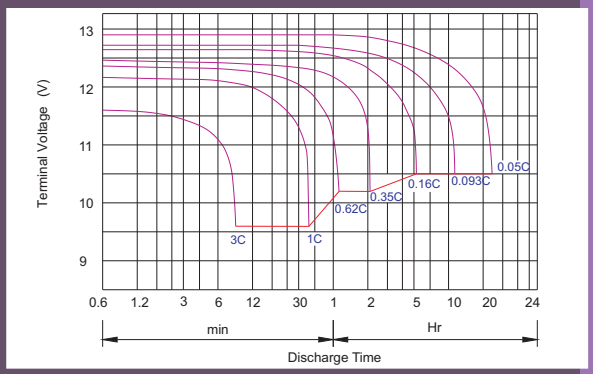
F.V/Time	5MIN	10MIN	15MIN	30MIN	1HR	2HR	3HR	4HR	5HR	8HR	10HR	20HR
9.60V	2032	1510	1153	632.6	397.8	248.4	169.6	139.0	115.5	76.04	68.63	36.50
10.0V	1992	1464	1135	626.0	394.2	245.3	167.1	137.1	114.5	75.75	68.09	35.86
10.2V	1969	1425	1122	620.6	391.9	243.6	166.3	135.8	113.8	75.18	67.49	35.20
10.5V	1792	1327	1070	607.9	389.4	240.5	165.0	133.9	112.9	74.54	66.82	34.54
10.8V	1633	1223	989.0	593.5	384.4	238.7	163.1	129.4	112.3	74.22	66.16	34.20
11.1V	1434	1106	890.3	577.2	378.6	229.8	160.4	127.6	111.9	73.70	65.44	32.98

All mentioned values are average values (Tolerance ±2%).









Capacity Factors With Different Temperature

Battery Type		-20℃	-10℃	0℃	5℃	10℃	20℃	25℃	30℃	40℃	45℃
GEL Battery	6V&12V	50%	70%	83%	85%	90%	98%	100%	102%	104%	105%
	2V	60%	75%	85%	88%	92%	99%	100%	103%	105%	106%
AGM Battery	6V&12V	46%	66%	76%	83%	90%	98%	100%	103%	107%	109%
	2V	55%	70%	80%	85%	92%	99%	100%	104%	108%	110%

Discharge Current VS. Discharge Voltage

Final Discharge Voltage V/cell	1.75V	1.70V	1.60V
Discharge Current (A)	（A）≤0.2C	0.2C＜（A）＜1.0C	（A）≥1.0C

Charge the batteries at least once every six months, if they are stored at 25℃.

Charging Method:

Constant Voltage	-0.2Cx2h+14.4-14.7Vx24h,Max. Current 0.3C
Constant Current	-0.2Cx2h+0.1Cx12h
Fast	-0.2Cx2h+0.3Cx4h

Bolt	M5	M6	M8
Terminal	F3 F4 F13 F18 T25 T26	F8 F11 F12-1 F15	F5 F9 F10 F12 F14 F16
Torque	6~7N-m	8~10N-m	10~12N-m

Maintenance & Cautions

Float Service:

※ Every month, recommend inspection every battery voltage.

※ Every three months, recommend equalization charge for one time.

Equalization charge method:

Discharge: 100% rate capacity discharge.

Charge: Max. current 0.3CA, constant voltage 14.4-14.7V charge 24h.

※ Effect of temperature on float charge voltage: -3mV/℃/Cell.

※ Length of service life will be directly affected by the number of discharge cycles, depth of discharge, ambient temperature and charging voltage.

SHENZHEN RITAR POWER CO.,LTD.
URL:www.ritarpower.com
Address: Rm405,Tower C, Huahan Building,Langshan Rd16, Nanshan District, ShenZhen, 518057, China
Tel:+86-755-33981668 Fax:86-755-8347-5180

2015- Version 0

RA12-100 (12V100Ah)

RA series is a general purpose battery with 10 years design life in float service. It meets with IEC, JIS and BS standards .With up-dated AGM valve regulated technology and high purity raw materials, the RA series battery maintains high consistency for better performance and reliable standby service life. It is suitable for UPS/EPS, medical equipment, emergency light and security system applications.

RITAR®

Specification

Cells Per Unit	6
Voltage Per Unit	12
Capacity	100Ah@10hr-rate to 1.80V per cell @25℃
Weight	Approx.30.0 Kg(Tolerance ±2%)
Max. Discharge Current	1000A (5 sec)
Internal Resistance	Approx. 5mΩ
Operating Temperature Range	Discharge: -20℃~60℃ Charge: 0℃~50℃ Storage: -20℃~60℃
Normal Operating Temperature Range	25℃±5℃
Float charging Voltage	13.6 to 13.8 VDC/unit Average at 25℃
Recommended Maximum Charging Current Limit	30 A
Equalization and Cycle Service	14.6 to 14.8 VDC/unit Average at 25℃
Self Discharge	RITAR Valve Regulated Lead Acid (VRLA) batteries can be stored for more than 6 months at 25℃. Self-discharge ratio less than 3% per month at 25℃. Please charge batteries before using.
Terminal	Terminal F5/F12
Container Material	A.B.S. UL94-HB, UL94-V0 Optional.

MH28539

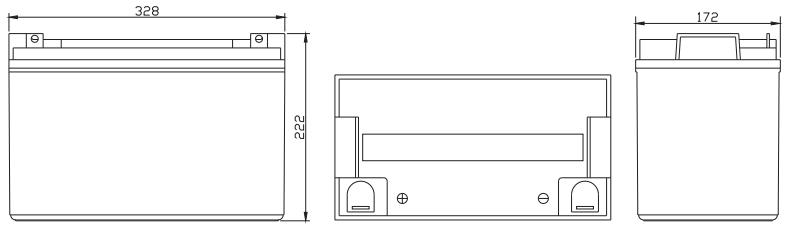
G4M20206-0910-E-16

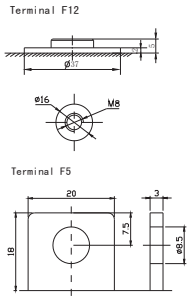
IQNet CERTIFICATE Postcode:421001 is in conformity with ISO 14001:2004 Standard

IQNet CERTIFICATE Postcode:421001 is in conformity with OHSAS 18001:1999 Standard

Dimensions

Unit: mm Dimension: 328(L) ×172(W) ×222 (H)





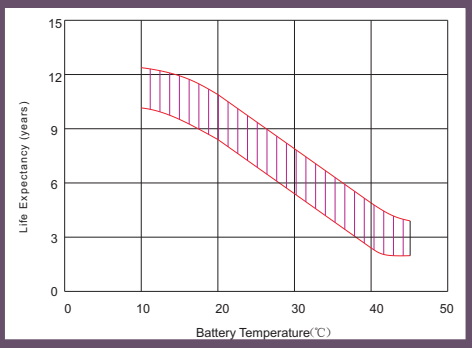
Constant Current Discharge Characteristics: A (25℃)

F.V/Time	5MIN	10MIN	15MIN	30MIN	1HR	2HR	3HR	4HR	5HR	8HR	10HR	20HR
9.60V	320.7	226.9	181.4	112.7	65.00	38.89	26.88	22.03	18.03	12.42	10.50	5.78
10.0V	311.4	215.8	177.7	110.8	64.70	38.60	26.78	21.93	17.93	12.32	10.40	5.67
10.2V	302.2	208.2	174.9	109.8	64.10	38.31	26.57	21.83	17.82	12.22	10.30	5.57
10.5V	271.3	192.1	166.5	107.1	63.50	38.02	26.47	21.62	17.61	12.12	10.20	5.46
10.8V	244.9	175.2	153.5	102.4	62.00	37.33	25.75	21.11	17.29	11.92	10.10	5.36
11.1V	209.1	156.6	137.7	95.91	58.90	35.68	24.62	20.09	16.55	11.41	9.80	5.04

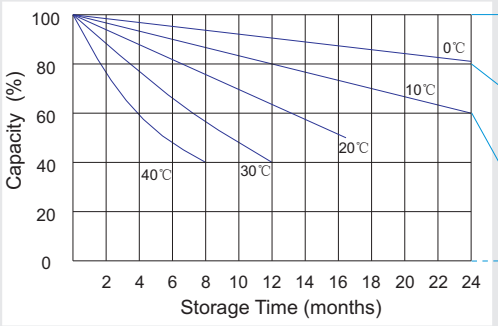
Constant Power Discharge Characteristics: W(25℃)

F.V/Time	5MIN	10MIN	15MIN	30MIN	1HR	2HR	3HR	4HR	5HR	8HR	10HR	20HR
9.60V	3317	2416	1996	1284	751.1	458.4	319.9	262.6	215.1	148.3	125.5	69.26
10.0V	3251	2342	1964	1269	749.3	456.0	320.0	262.3	214.6	147.6	124.7	68.06
10.2V	3214	2280	1941	1260	743.5	453.3	318.6	261.7	213.9	146.6	123.6	66.80
10.5V	2926	2123	1852	1230	736.8	450.0	317.4	259.3	211.3	145.4	122.4	65.54
10.8V	2665	1957	1712	1179	723.2	444.2	308.7	253.4	207.5	143.0	121.2	64.28
11.1V	2341	1770	1541	1108	692.3	427.7	295.4	241.1	198.6	136.9	117.6	60.50

All mentioned values are average values (Tolerance ±2%).



Storage characteristic

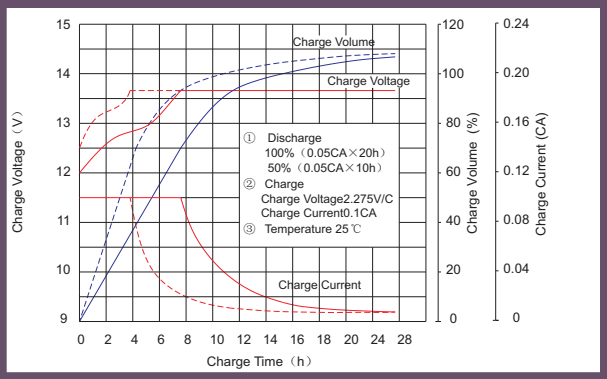


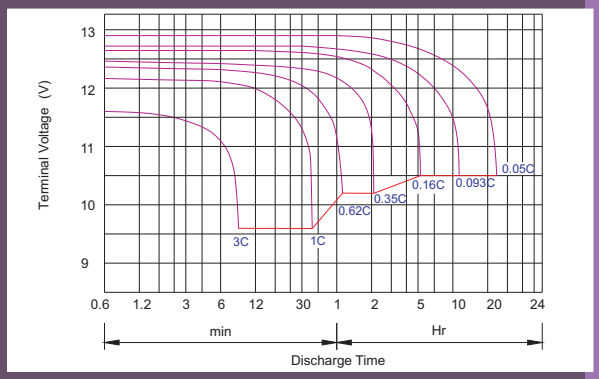
Supplementary charge required (Carry out supplementary charge before use if 100% capacity is requires)

Supplementary charge required before use. This supplementary charge will help to recover the capacity and should be made as early as possible.

Supplementary charge may often fail to recover the capacity. The battery should never be left standing till this state is reached

Supplementary charge and storage guidelines





Capacity Factors With Different Temperature

Battery Type		-20℃	-10℃	0℃	5℃	10℃	20℃	25℃	30℃	40℃	45℃
GEL Battery	6V&12V	50%	70%	83%	85%	90%	98%	100%	102%	104%	105%
	2V	60%	75%	85%	88%	92%	99%	100%	103%	105%	106%
AGM Battery	6V&12V	46%	66%	76%	83%	90%	98%	100%	103%	107%	109%
	2V	55%	70%	80%	85%	92%	99%	100%	104%	108%	110%

Discharge Current VS. Discharge Voltage

Final Discharge Voltage V/cell	1.75V	1.70V	1.60V
Discharge Current (A)	（A）≤0.2C	0.2C＜（A）＜1.0C	（A）≥1.0C

Charge the batteries at least once every six months, if they are stored at 25℃.

Charging Method:

Constant Voltage	-0.2Cx2h+14.4-14.7Vx24h,Max. Current 0.3C
Constant Current	-0.2Cx2h+0.1Cx12h
Fast	-0.2Cx2h+0.3Cx4h

Bolt	M5	M6	M8
Terminal	F3 F4 F13 F18 T25 T26	F8 F11 F12-1 F15	F5 F9 F10 F12 F14 F16
Torque	6~7N-m	8~10N-m	10~12N-m

Maintenance & Cautions

Float Service:

※ Every month, recommend inspection every battery voltage.

※ Every three months, recommend equalization charge for one time.

Equalization charge method:

Discharge: 100% rate capacity discharge.

Charge: Max. current 0.3CA, constant voltage 14.4-14.7V charge 24h.

※ Effect of temperature on float charge voltage: -3mV/℃/Cell.

※ Length of service life will be directly affected by the number of discharge cycles, depth of discharge, ambient temperature and charging voltage.

SHENZHEN RITAR POWER CO.,LTD.
URL:www.ritarpower.com
Address: Rm405,Tower C, Huahan Building,Langshan Rd16, Nanshan District, ShenZhen, 518057, China
Tel:+86-755-33981668 Fax:86-755-8347-5180

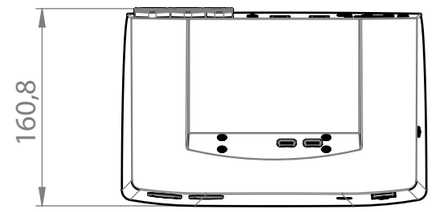
2015-Version 0

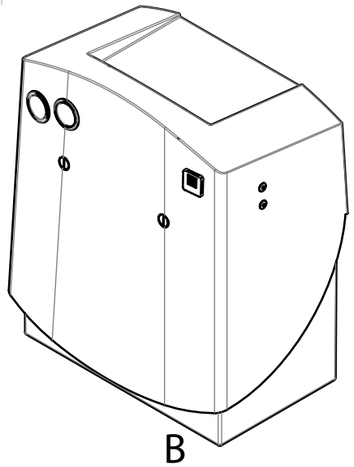
H Technical drawings Battery Box

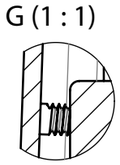
In this section the technical drawings of the assembled battery boxes and its parts are provided. An overview of the parts can be found, which is used for the cost estimation of the redesign (appendix L).

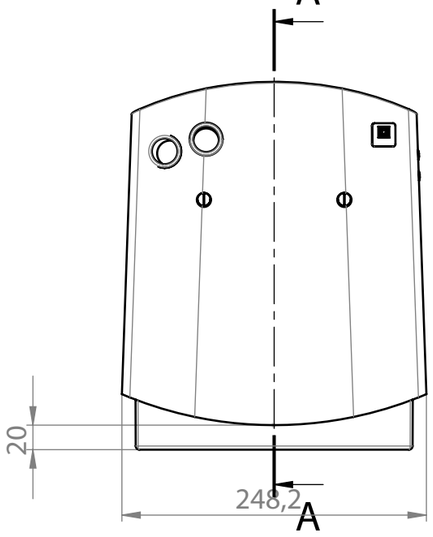
The technical drawings are divided in three parts, indicated with a yellow bar (see the right page). The first part is the regular battery box and the parts that are only used for this system size. The second part is the same, but for the large battery box. The last parts are some parts that are used in both battery boxes.

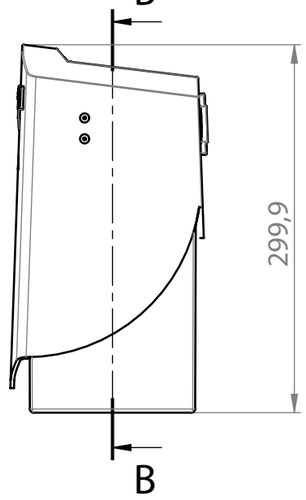
Standard parts (sockets, screws, etcetera) are only included in the CAD model. They cannot be found in these drawings.

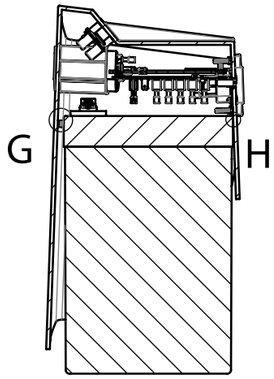




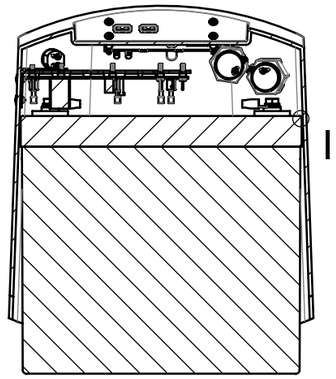




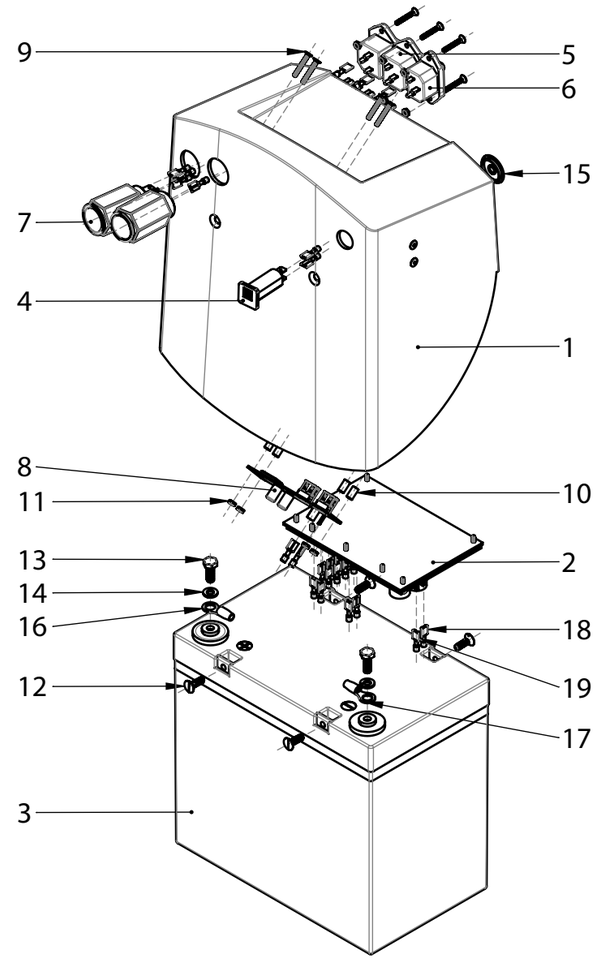




A-A



B-B



Item No.	Qty.	Name	Material	Remarks
19	15	6.3 Faston B	Multiple	Imported
18	15	6.3 Faston	Multiple	Imported
17	1	M8 Ring Terminal B	Multiple	Bought in local shops PP
16	1	M8 Ring Terminal	Multiple	Bought in local shops PP
15	1	20.5 End Cap	PE	Imported (See Appendix)
14	2	M6 Washer s	Stainless Steel	Included in Battery (PRT1001)
13	2	M6x16	Stainless Steel	Included in Battery (PRT1001)
12	4	M5x16 CS	Galvanized steel	Bought in local shops PP
11	10	M3 Nut	Galvanized steel	Bought in local shops PP
10	4	M3 Spacer 10	Galvanized steel	Bought in local shops PP
9	10	M3x20 CS	Galvanized steel	Bought in local shops PP
8	1	PRT-0006-PCB-USB	Multiple	Imported
7	2	PRT-0004-C-Socket	Aluminium	Imported
6	1	PRT-0003-IEC-M	Multiple	Imported
5	2	PRT-0002-IEC-F	Multiple	Imported
4	1	PRT-0001-CircuitBreaker	Multiple	Imported
3	1	PRT-1001-Ritar55Ah	Multiple	Imported
2	1	SUB-0100-PowerBoard	Multiple	Imported | Assembled in SA
1	1	SUB-1100-Box-R	Multiple	Produced & Assembled in SA

Wiring is excluded in drawing & part list

scale 1:5		date 11-4-2017	remarks Solar Home System - Regular
units mm	weight grams		
author Kane JA		group -	

name

Regular SHS

20 | 21

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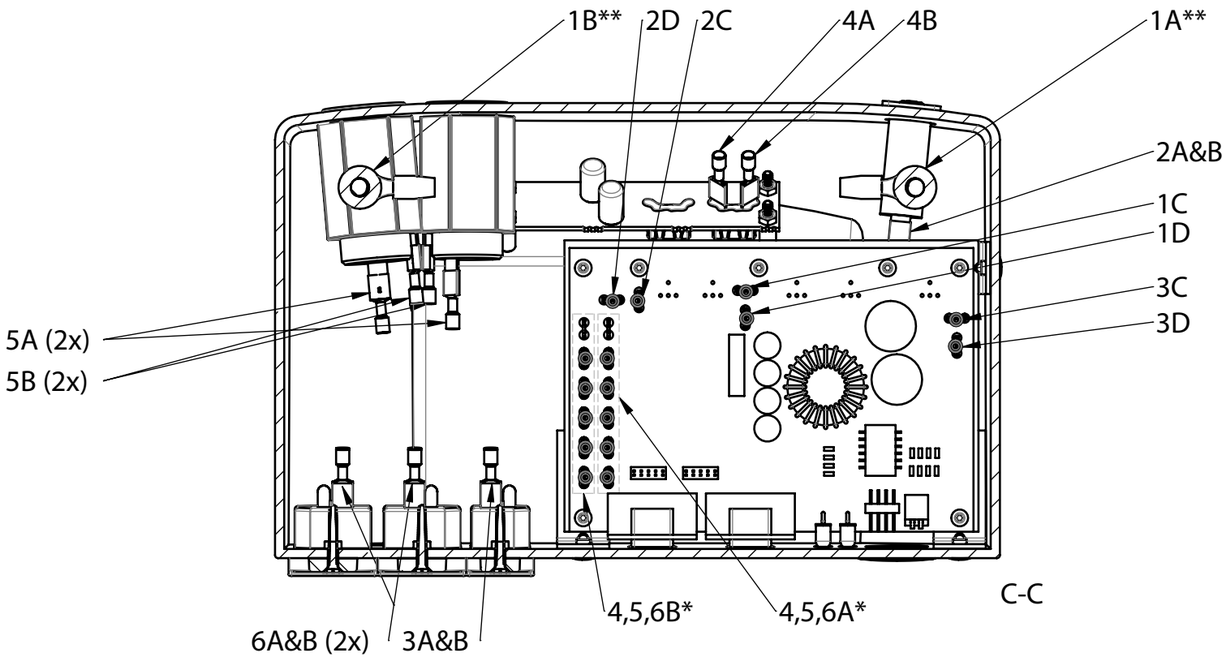
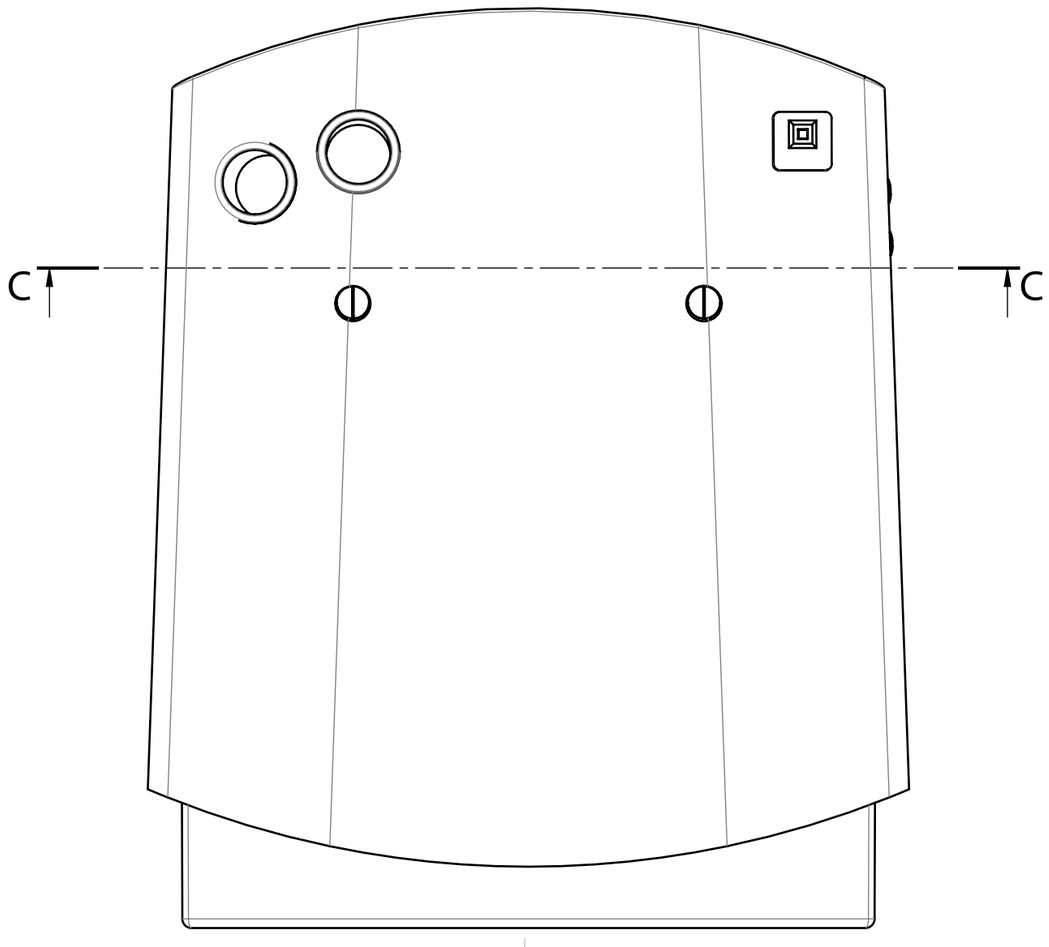
format A3

drawing no. ASM-1000





Electronics:

1 = Battery
2 = Circuit Breaker
3 = Solar Panel
4 = USB
5 = Cigarette sockets
6 = Lampkit/Expansion Battery

Connect all components (A&B) topowerboard (C&D)

* Make horizontal pairs. Sequence 4,5 and 6 is irrelevant
** Connected to the battery

scale 1:2		date 11-4-2017	remarks Solar Home System - Regular - Electronics Wiring
units mm	weight grams		
author Kane JA		group -	

name

Regular SHS

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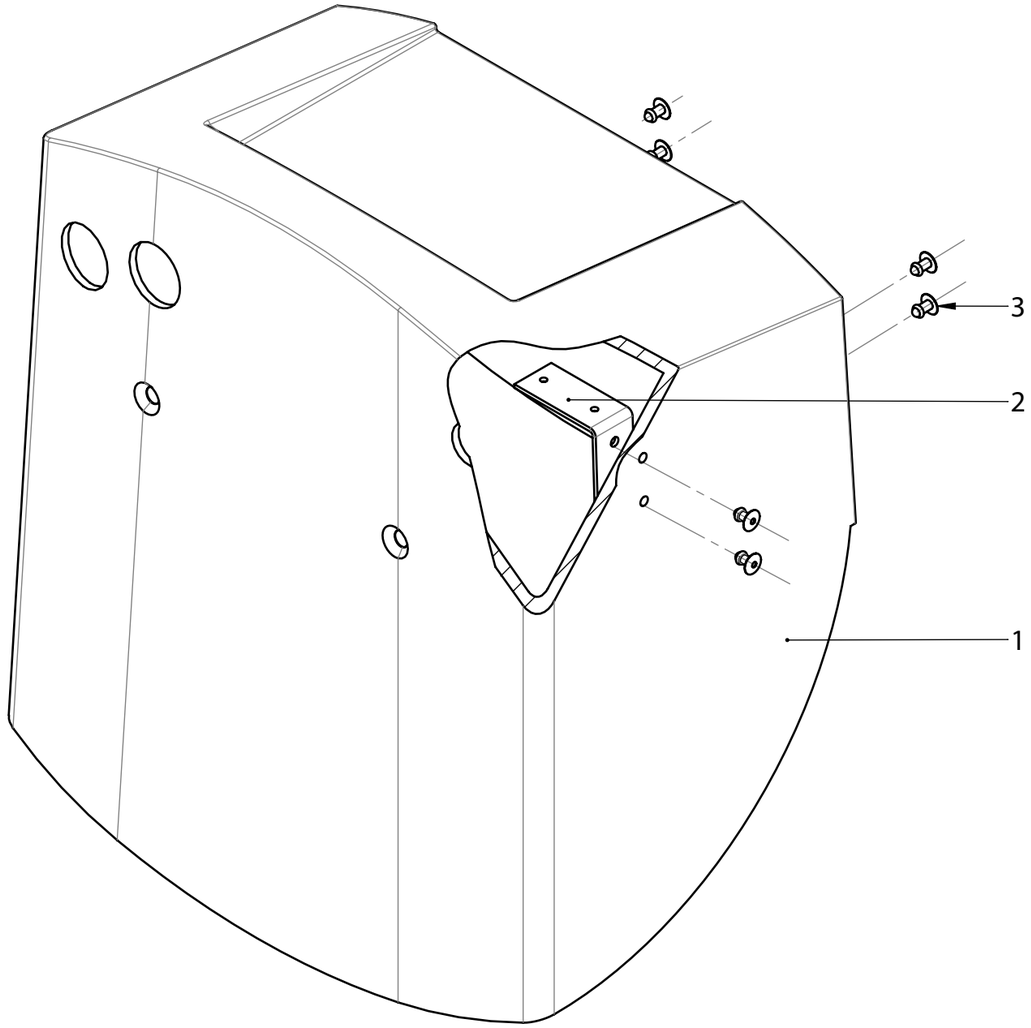
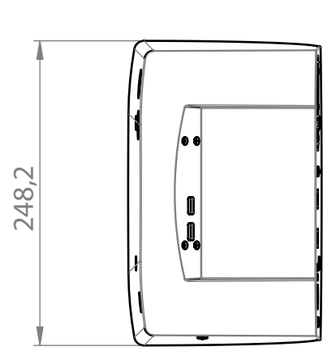
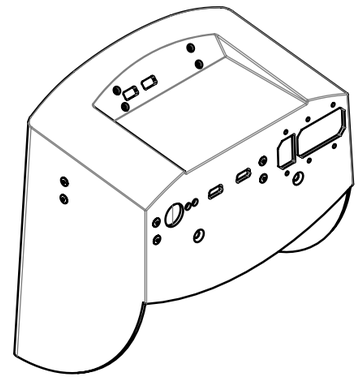
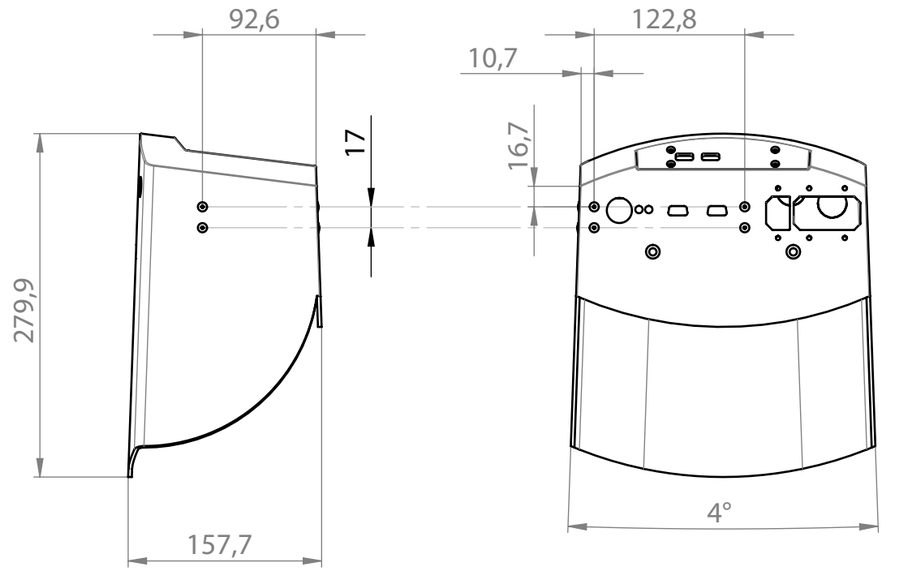
format	drawing no.
A3	ASM-1000



Scale 1:2







Item No.	Qty.	Name	Material	Remarks / Drawing. No.
3	6	3,2x8 Blind Rivet	Aluminium	Bough in local shops PP
2	3	PRT-0005-BracketPCB	Galvanized steel	Raw material PP - Produced in SA
1	1	PRT-1101-Box-R	Glassfiber	Raw material PP - Produced in SA

scale 1:5		date 11-4-2017	remarks Solar Home Systen - Regular
units mm	weight grams		
author Kane J A		group -	

name

Regular SHS

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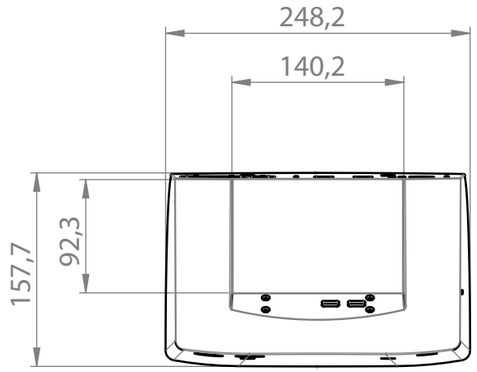
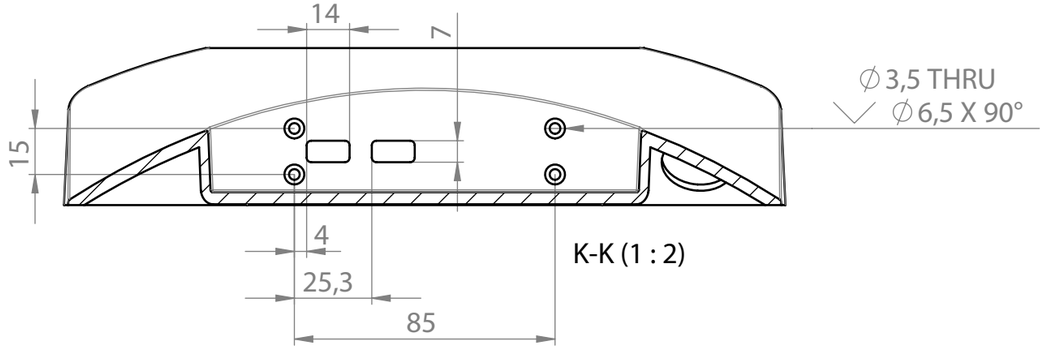
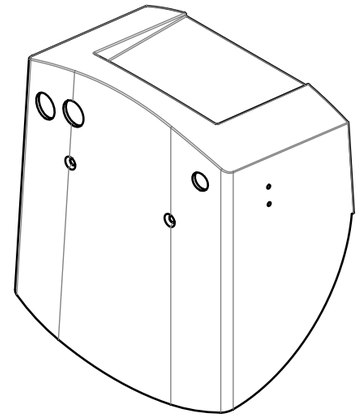
format A3

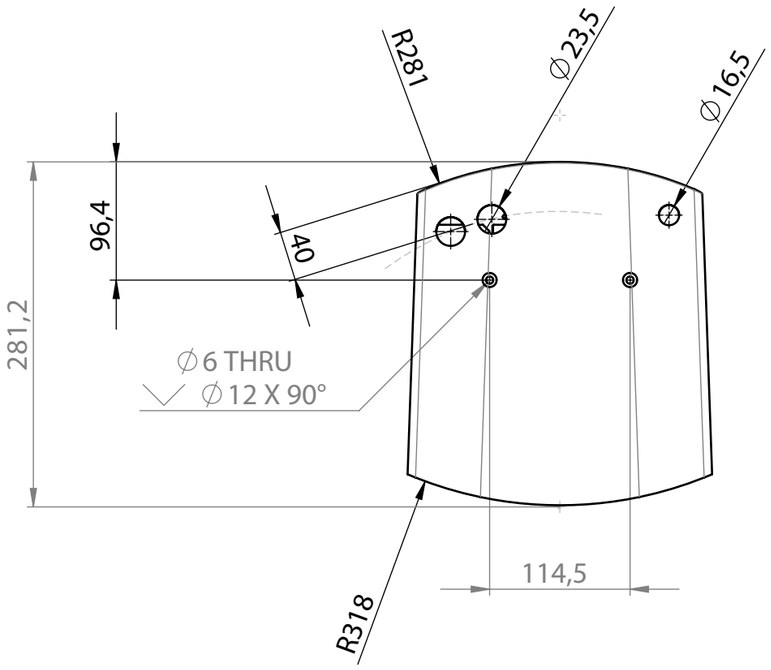
drawing no. SUB-1100

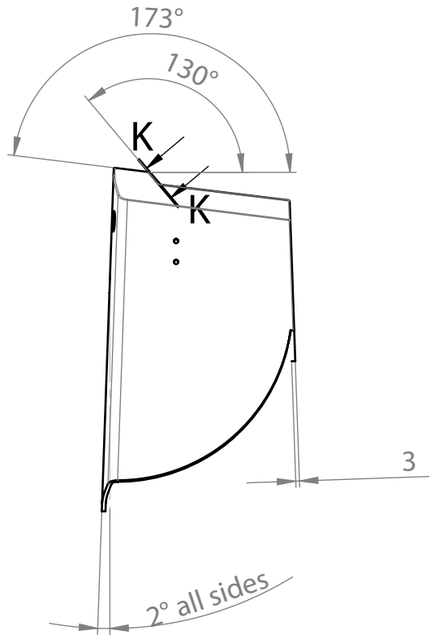
Exact dimensions determined by mould: available at Kamworks
For exact hole distaces (steel) templates of the front, back, left side and USB will be made

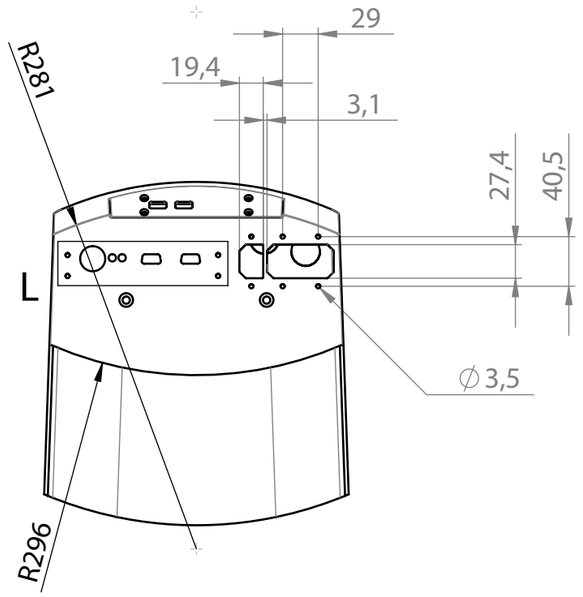


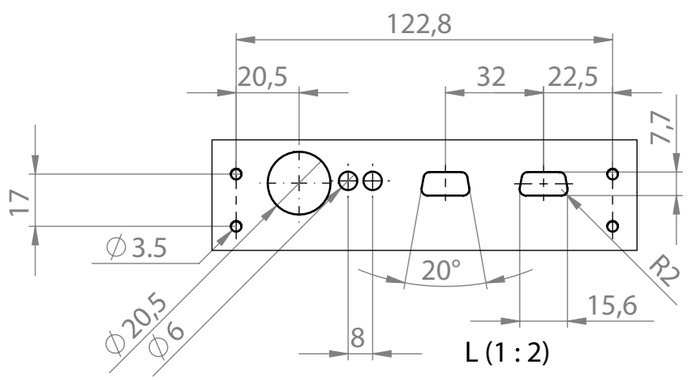












scale 1:5		date 11-4-2017	remarks Solar Home Systen - Regular
units mm	weight grams		
author Kane J A		group -	

name

Regular SHS

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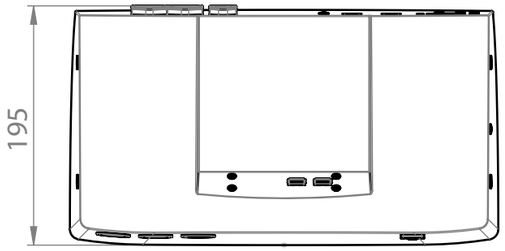
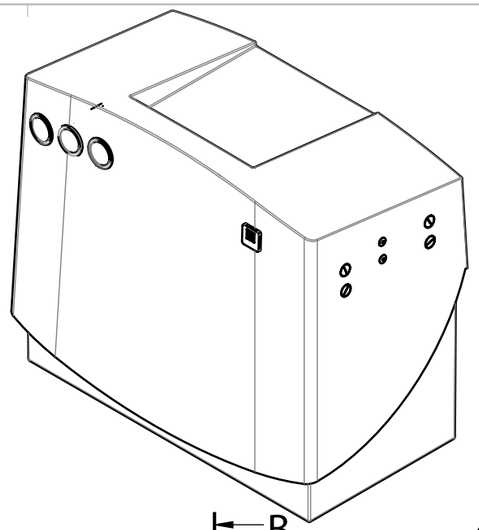
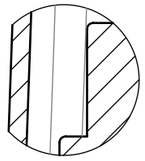
format	drawing no.
A3	PRT-1101







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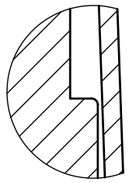
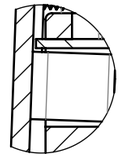
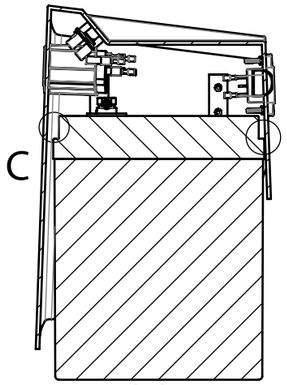
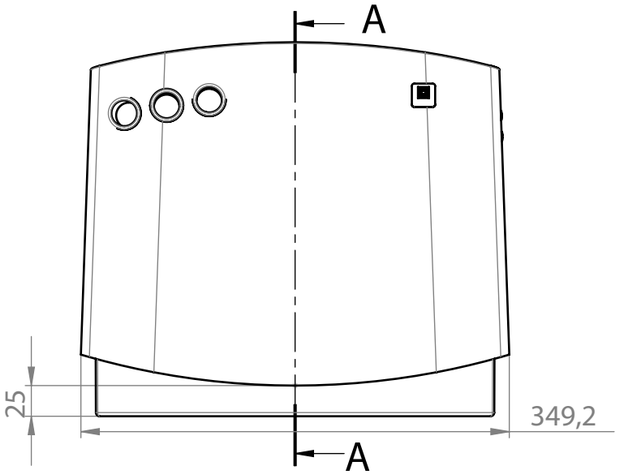


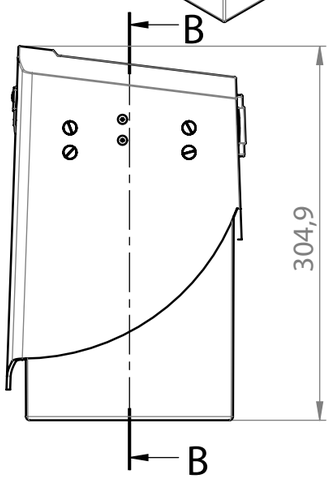
D (1 : 1)

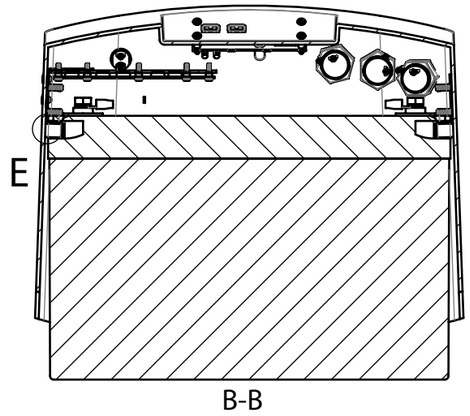


E (1 : 1)









Item No.	Qty.	Name	Material	Remarks / Drawing. No.
20	17	6.3 Faston B	Multiple	Imported
19	17	6.3 Faston	Multiple	Imported
18	1	M8 Ring Terminal B	Multiple	Bought in local shops PP
17	1	M8 Ring Terminal	Multiple	Bought in local shops PP
16	1	20.5 End Cap	PE	Imported (See Appendix)
15	2	M8 Washer s	Stainless Steel	Included in Battery (PRT2001)
14	2	M8x20	Stainless Steel	Included in Battery (PRT2001)
13	8	M5x16 CS	Galvanized steel	Bought in local shops PP
12	10	M3 Nut	Galvanized steel	Bought in local shops PP
11	4	M3 Spacer 10	Galvanized steel	Bought in local shops PP
10	10	M3x20 CS	Galvanized steel	Bought in local shops PP
9	1	PRT-0006-PCB-USB	Multiple	Imported
8	3	PRT-0004-C-Socket	Aluminium	Imported
7	1	PRT-0003-IEC-M	Multiple	Imported
6	2	PRT-0002-IEC-F	Multiple	Imported
5	1	PRT-0001-CircuitBreaker	Multiple	Imported
4	2	PRT-2002-BracketBattery	Galvanized Steel	Produced & Assembled in SA
3	1	PRT-2001-Ritar100Ah	Multiple	Imported
2	1	SUB-0100-PowerBoard	Multiple	Imported | Assembled in SA
1	1	SUB-2100-Box-L	Multiple	Produced & Assembled in SA

scale 1:5		date 11-4-2017	remarks Solar Home System - Large
units mm	weight 12927 grams		
author Kane JA		group -	

name

Large SHS

24 | 25

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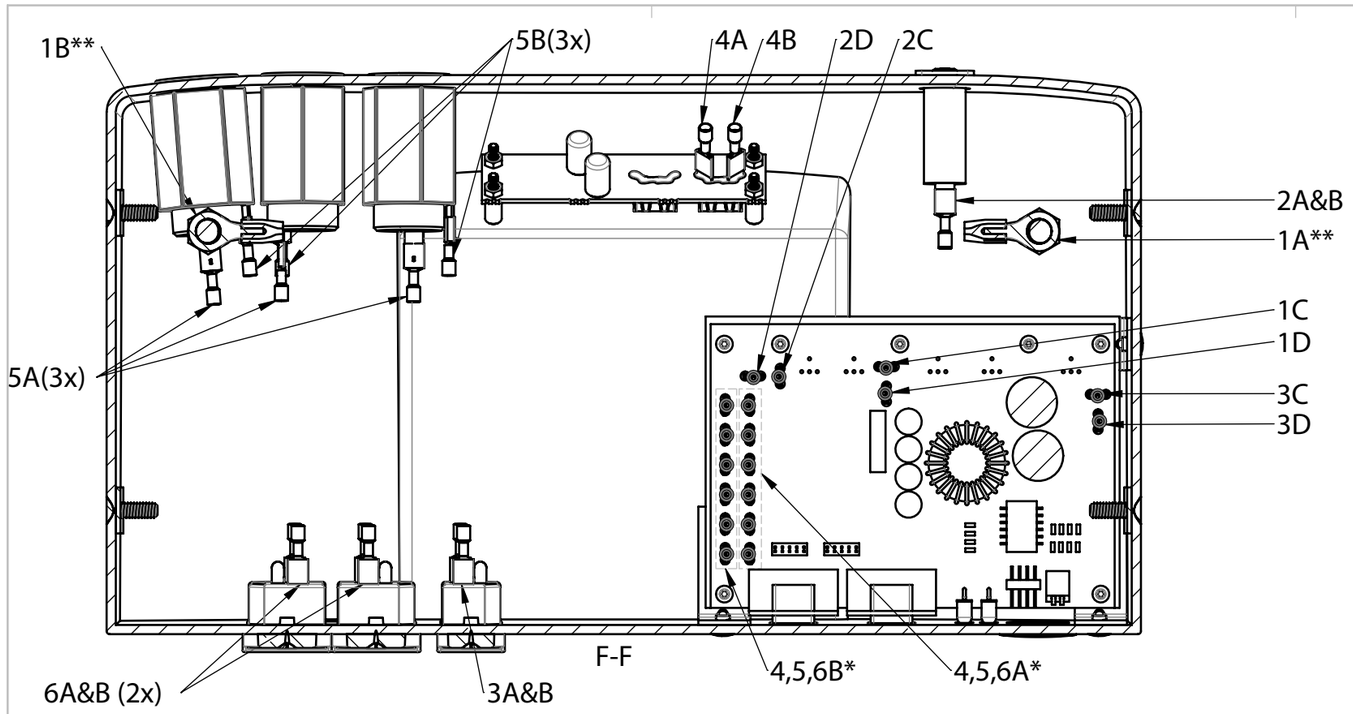
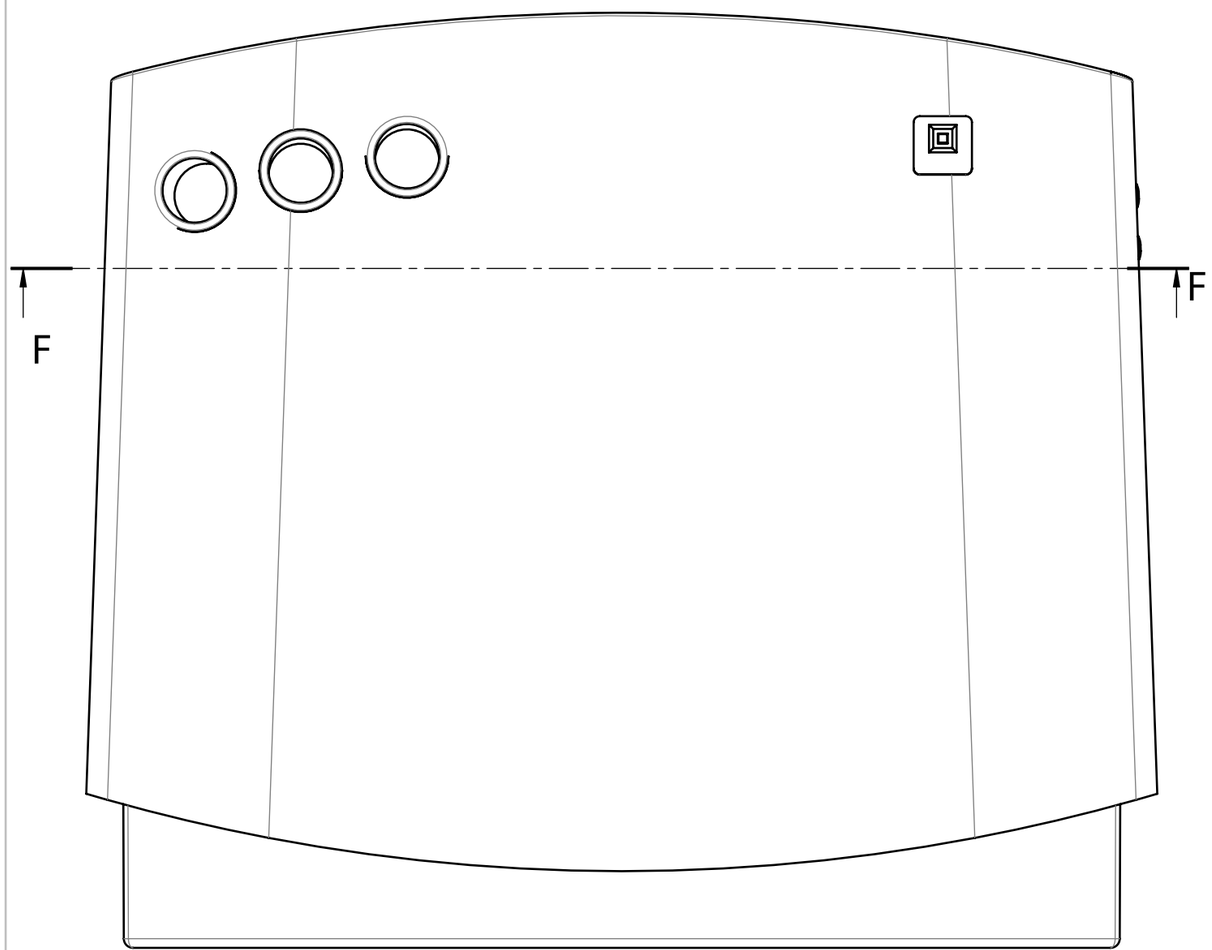
format A3

drawing no. ASM-2000





Electronics:

1 = Battery
2 = Circuit Breaker
3 = Solar Panel
4 = USB
5 = Cigarette sockets
6 = Lampkit/Expansion Battery

Connect all components (A&B) topowerboard (C&D)

* Make horizontal pairs. Sequence 4,5 and 6 is irrelevant
** Connected to the battery

scale 1:2		date 11-4-2017	remarks Solar Home System - Large - Electronics Wiring
units mm	weight 12927 grams		
author Kane JA		group -	

name

Large SHS

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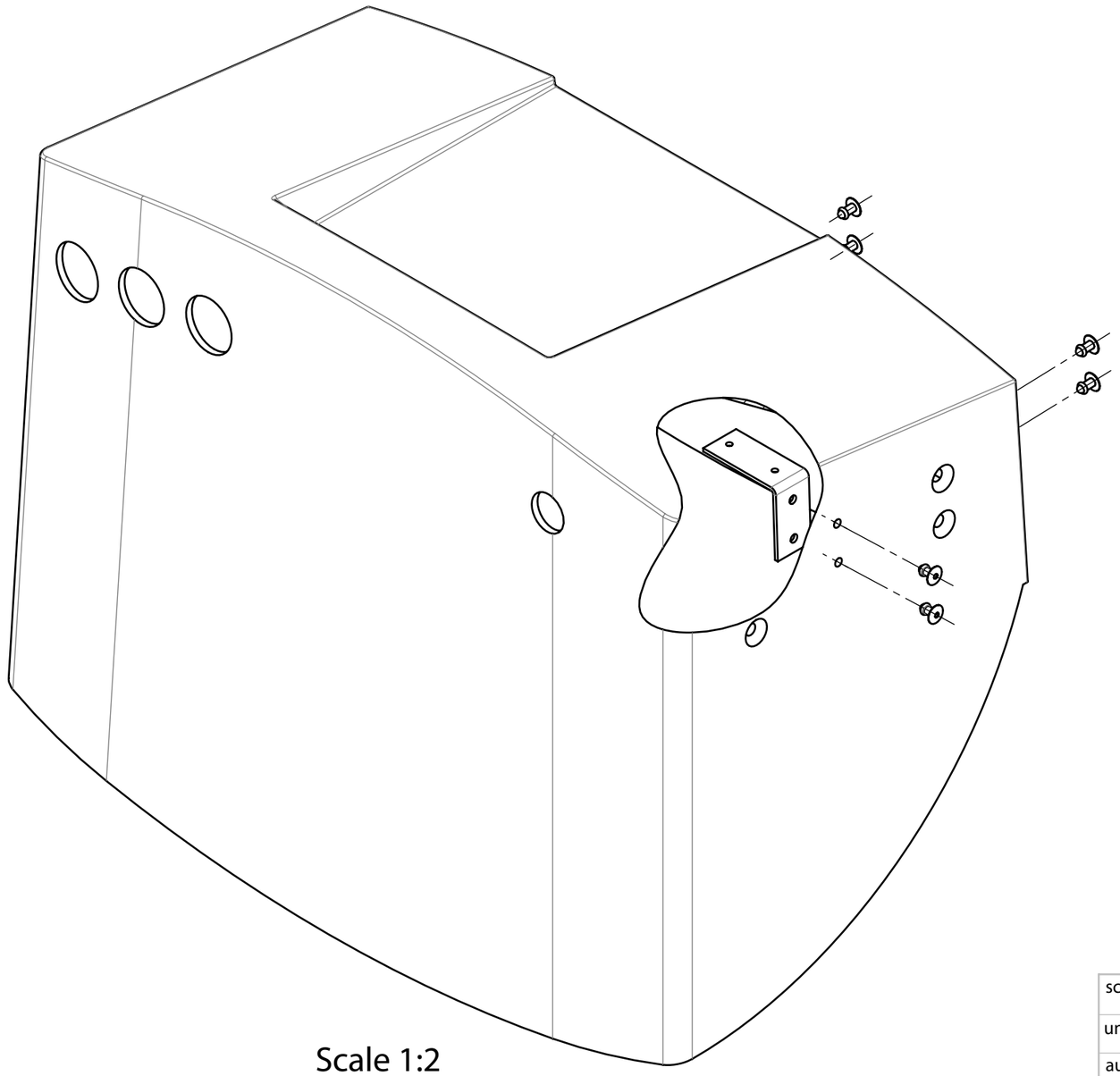
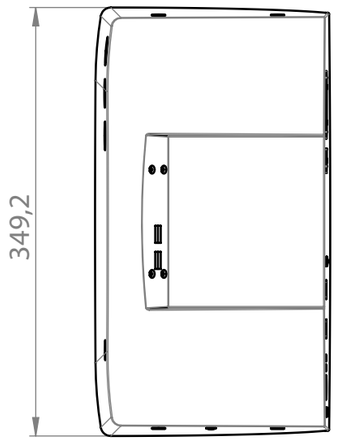
Industrial Design Engineering

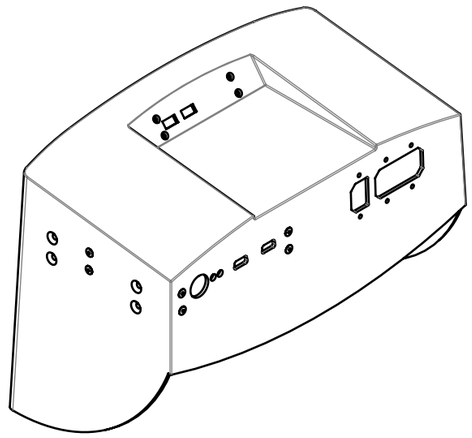
format A3

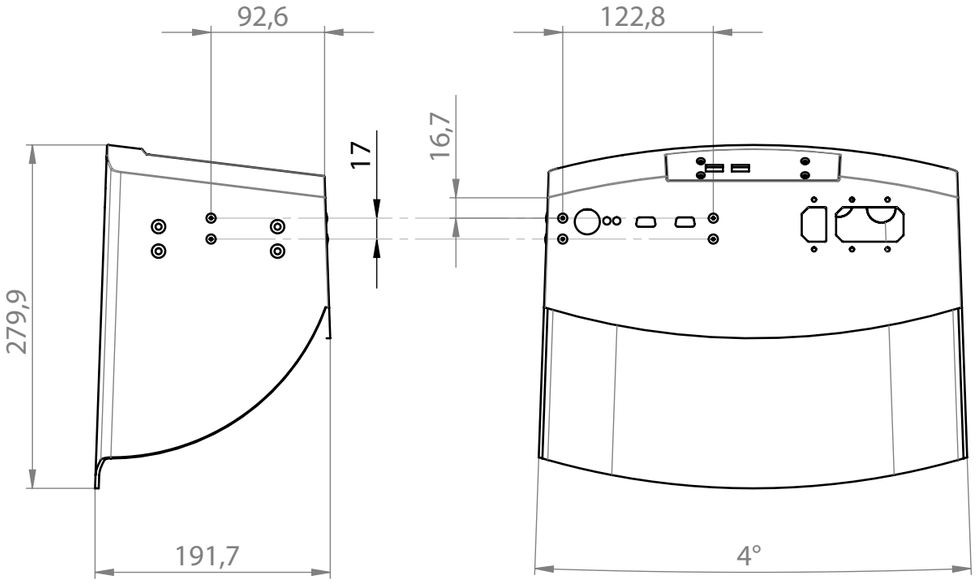
drawing no. ASM-2000



Scale 1:2







scale	1:5		date	11-4-2017	remarks	Solar Home System - Large
units	mm	weight	797	grams		
author	Kane JA		group	-		

name

Large SHS

26 | 27

Item No.	Qty.	Name	Material	Remarks / Drawing. No.
3	6	3,2x8 Blind Rivet	Aluminium	Bough in local shops PP
2	3	PRT-0005-BracketPCB	Galvanized steel	Raw material PP - Produced in SA
1	1	PRT-2101-Box-L	Glassfiber	Raw material PP - Produced in SA

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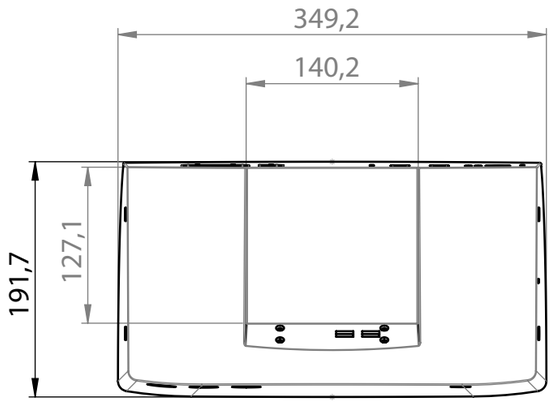
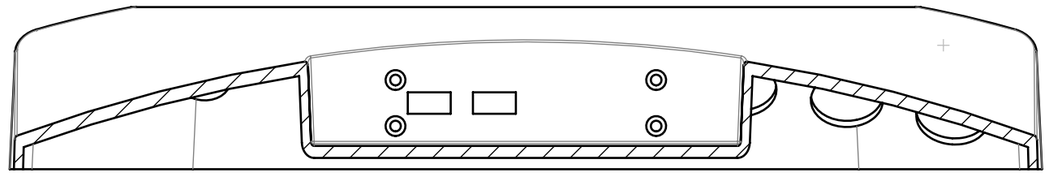
Industrial Design Engineering

format A3

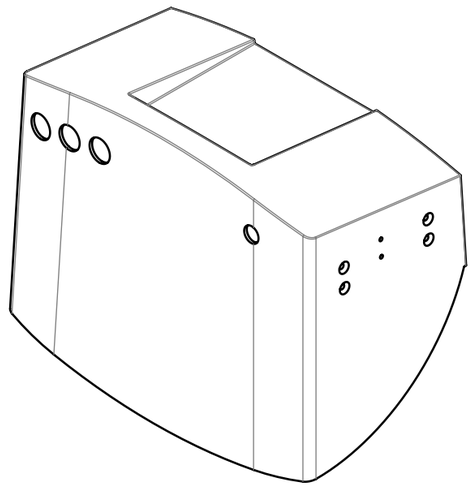
drawing no. SUB-2100

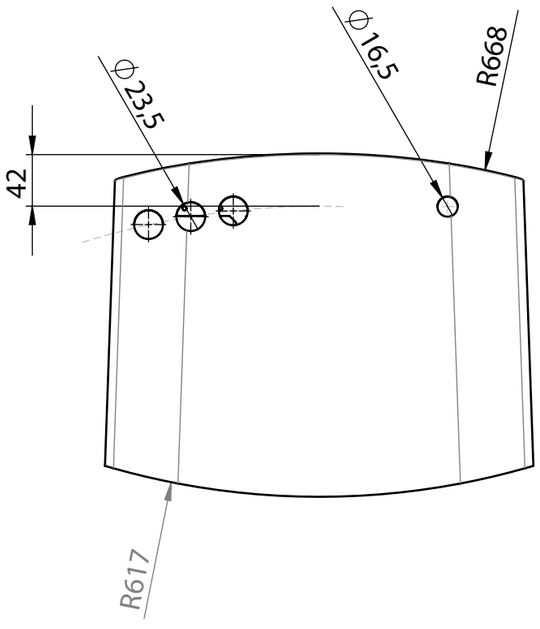
Exact dimensions determined by mould: available at Kamworks
For exact hole distaces (steel) templates of the front, back, left side and USB will be made

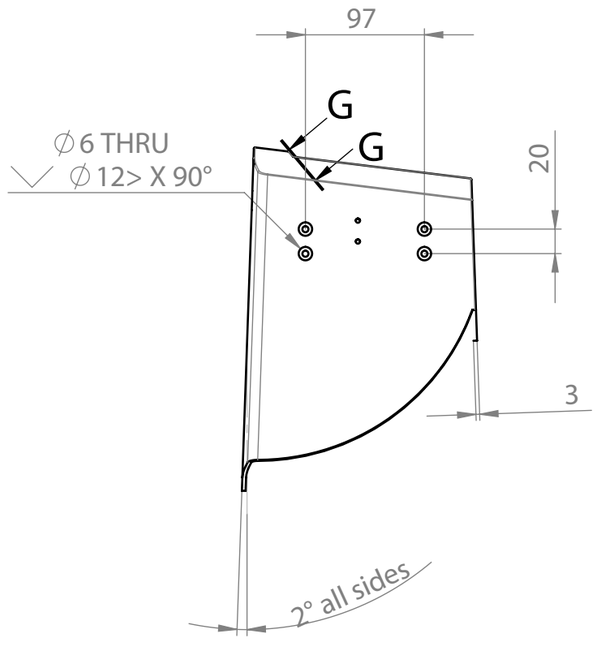


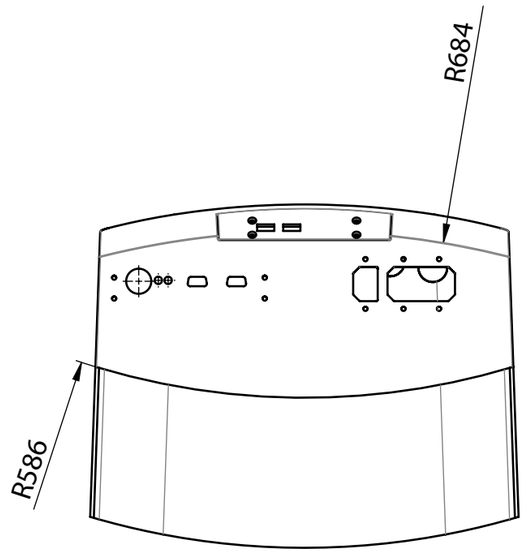


G-G (1 : 2)









scale 1:5		date 11-4-2017	remarks Solar Home System - Large
units mm	weight grams		
author Kane JA		group -	

name

Large SHS

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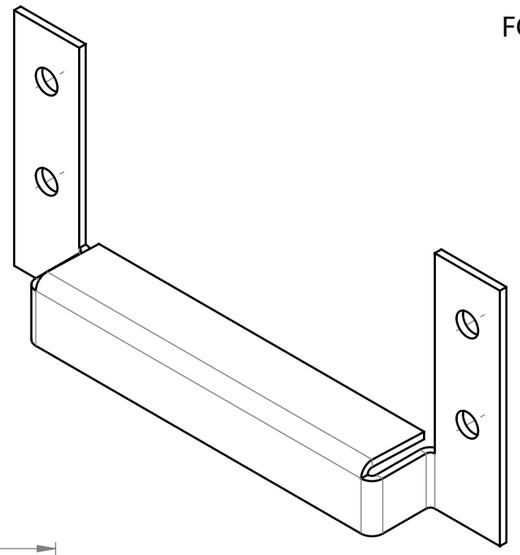
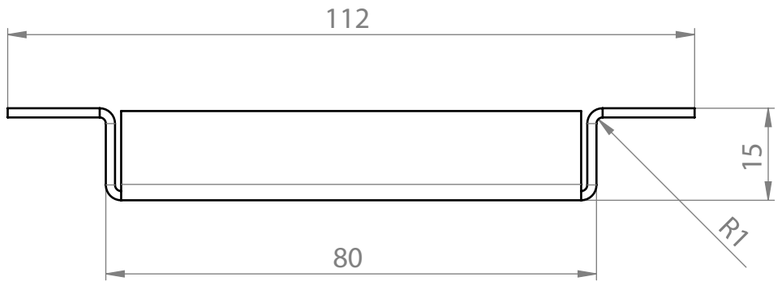
Industrial Design Engineering

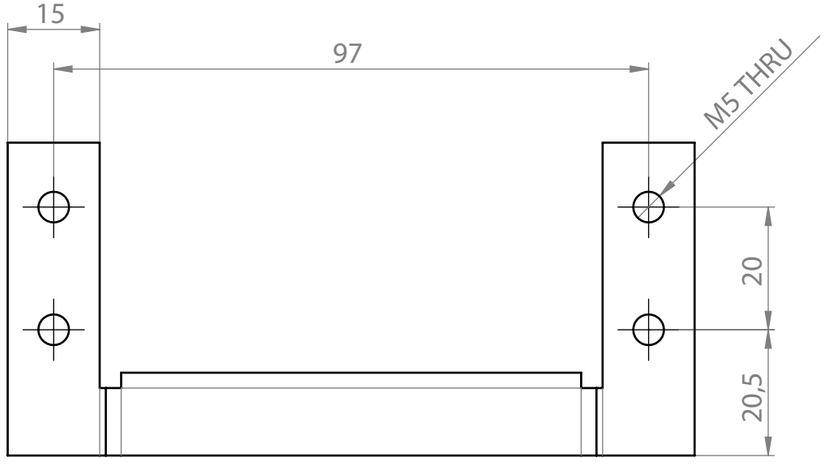
format A3

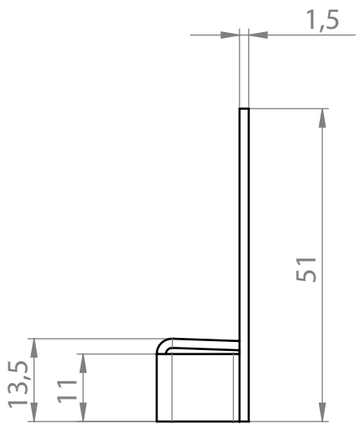
drawing no. PRT-2101

FOLD









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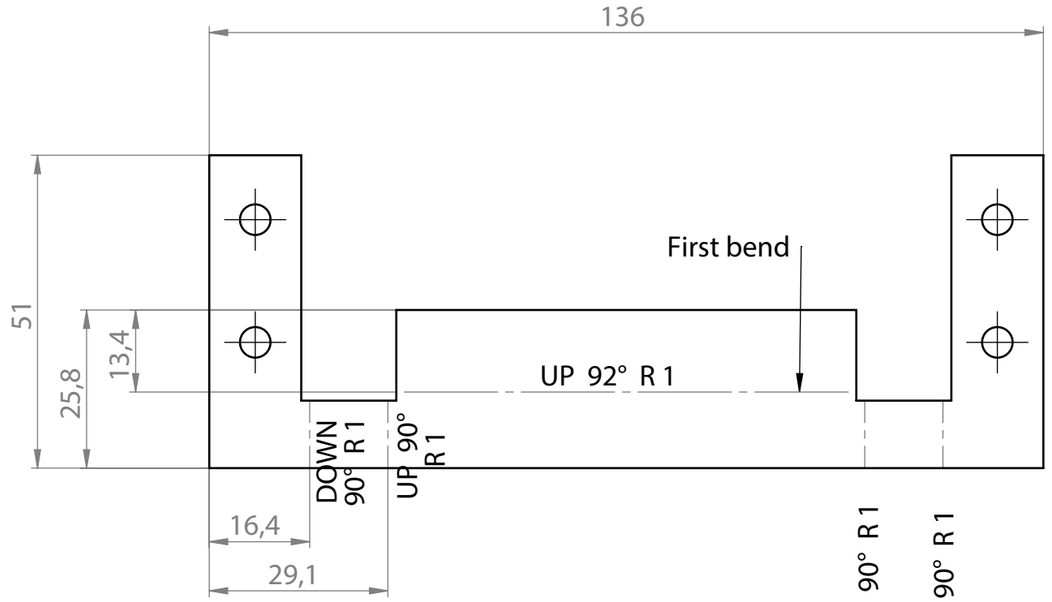


scale 1:1		date 11-4-2017	remarks Solar Home System - Large
units mm	weight	44 grams	
author Kane JA		group -	

name

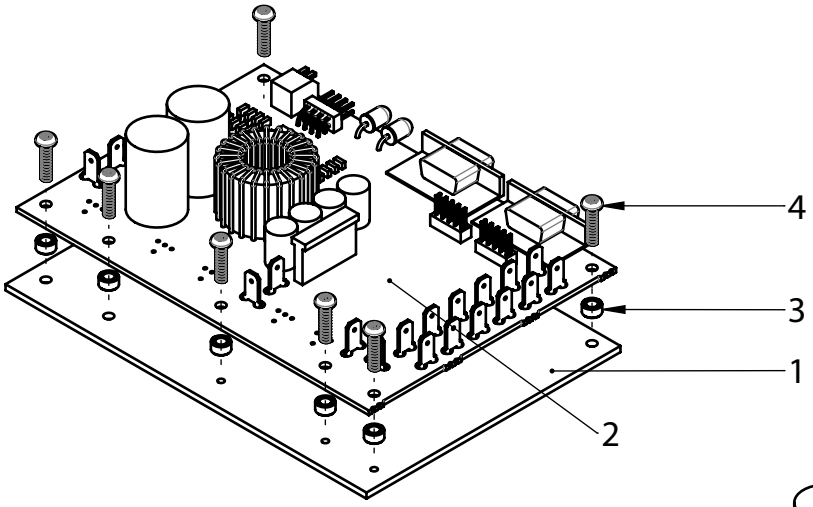
Large SHS

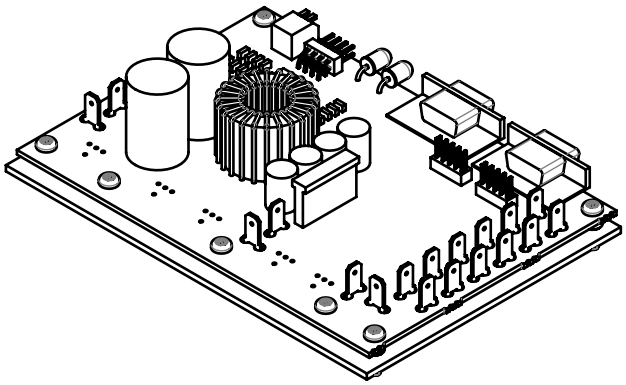
28 | 29

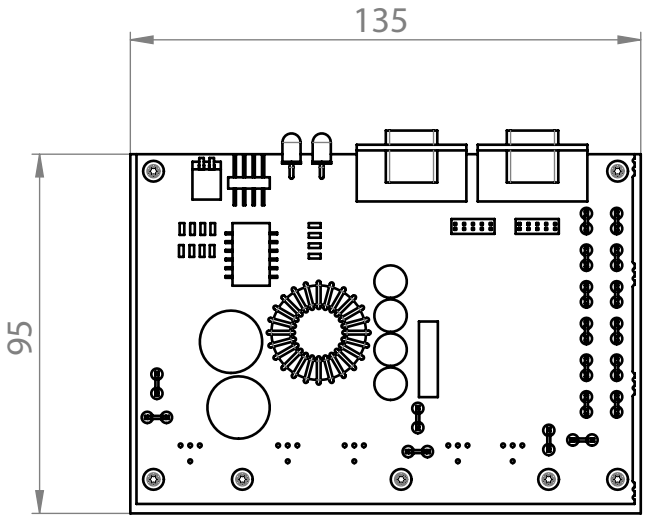
TU Delft
Industrial Design Engineering

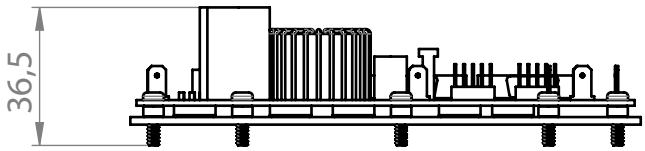
format A3

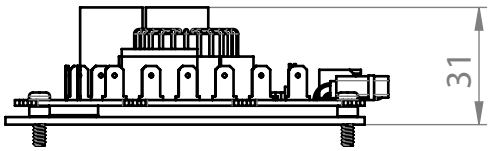
drawing no. PRT-2002











Item No.	Qty.	Name	Material	Remarks / Drawing. No.
4	7	3x12 Torx-st	Stainless steel	Bought in local shops PP / Import
3	7	M3 Spacer 3	Stainless steel	Bought in local shops PP / Import
2	1	PB-PCB	Multiple	Imported
1	1	PRT0101-PCBsheet	Aluminium	Raw material PP - Produced in SA

name **Both SHS**

units mm

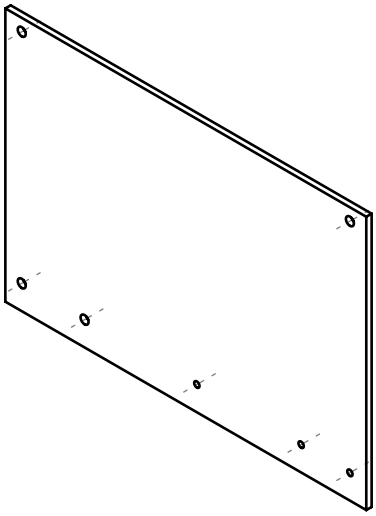
format A4

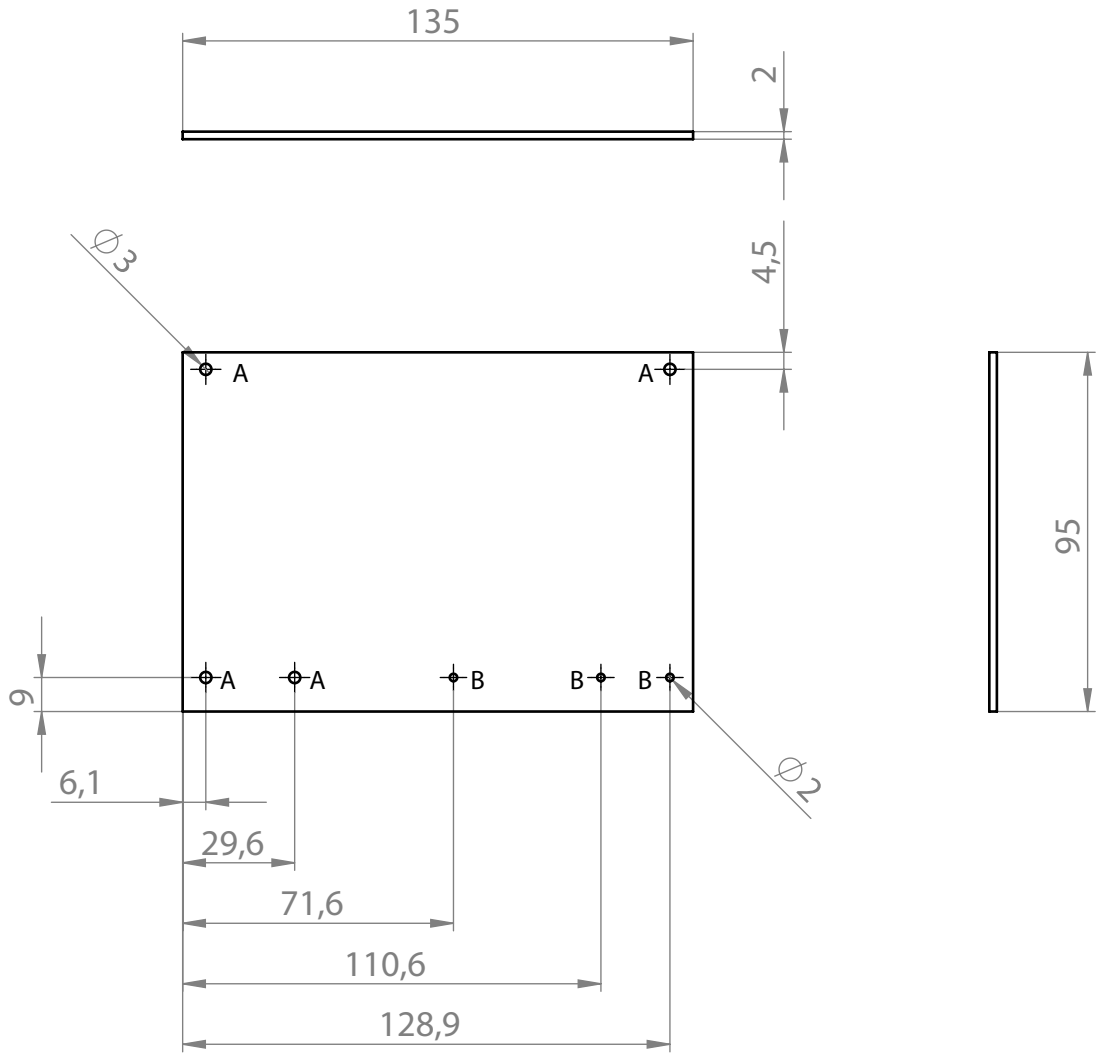
drawing no. SUB-0100

TU Delft
Industrial Design Engineering

scale 1:2 | date 11-4-2017 | weight 121 grams

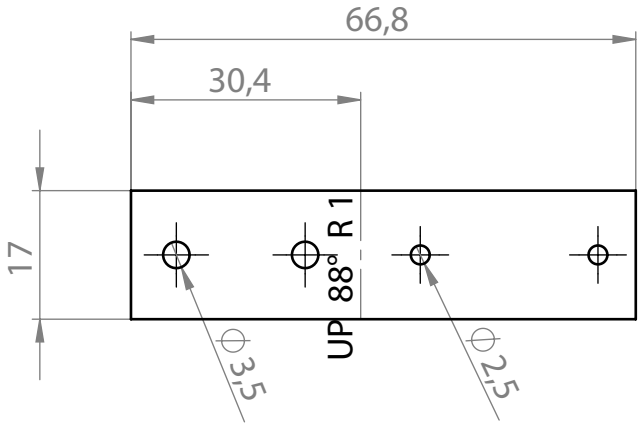
author Kane JA



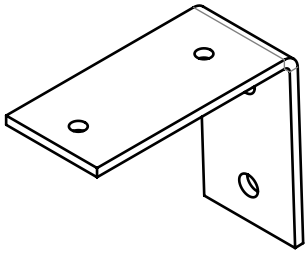


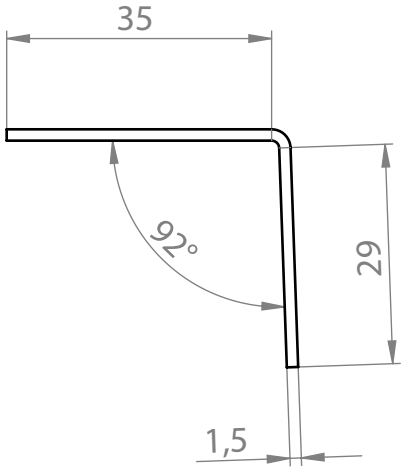
name	Both SHS			units mm	
TU Delft Industrial Design Engineering	scale 1:2	date 11-4-2017	weight 69 grams	format A4	drawing no. PRT-0101
	author Kane JA				group -

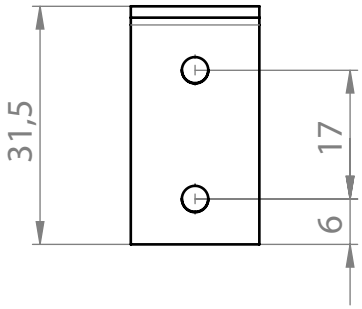
FLAT

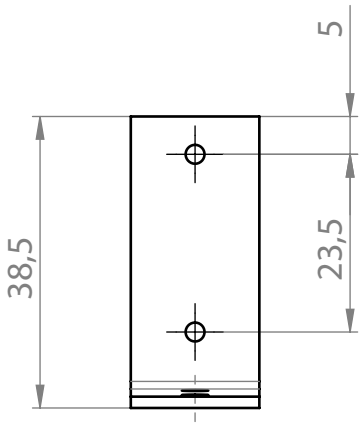


FOLD

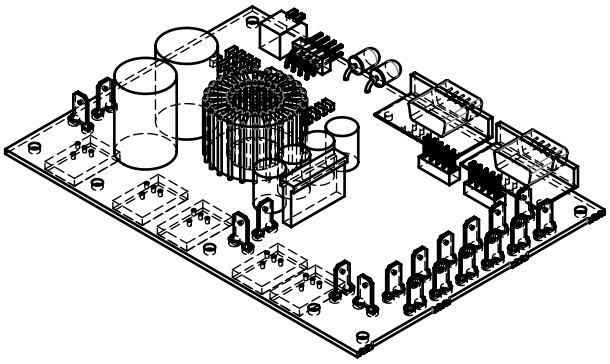


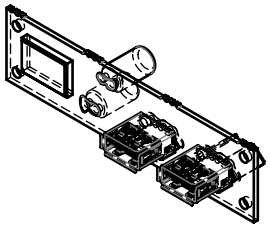


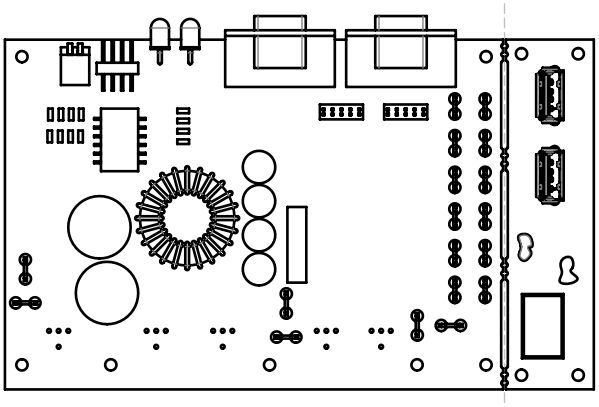




name	Both SHS			units	mm
				format	A4
TU Delft Industrial Design Engineering	scale 1:1	date 11-4-2017	weight 13 grams	drawing no.	PRT-0005
	author Kane JA				

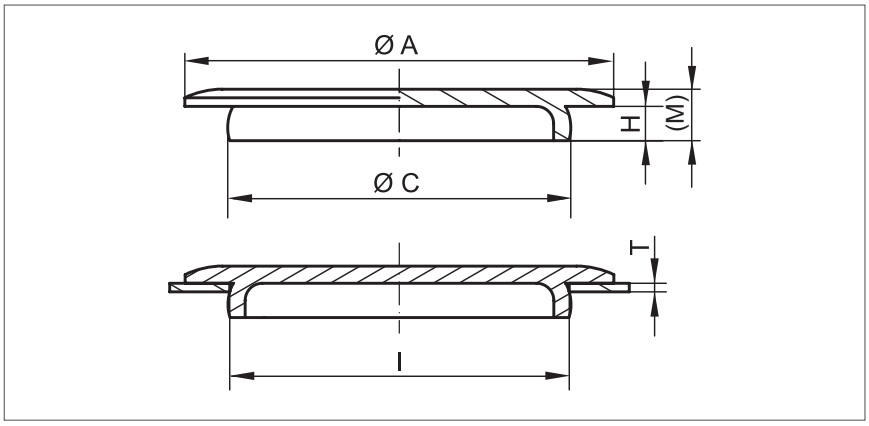






name	Both SHS				units mm
TU Delft Industrial Design Engineering	scale 1:2	date 11-4-2017	weight grams	format A4	drawing no. PCBs
	author Kane JA				group -

Covers
GPN 910



Suitable for casings		Dimensions				Order no.
Aperture l	Wall thickness T	A	C	H	(M)	
12.0	1.0	16.0	12.3	3.0	5.0	910 / 3280
15.0	1.0	18.0	15.4	4.0	5.0	910 / 2179
17.3	1.0	20.0	17.6	4.0	6.0	910 / 3759
20.0	1.0	35.0	20.5	5.0	7.5	910 / 2967
20.5	1.0	25.0	21.1	2.5	4.0	910 / 0766
25.0	1.5	28.0	26.0	4.0	6.2	910 / 4015
25.5	1.0	38.0	26.0	5.3	7.4	910 / 3040
26.3	2.2	38.0	27.0	7.5	9.5	910 / 3043
26.5	1.5	38.0	27.0	4.3	6.3	910 / 0763
33.0	1.5	36.0	33.5	4.0	6.0	910 / 3790
36.0	2.0	53.0	36.5	5.0	7.0	910 / 5539
39.5	0.9	50.0	40.0	4.0	6.0	910 / 3205
39.7	0.8	50.0	40.4	2.4	4.2	910 / 4010
50.0	1.0	55.0	50.6	4.0	6.0	910 / 3097
53.0	1.5	62.0	53.8	4.0	6.0	910 / 0715
60.8	2.2	66.0	61.5	7.8	9.8	910 / 3044
61.0	1.5	68.0	62.0	4.0	5.8	910 / 0714
64.0	1.5	85.0	64.6	4.1	6.1	910 / 3791
71.0	1.5	76.0	71.5	5.0	7.5	910 / 2713
72.0	3.0	90.0	72.8	7.5	9.5	910 / 3042
74.5	1.5	83.0	75.0	8.0	10.0	910 / 3223
81.5	1.5	90.0	82.0	8.0	10.0	910 / 3222
92.0	3.0	103.0	93.0	7.7	9.7	910 / 3277
100.0	2.0	109.0	101.0	5.0	7.0	910 / 4395

Size in mm

Your KAPSTO® quality benefits:

Additional information:
Flat design, ideal for closing apertures in cover panels.

Material: PE-LLD
Colour: Black

Colour and material alternatives, additional sizes, bespoke designs and technical cleanliness on request. For more information about materials, colours, drawings and application of our items, please see page 114/115.

>> You also might be interested in the following products: GPN 300 F, GPN 600, GPN 915

I Building moulds for BB production

As mentioned in the report, the VRTM process is slightly adjusted based on Kamworks' experiences with the battery box. Where the VRTM process is explained in the literature, this appendix will describe the process towards two production moulds for Kamworks' battery boxes.

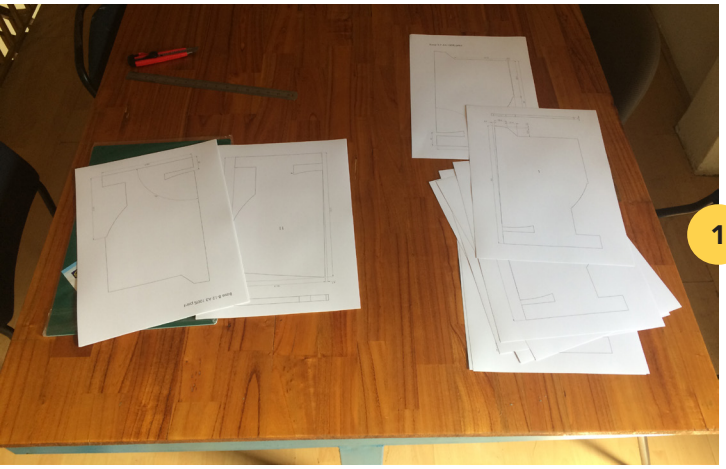
The line drawings on these pages show the first setup for making the production moulds. At first, the shape of the battery boxes are translated into solid blocks with a surrounding flange of 20 centimetre.

The flange, coloured brown in the drawing, is made from leftover wood from Kamworks' workshop. The block (yellow) is made from 6 and 12 millimetre MDF. First the blocks are produced, after which the flange is attached to it.

The block is split up in slices of 6 and 12 millimetre. These sections were printed [1], traced on MDF [2] and sawed [3]. After applying glue [4], the sections are joined layer by layer [5]. The dimensions are compared to the battery [6], after which some final adjustments and finishing are done [7, 8].
When the block is smooth, the flange is built around it [9]. The flange is made from different kinds of wood [10]. When all parts are fixed, edges are finished and body filler is applied to close gaps and give the block a hard top layer [11]. The block is sanded and spray painted with car paint [12]. With the car paint applied, the blocks are finished and the moulds can be made.

The block is waxed to avoid the mould sticking to it. The first half of the mould is made by applying glass fibre and resin to the block [13]. When the fibreglass is dry, it is separated from the block [14]. This first mould is the outside shape of the box. The second half of the mould is made based on this one, so this mould is smoothed first [15].

Before the second half of the mould is made, a first box is made by hand lay-up [16]. This prototype shows if the draft of the mould and the dimensions of the box are correct. When approved, foam is applied that has the same thickness as the product [17]. When the mould is fully covered with foam, edges are finished and the foam is waxed [18]. Thereafter the inserts to create a vacuum and allow the resin to flow through the moulds are applied [19]. The second mould is made by applying glass fibre and resin on the foam and the inserts. After all this, the two mould sets are ready for use. The first batch [20] can be used for production.



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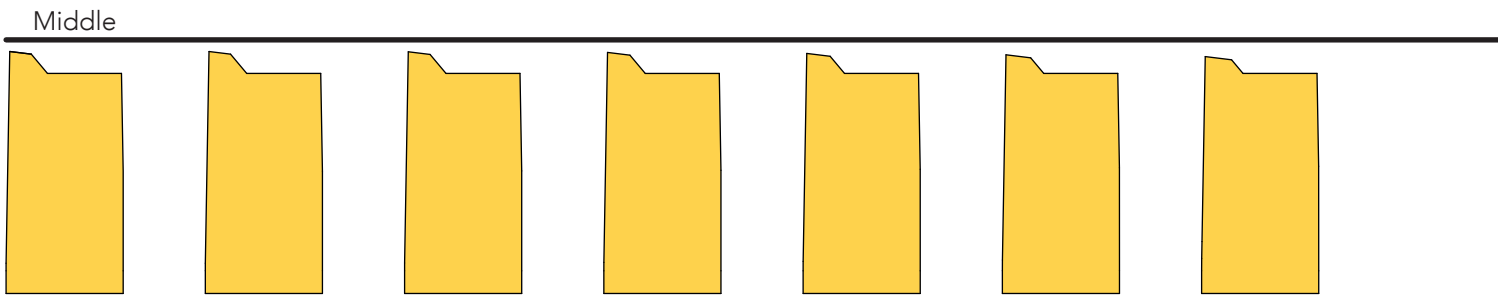
2



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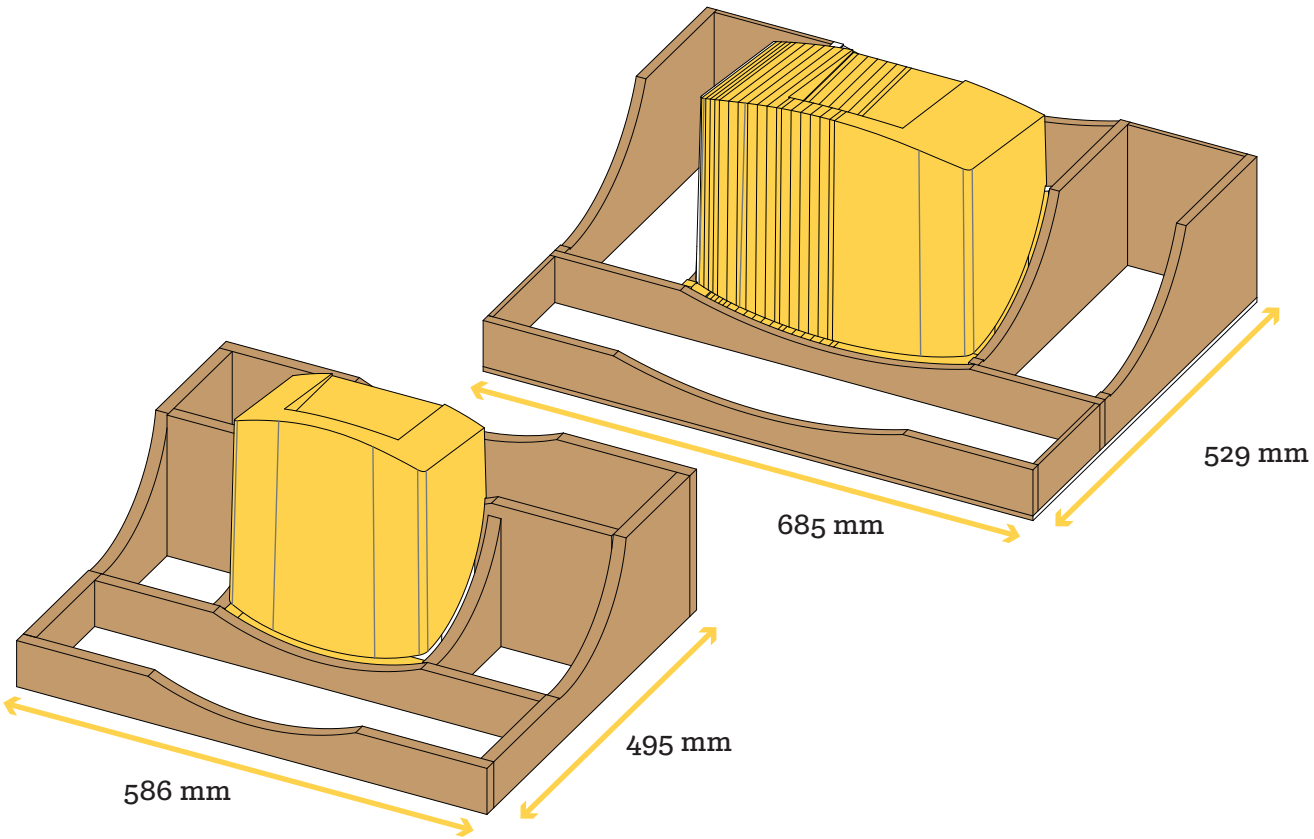

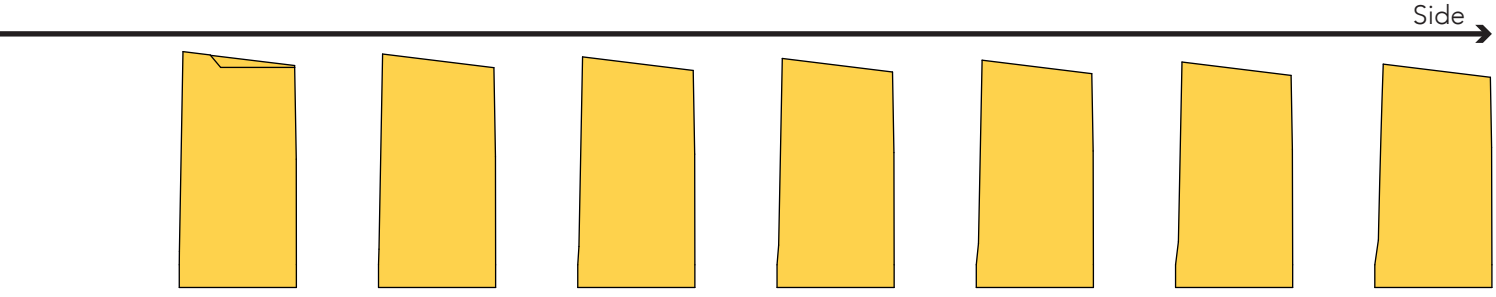

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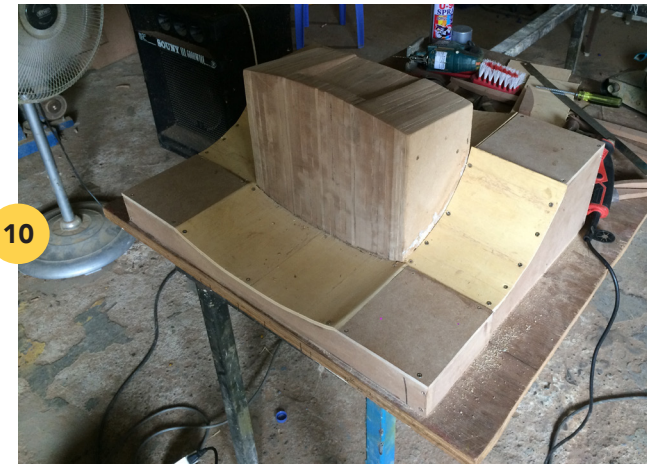

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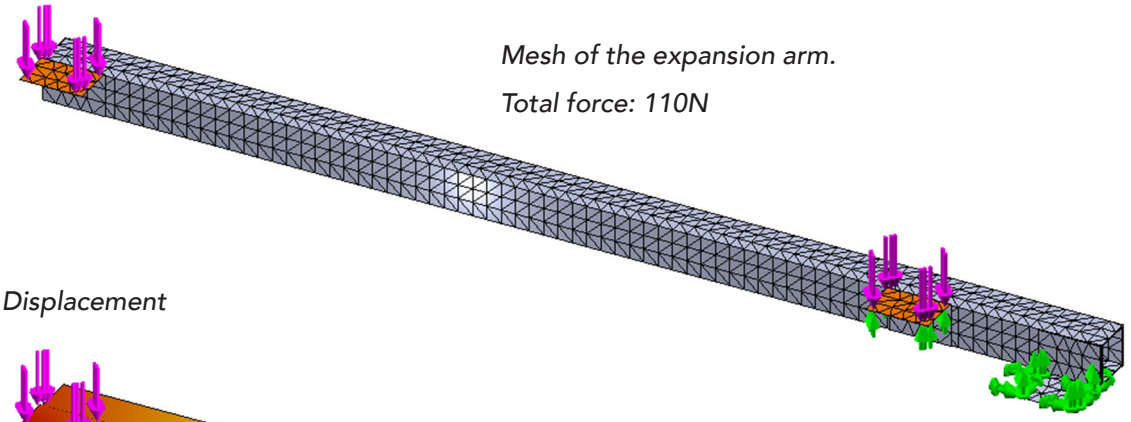
J Analysis mounting system

The final profile dimension is determined on 30x30x1 mm (Galvanized steel). This dimension is based on the available profiles in Cambodia and the simulations that are found on this page.

Besides the yield strength that cannot be exceeded with a safety factor of 2, the displacement was taken into account too. Since the accuracy of the panel was determined on 2˚, the deformation should fit into this requirement.

On the right page a simplified model of the mounting system is visualized. The length of the horizontal supports is the length of the actual supports + the extension arms (2m). With the large panel's load of approximately 11kg (≈110N), 660N force was applied to the mounting system (3 panels x110N x 2SF). The stresses stay below the yield strength, while the displacement is 13,6 milimeter. This comes down to a deviation of 0,78˚: well within the required accuracy.

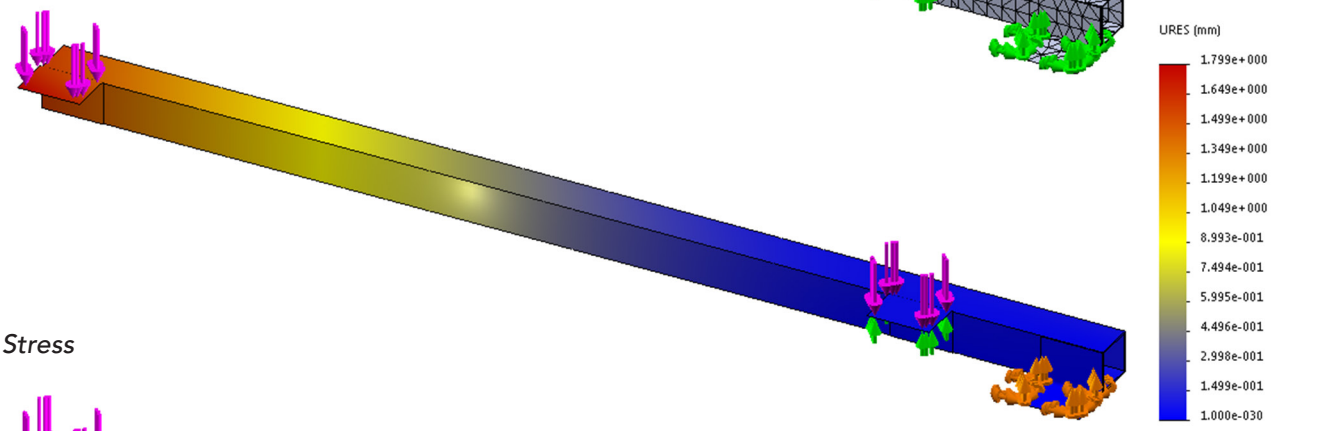
Below a simulation is given of on of the arms. Also here, the yield strength is not exceeded and deformations are acceptable.



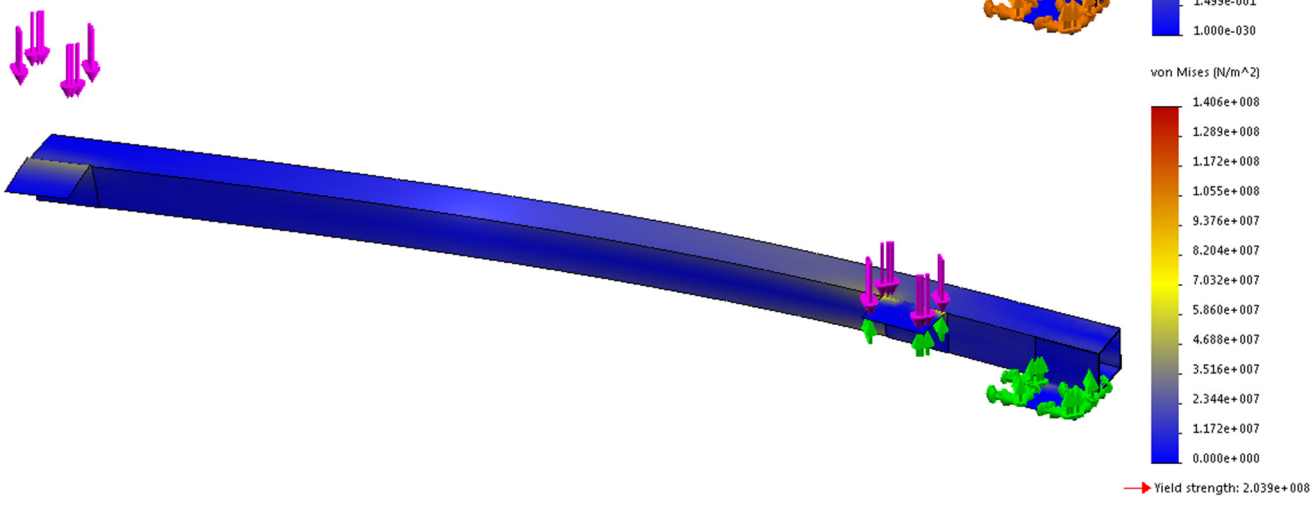
Mesh of the expansion arm.

Total force: 110N

Displacement

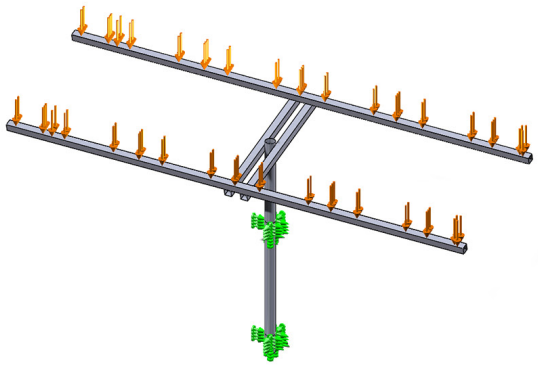


Stress



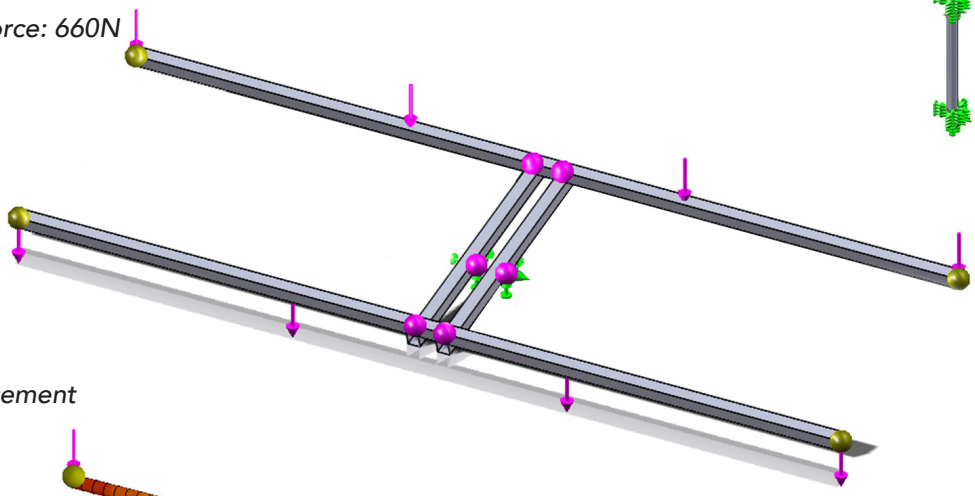
Forces and fixtures mounting system

Total force: 660N

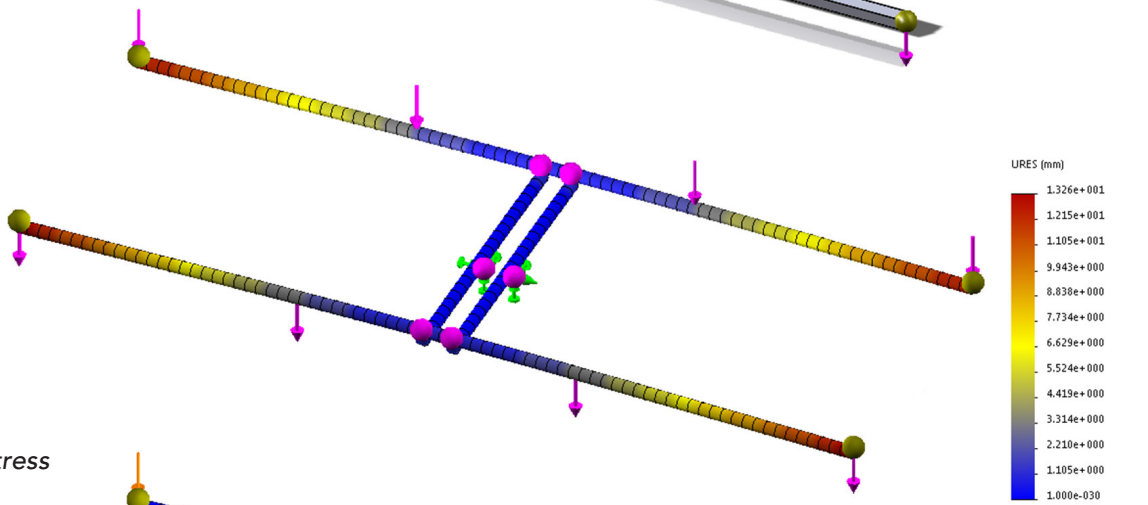


Simplified mounting system (total length 2000 mm)

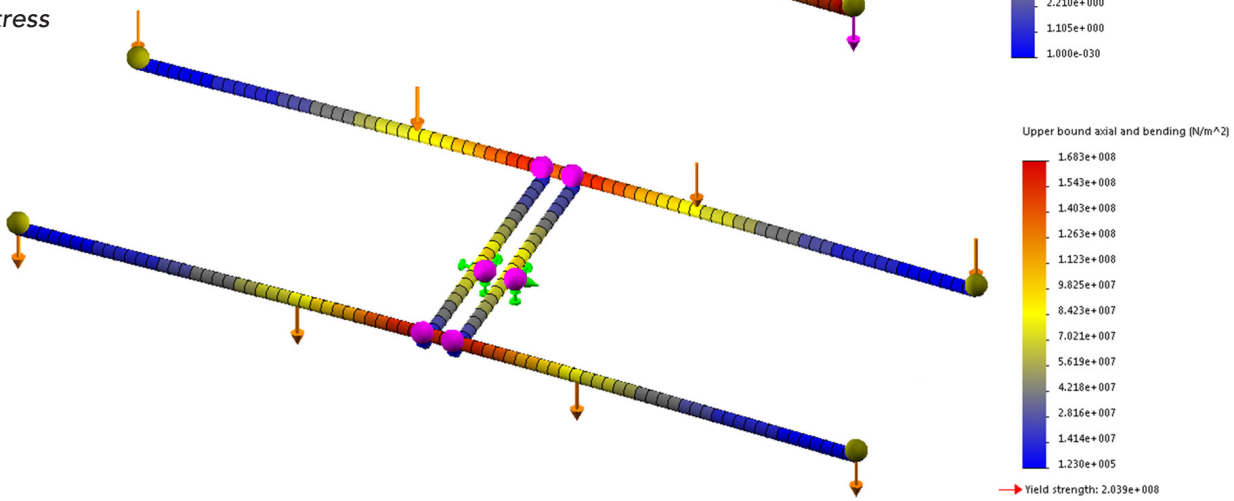
Total force: 660N



Displacement



Stress

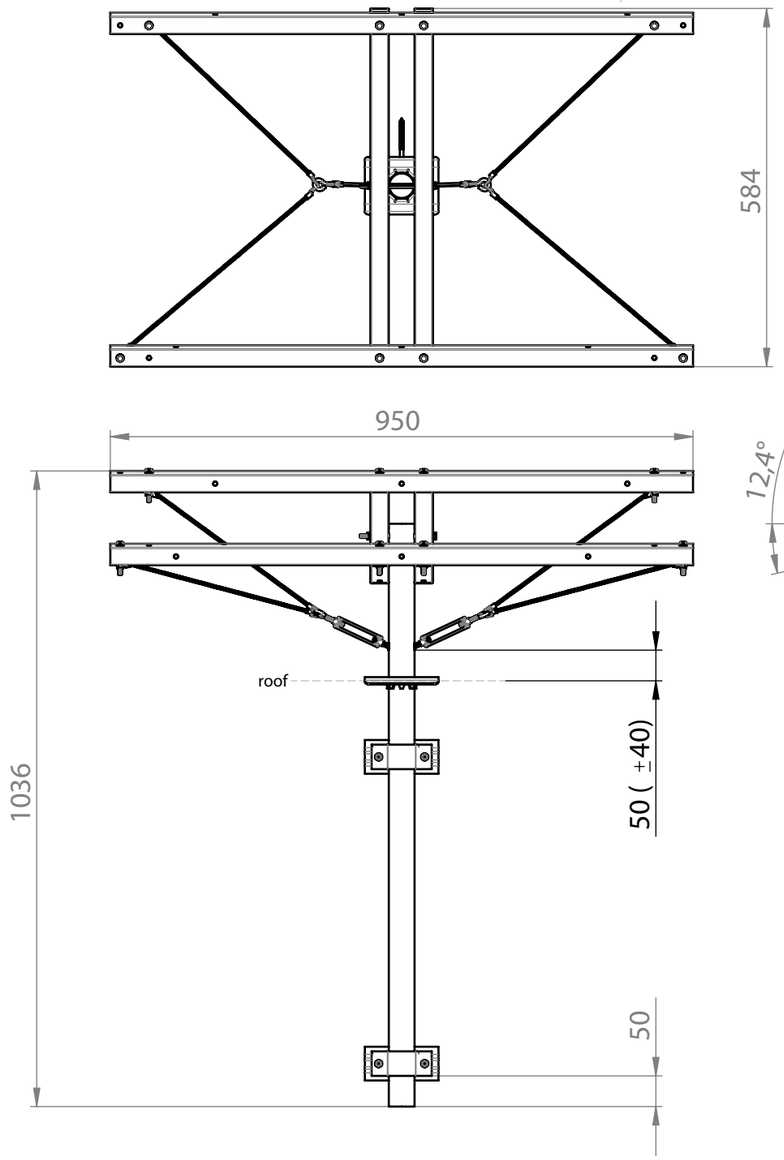


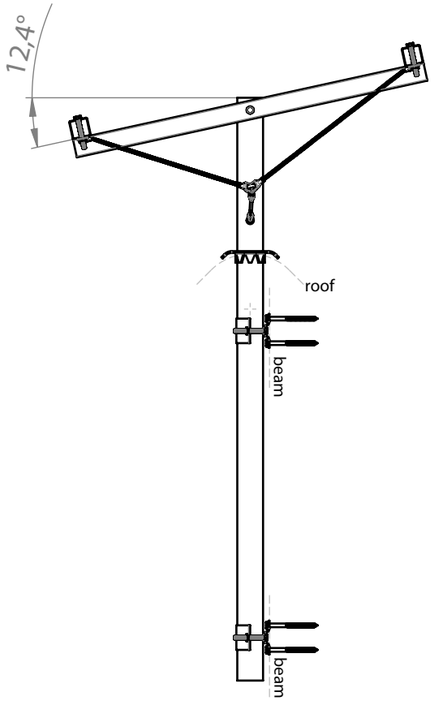
K Technical drawings Solar panels and mounting pole

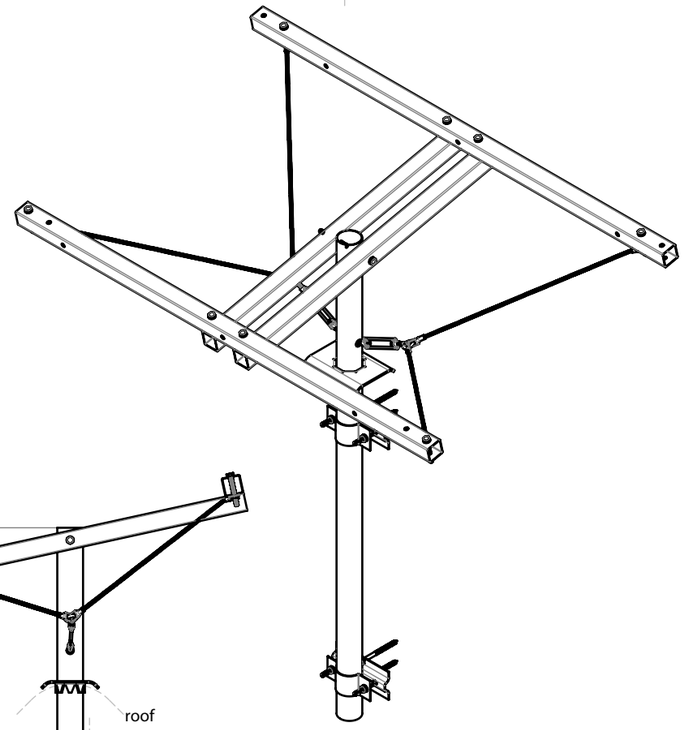
In this section the technical drawings of the mounting pole and solar panels are provided. An overview of the parts can be found, which is used for the cost estimation of the redesign (appendix L).

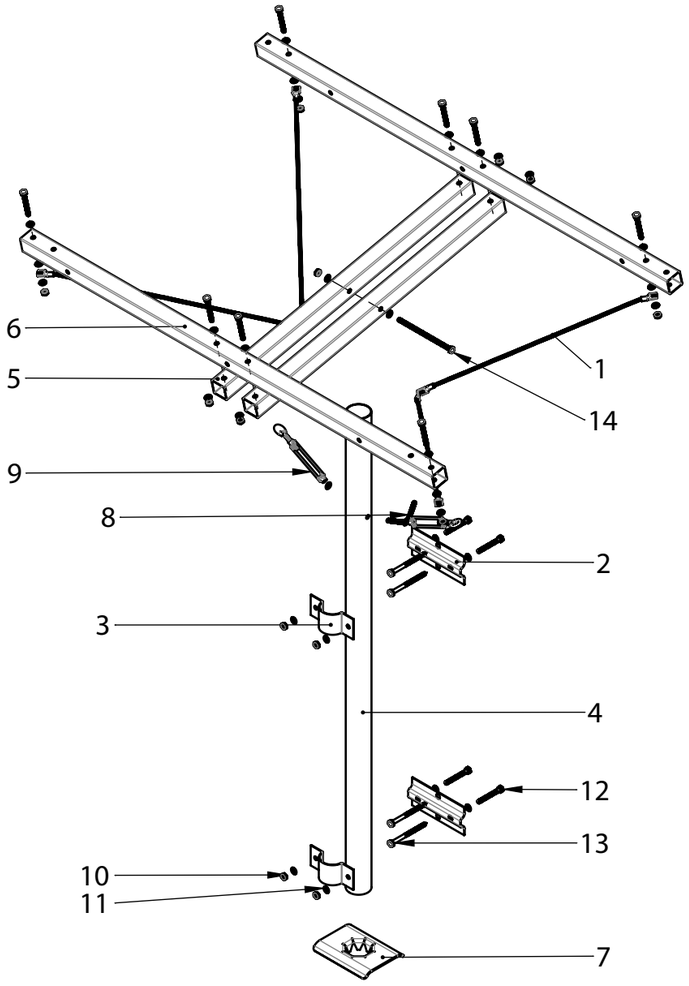
The technical drawings are divided in two parts, indicated with a yellow bar (see the right page). The first part is the mounting pole the parts that are used in this assembly. The second part is the solar panels and the supports that are used to attach the panel to the mounting system.

Standard parts (sockets, screws, etcetera) are only included in the CAD model. They cannot be found in these drawings.









Item No.	Qty.	Name	Material	Remarks
14	1	M6x120	Galvanized steel	Bought in local shops PP
13	4	M6x80 W	Galvanized steel	Bought in local shops PP
12	12	M6x50	Galvanized steel	Bought in local shops PP
11	32	M6 Washer	Stainless steel	Bought in local shops PP
10	13	M6 Nut	Galvanized steel	Bought in local shops PP
9	2	M6 Turnbuckle	Galvanized steel	Without hook | Bought in local shops PP
8	1	M6x100 r (bent)	Galvanized steel	Bend 50 degrees in center. Buy threaded rod PP
7	1	PRT-3006-HoleCover	Rubber (recycled car tire)	Bought and/or produced northern area PP
6	2	PRT-3005-HorizontalSupport	Galvanized steel	Bought in local shops PP
5	2	PRT-3004-VerticalSupport	Galvanized steel	Bought in local shops PP
4	1	PRT-3003-Pole	Galvanized steel	Bought in local shops PP
3	2	PRT-3002-Clamp	Galvanized steel	Bought in local shops PP
2	2	PRT-3001-Bracket	Galvanized steel	Bought in local shops PP
1	4	SUB-3100-Cable	Multiple	Bought in local shops PP - Assembled in SA

scale	1:10	date	18-4-2017
units	mm	weight	grams
author	Kane JA	group	-

remarks
Solar Home Systems - Mounting pole

name
MountingPole

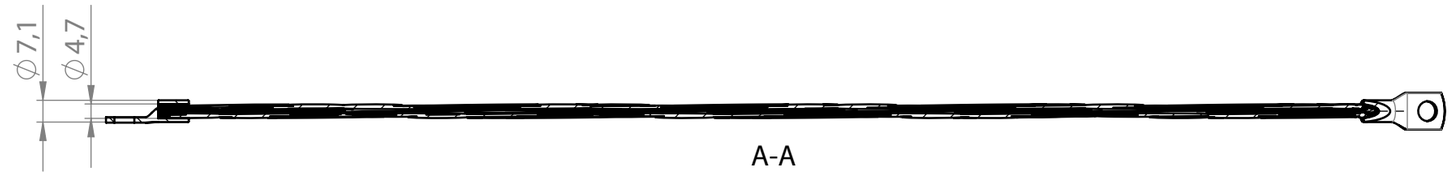
40 | 43

TU Delft
Industrial Design Engineering

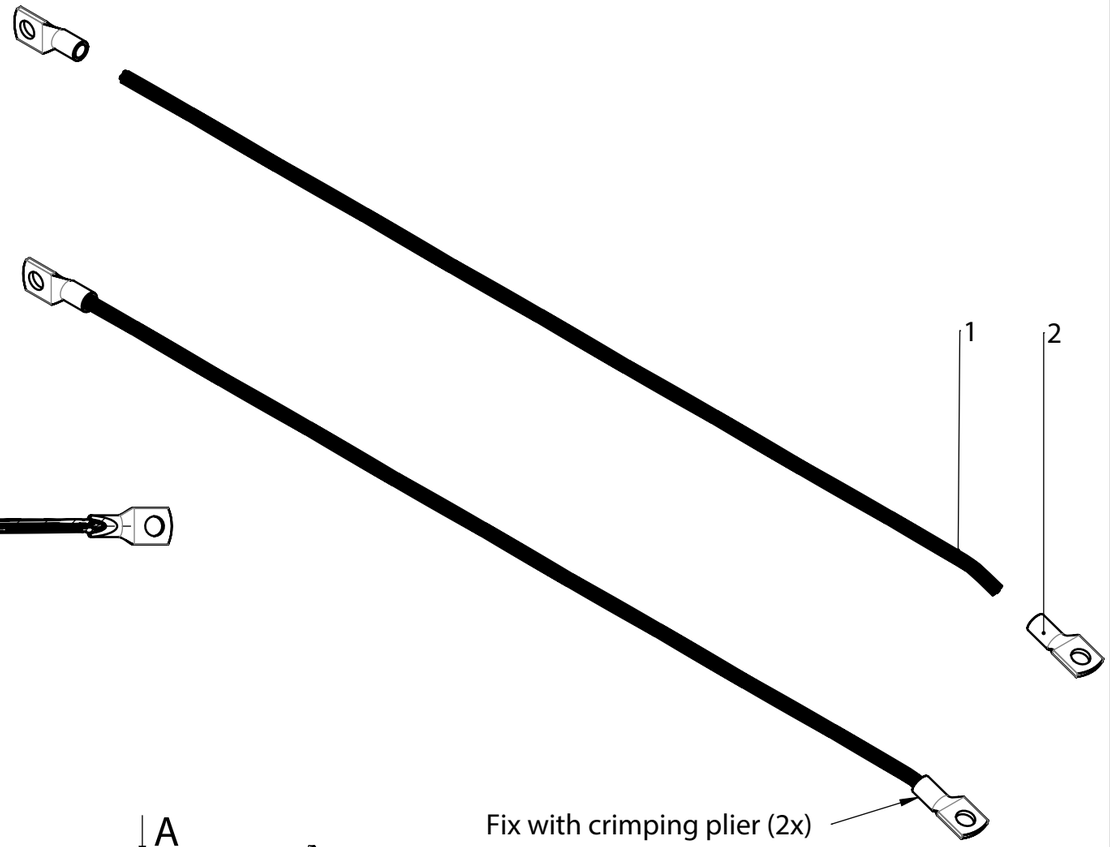
format
A3

drawing no.
ASM-0300

Make sure hole to hole distance is 40 cm!



A-A



Item No.	MirrorLug/QTY.	Name	Material	Remarks / Drawing. No.
2	2	Cable lug 10-6	Copper & Aluminium	PP electrical (shop)
1	1	Cable 4.5x400	Galvanized steel	40 cm, buy roll in PP

scale 1:2		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight grams		
author Kane JA		group -	

name

MountingPole

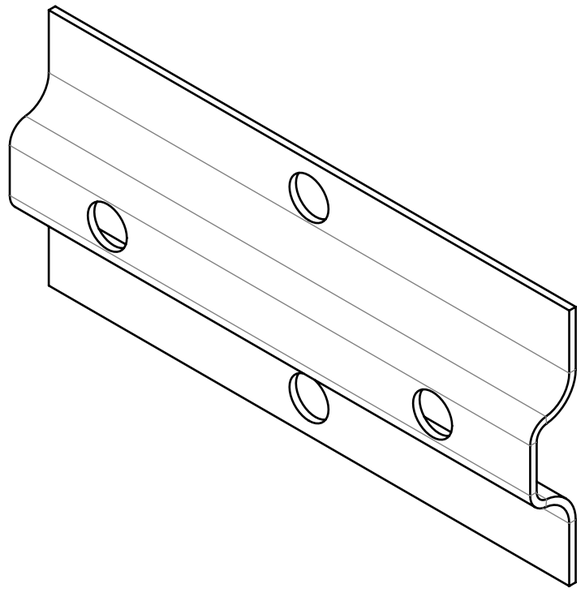
TU Delft
Industrial Design Engineering

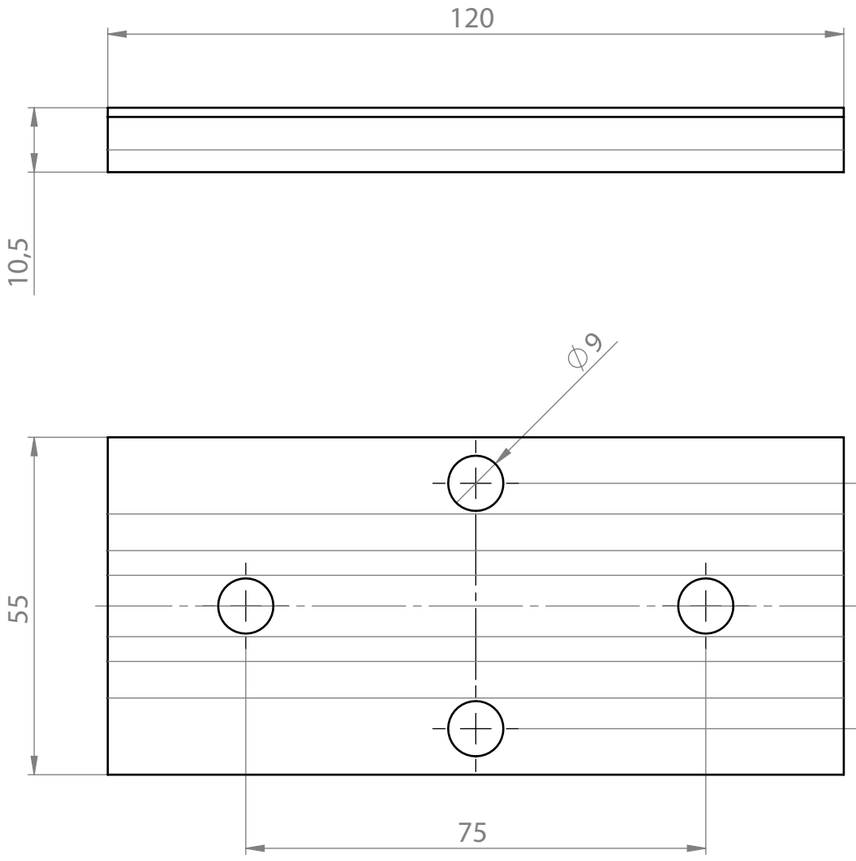
format A3

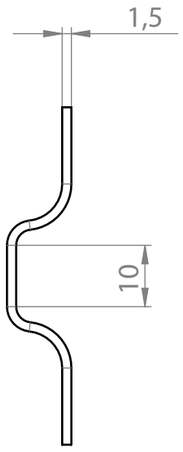
drawing no. SUB-3100

- Bends are made with stamp (available at Kamworks)

FOLD







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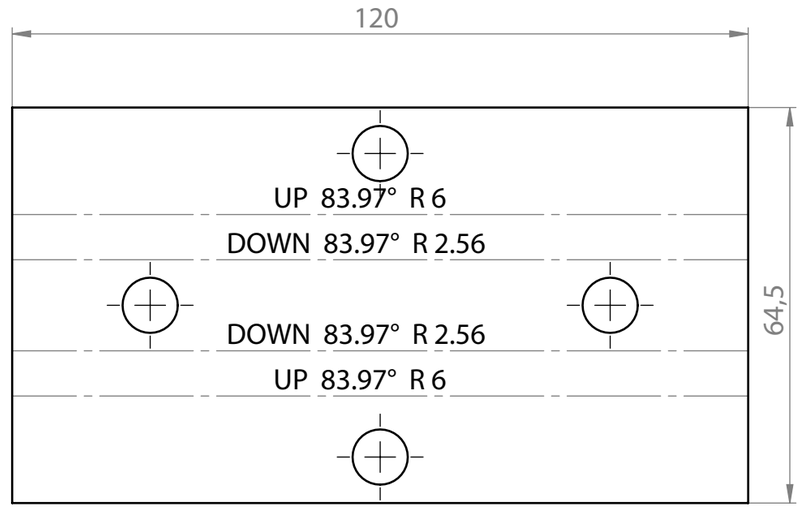

scale 1:1		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight	grams	
author Kane JA		group -	

name

MountingPole

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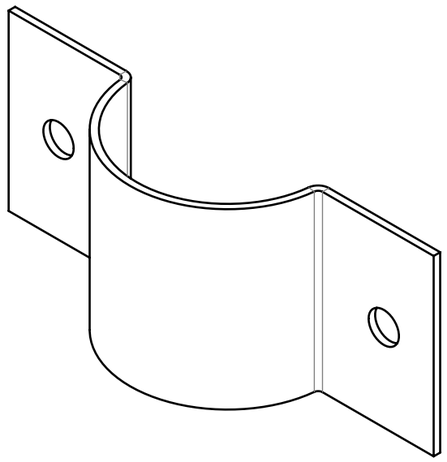
TU Delft
Industrial Design Engineering

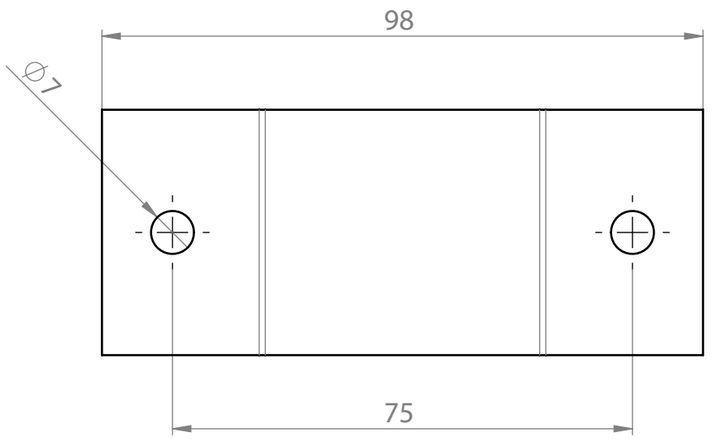
format A3

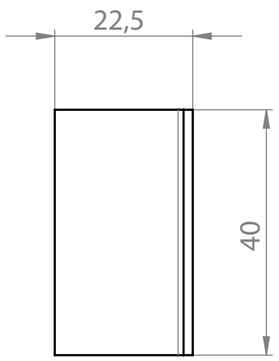
drawing no. PRT-0301

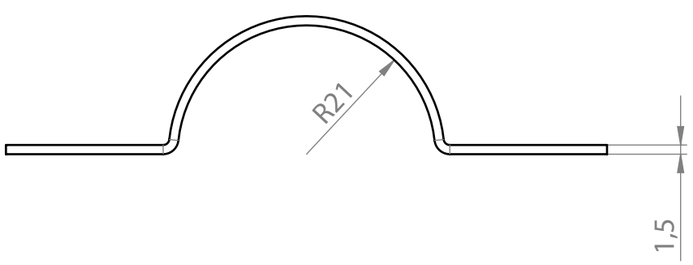
- Bends are made with stamp (available at Kamworks)

FOLD









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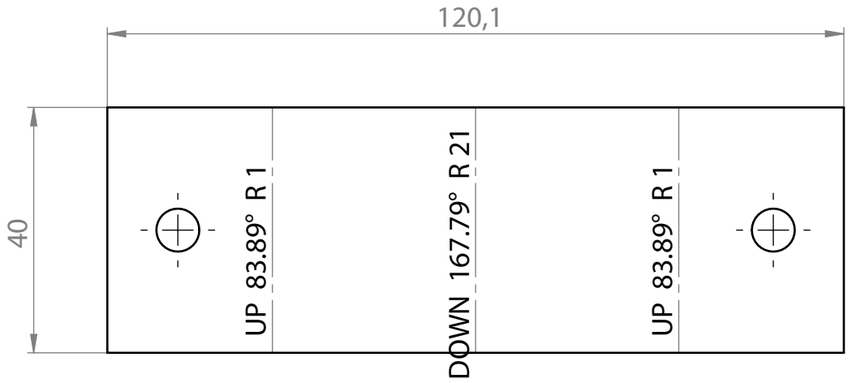

scale 1:1		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight grams		
author Kane JA		group -	

name

MountingPole

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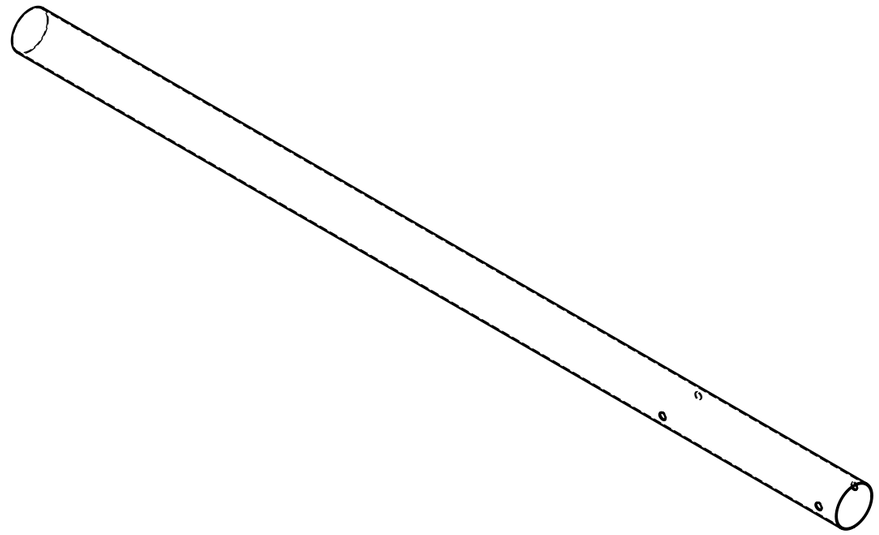
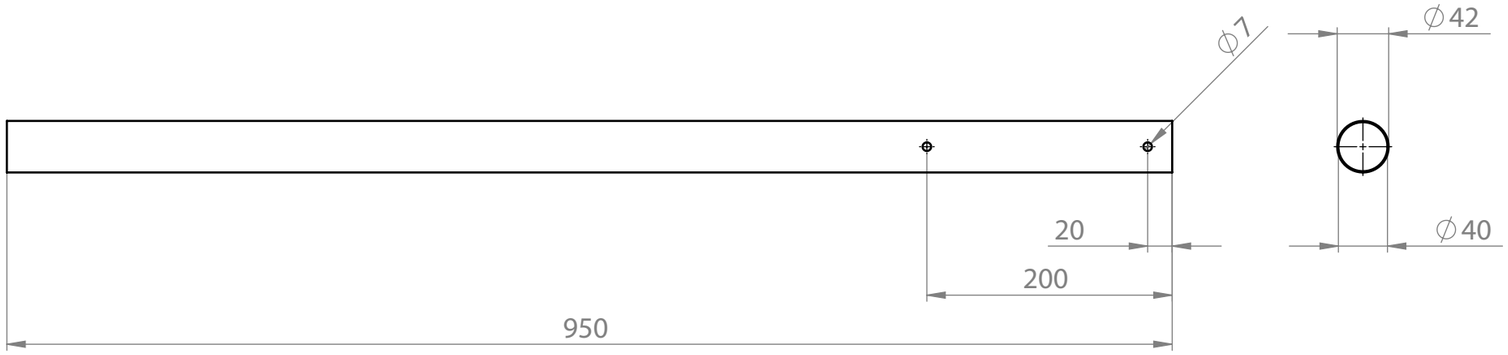
Industrial Design Engineering

format	drawing no.
A3	PRT-0302





scale 1:5		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight grams		
author Kane JA		group -	

name

MountingPole

46 | 47

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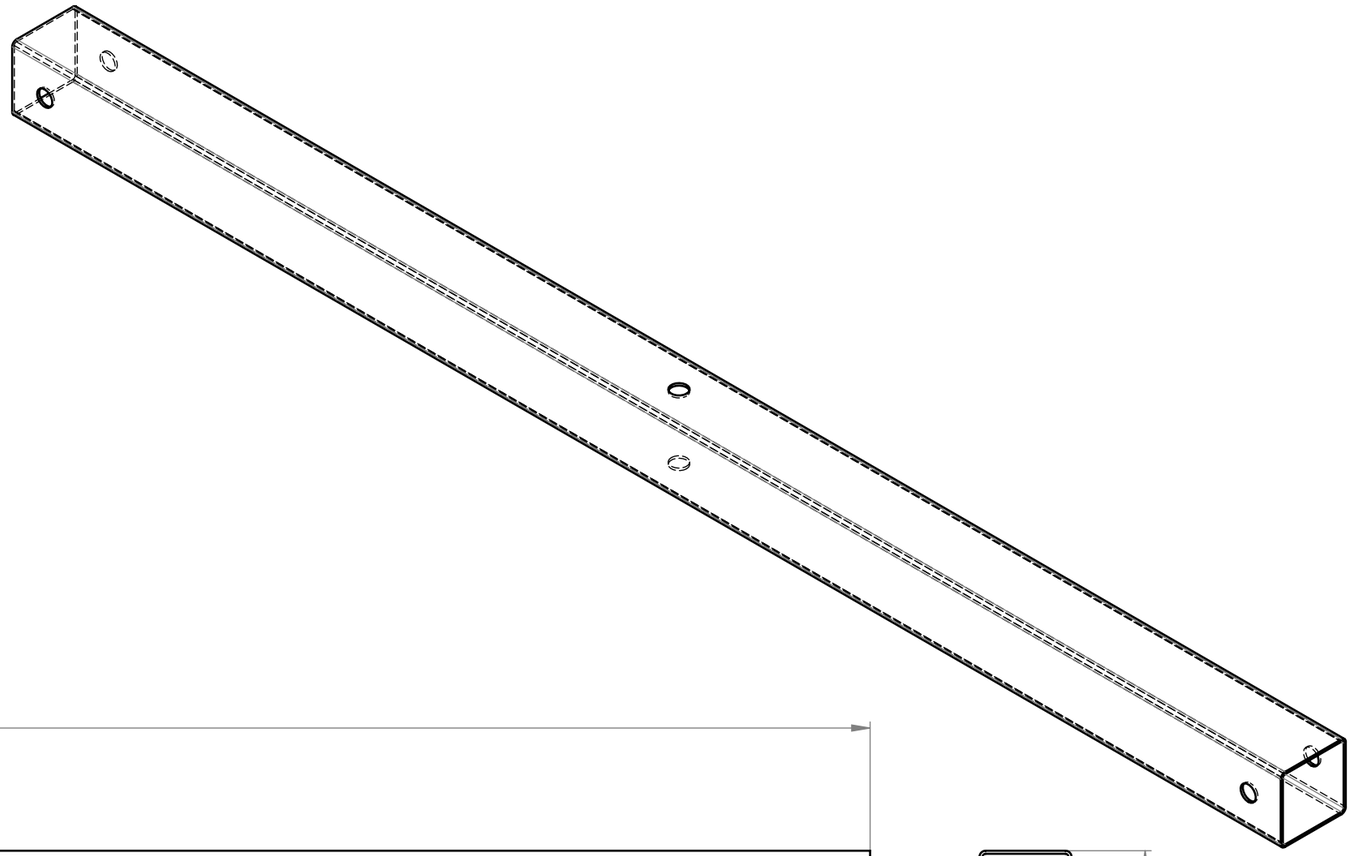
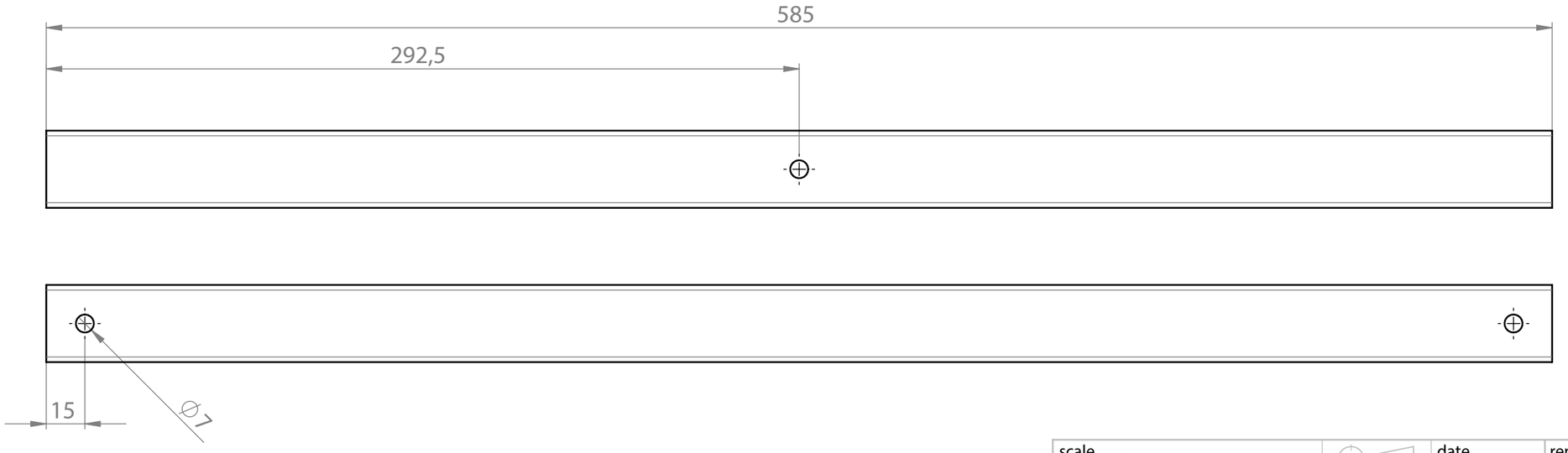
Industrial Design Engineering

format A3

drawing no. PRT-0303





scale 1:2		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight grams		
author Kane JA		group -	

name

MountingPole

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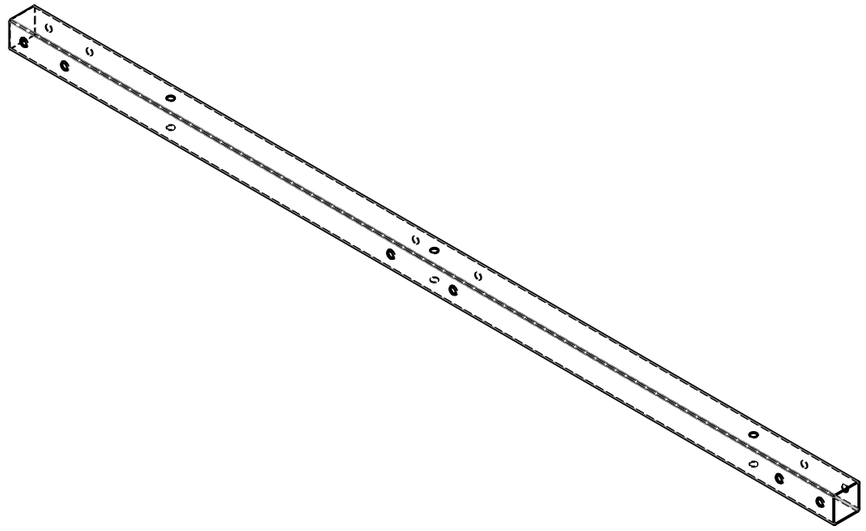
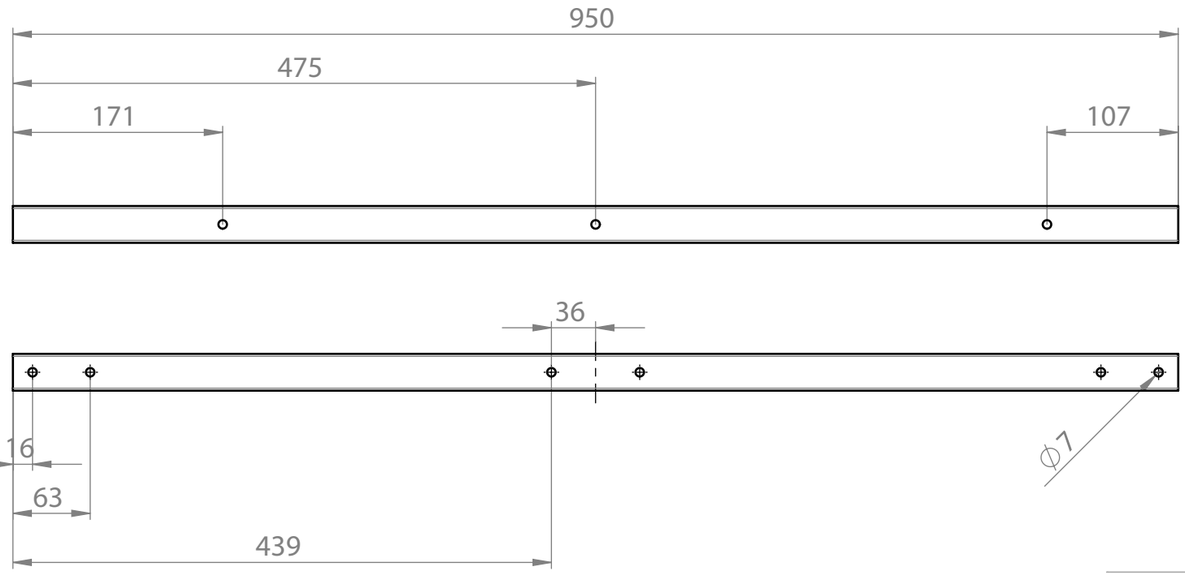
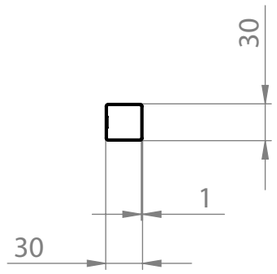
Industrial Design Engineering

format	drawing no.
A3	PRT-0304







scale 1:5		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight	grams	
author Kane JA		group -	

name

MountingPole

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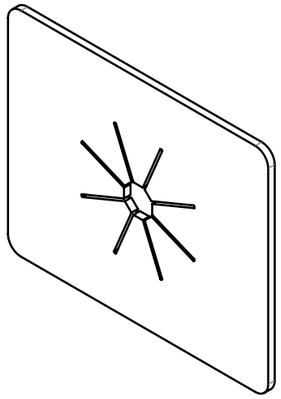
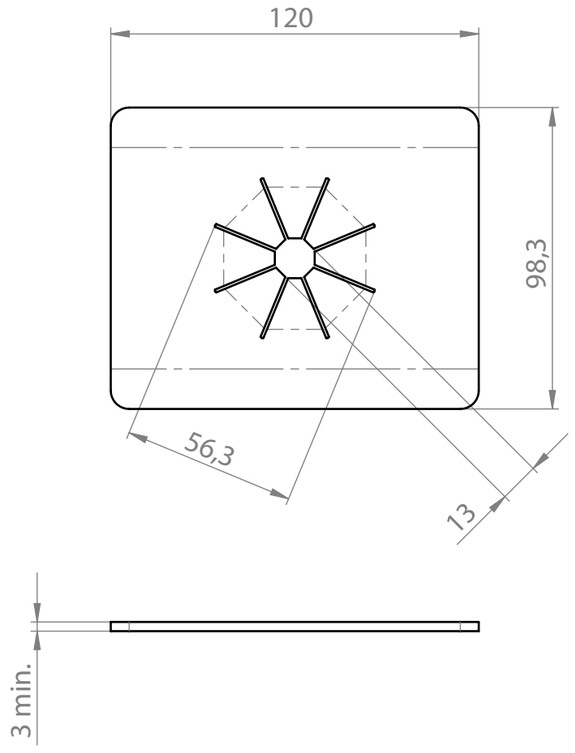
Industrial Design Engineering

format	drawing no.
A3	PRT-0305

FLAT





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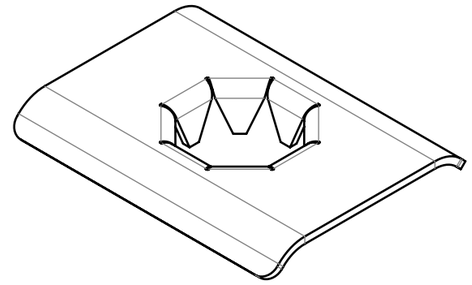
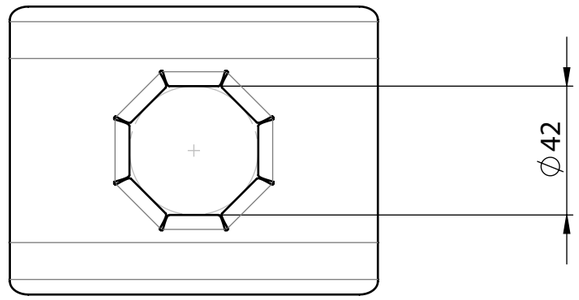
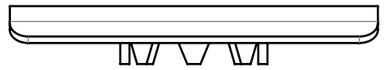






scale 1:2		date 18-4-2017	remarks Solar Home Systems - Mounting pole
units mm	weight grams		
author Kane JA		group -	

name

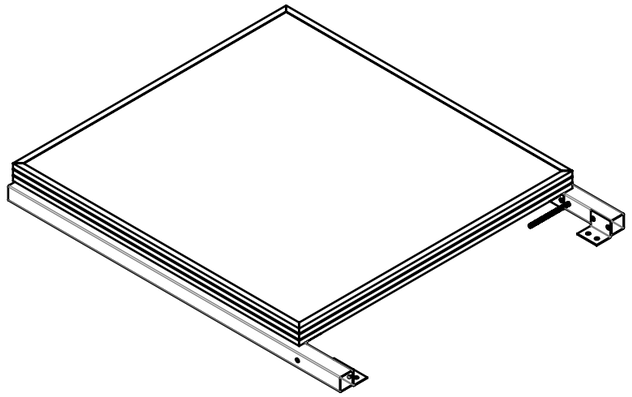
MountingPole

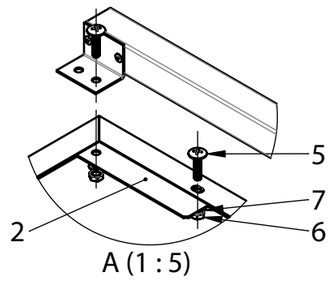
TU Delft
Industrial Design Engineering

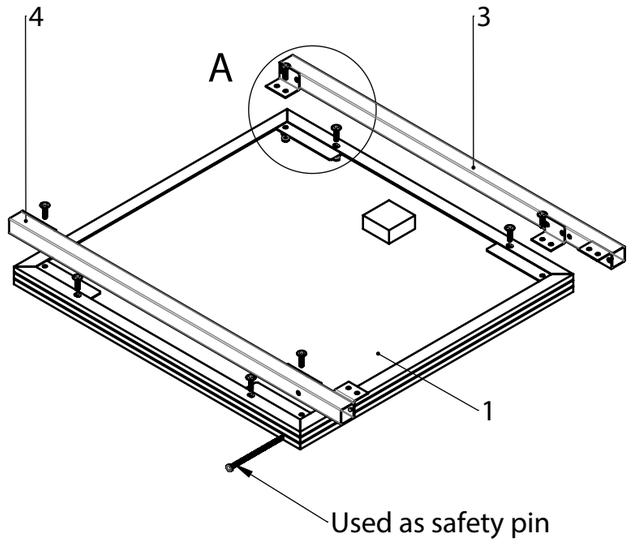
format A3

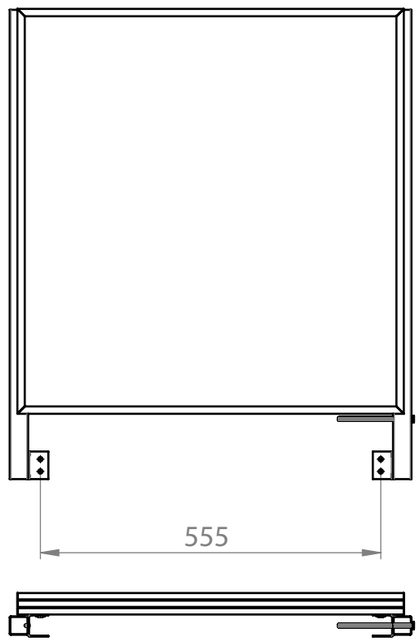
drawing no. PRT-0306

EXPANSION [installed by customer]

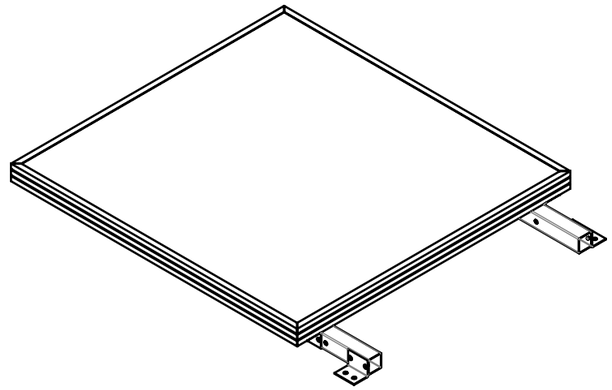


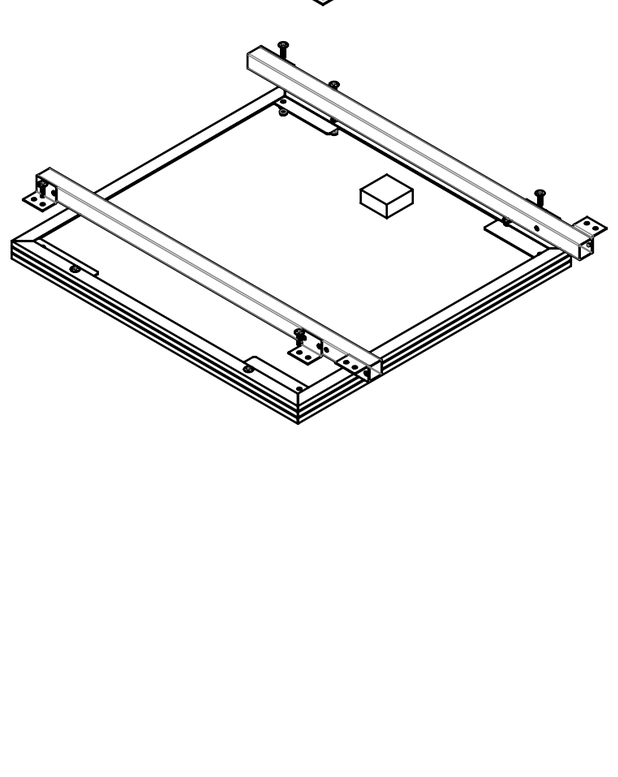






BASE [installed by technician]





Item No.	Extension-70/QTY.	Name	Material	Remarks / Drawing. No.
8	1	M6x120	Galvanized steel	Bought in local shops PP
7	4	M6 Washer		
6	4	M6 Nut		
5	4	M6x25 Flathead	Galvanized steel	Bought in local shops PP
4	1	SUB-4200-Arm-Right	Galvanized steel	Includes 2x M6x25 Flathead, 2x M6 Nut and 2x M6 Washer
3	1	SUB-4100-Arm-Left		
2	4	PRT4001-PanelClamp	Galvanized steel	Raw material PP - Produced SA
1	1	Panel_70Wp	Multiple (alu frame)	Imported

scale 1:10		date 18-4-2017	remarks 70 Wp Assemblies
units mm	weight grams		
author Kane JA		group -	

name

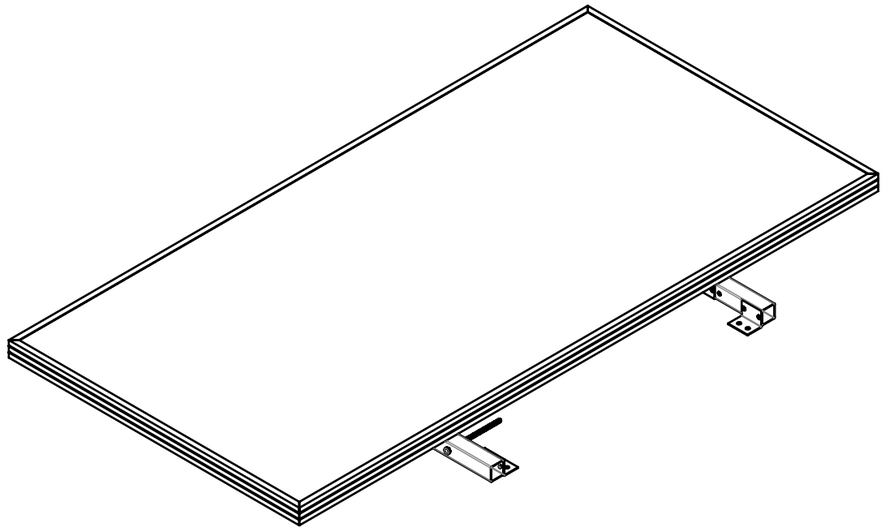
Solar Panels

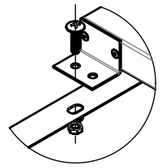
TU Delft
Industrial Design Engineering

format A3

drawing no. ASM-4000

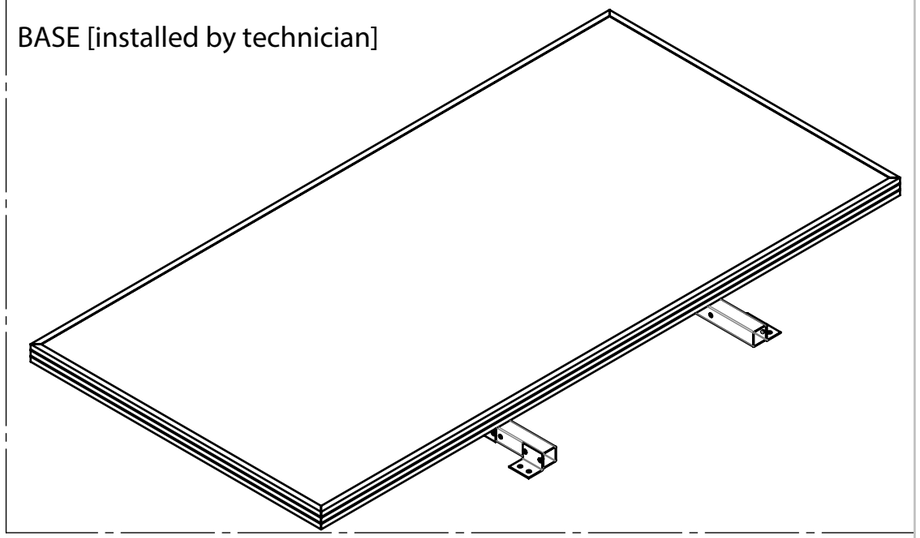
EXPANSION [installed by customer]



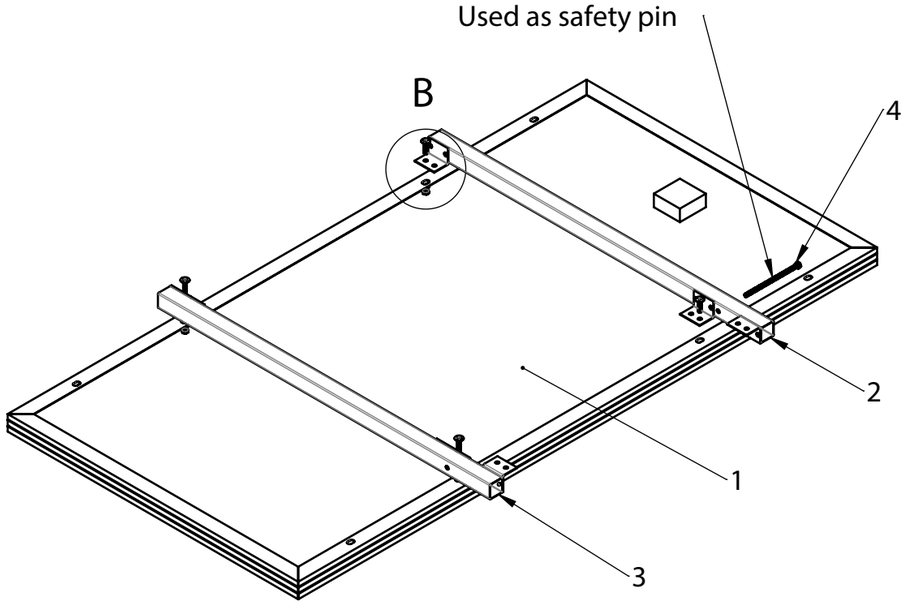


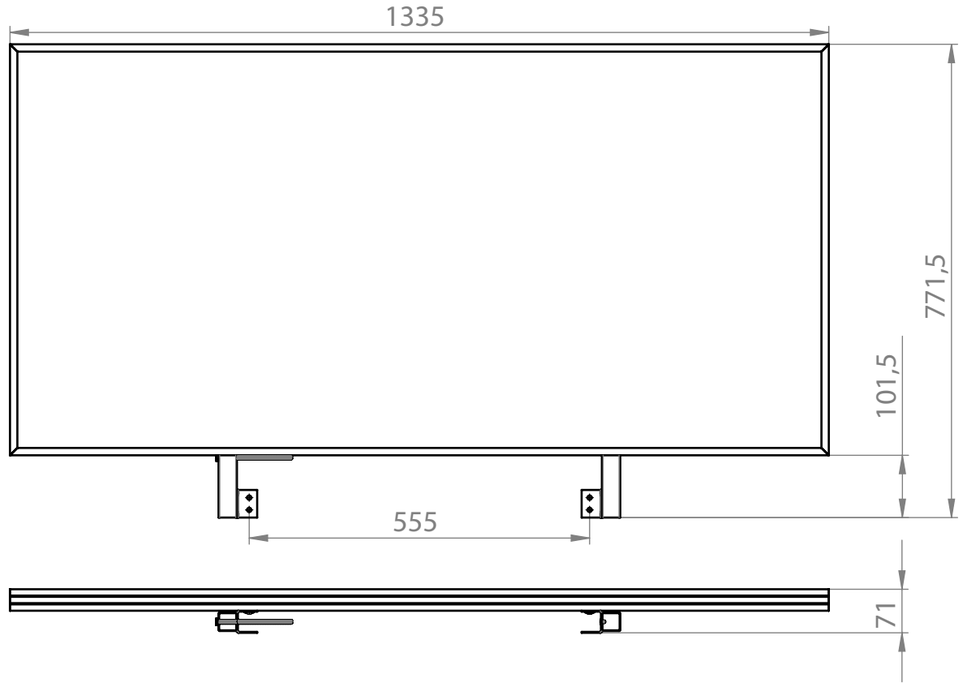
B (1 : 5)

BASE [installed by technician]



Used as safety pin





4	1	M6x120	Galvanized steel	Bought in local shops PP
3	1	SUB-4200-Arm-Right	Galvanized steel	Includes 2x M6x25 Flathead, 2x M6 Nut and 2x M6 Washer
2	1	SUB-4100-Arm-Left	Galvanized steel	Includes 2x M6x25 Flathead, 2x M6 Nut and 2x M6 Washer
1	1	Panel_130Wp	Multiple	Imported
Item No.	Extension-130/QTY.	Name	Material	Remarks / Drawing. No.

scale 1:10		date 18-4-2017	remarks 130 Wp Assemblies
units mm	weight grams		
author Kane JA		group -	

name

Solar Panels

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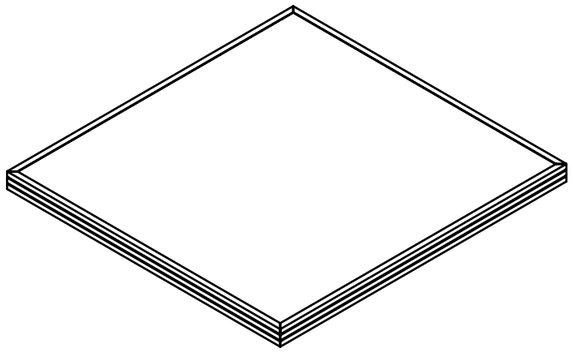
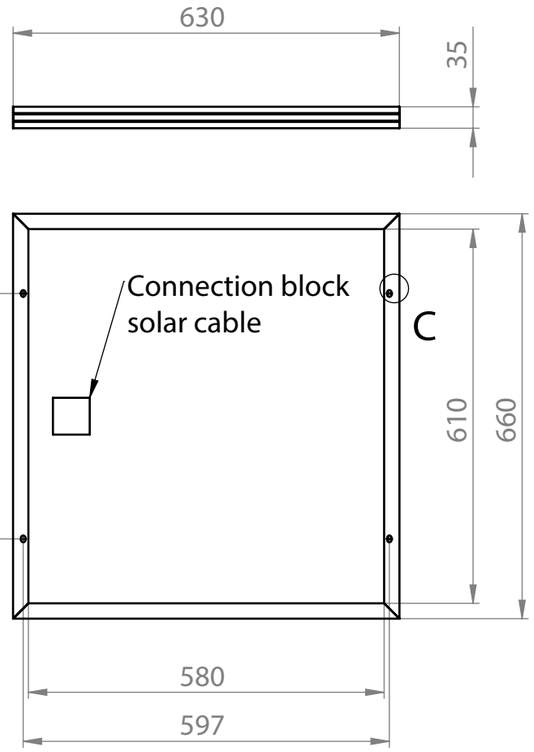
Industrial Design Engineering

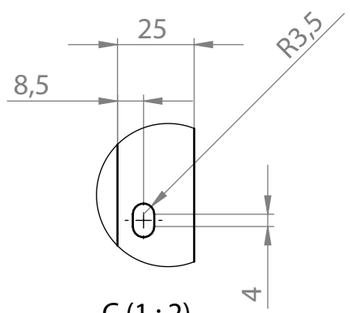
format A3

drawing no. ASM-4000

70Wp

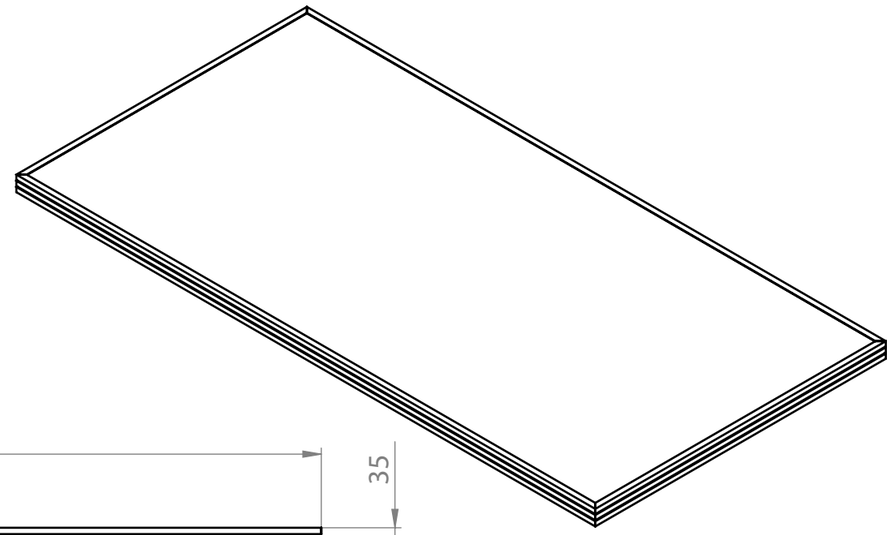


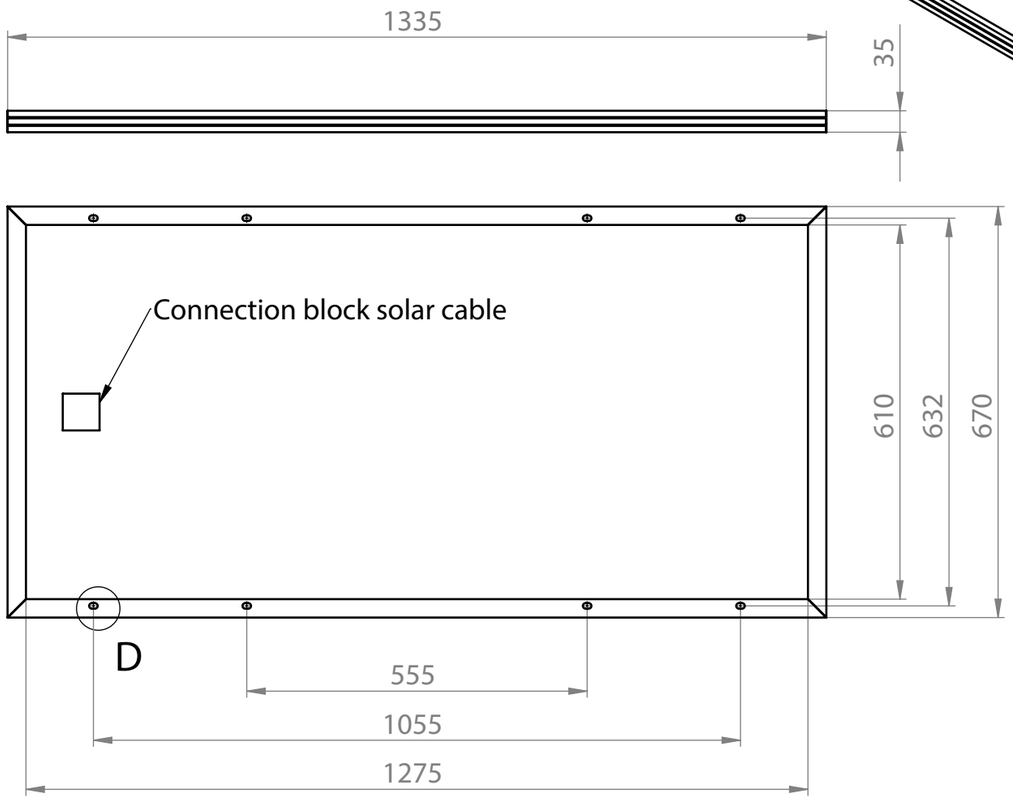


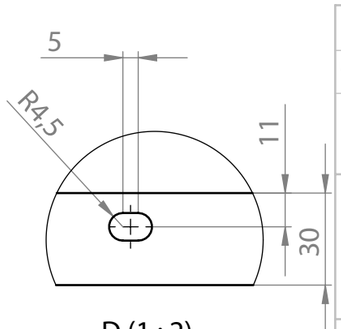


C (1 : 2)

130Wp







D (1 : 2)

scale 1:10		date 18-4-2017	remarks 70W and 130 W
units mm	weight grams		
author Kane JA		group -	

name

Solar Panels

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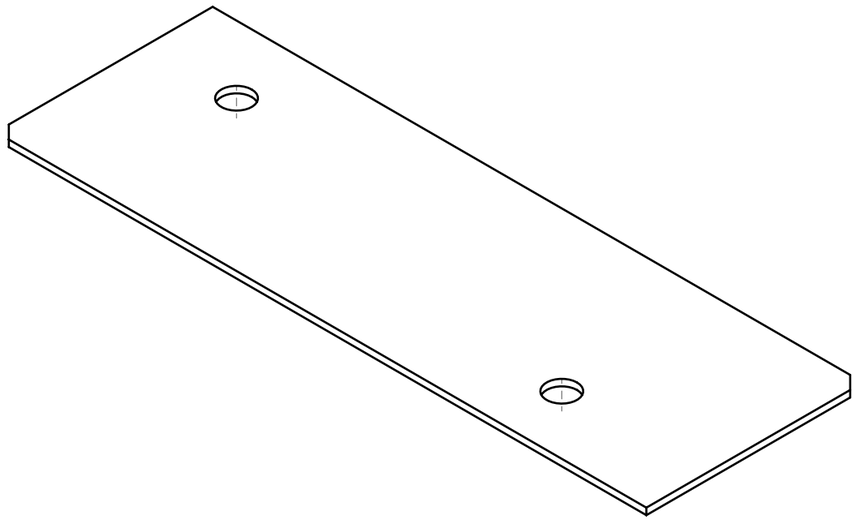
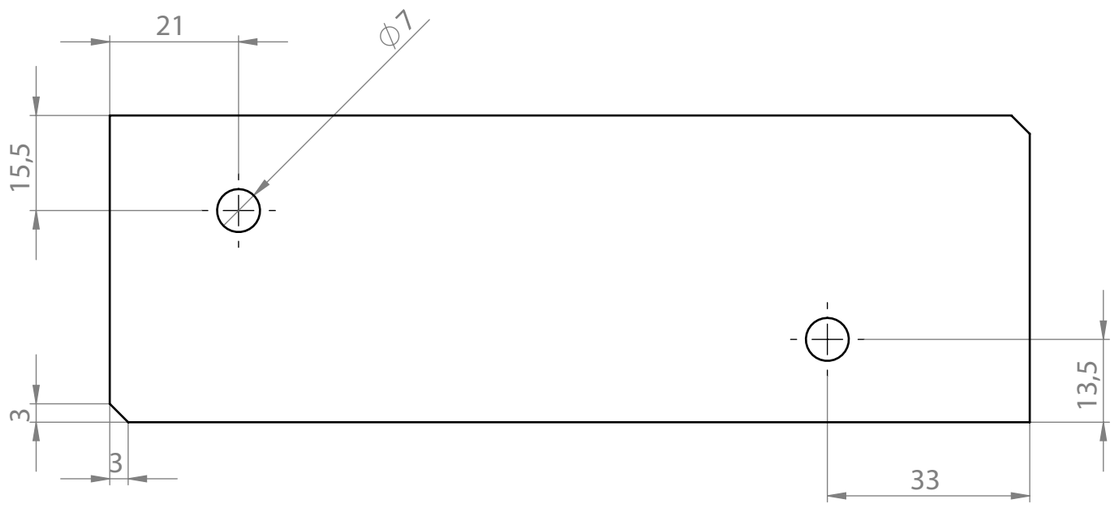
Industrial Design Engineering

format A3

drawing no. Solar Panels





scale 1:1		date 18-4-2017	remarks Panel clamp for 70W panel
units mm	weight grams		
author Kane JA		group -	

name

Solar Panels

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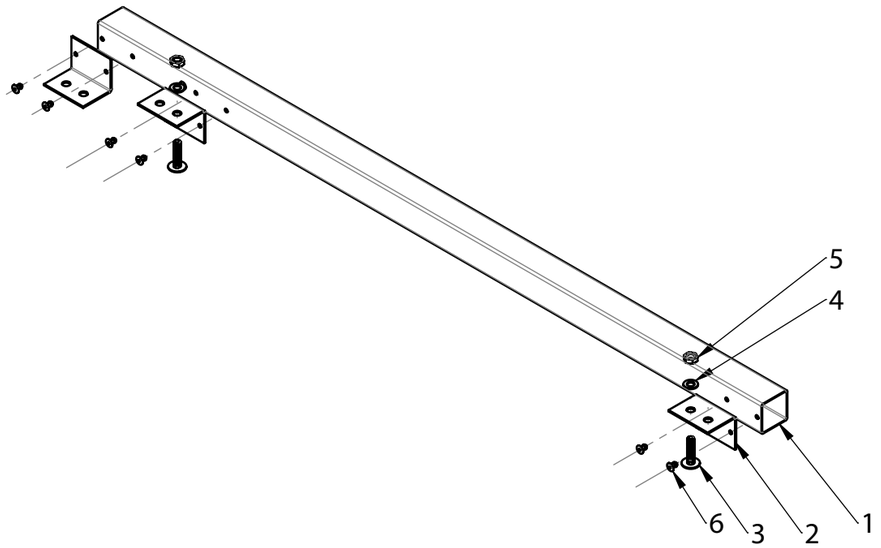
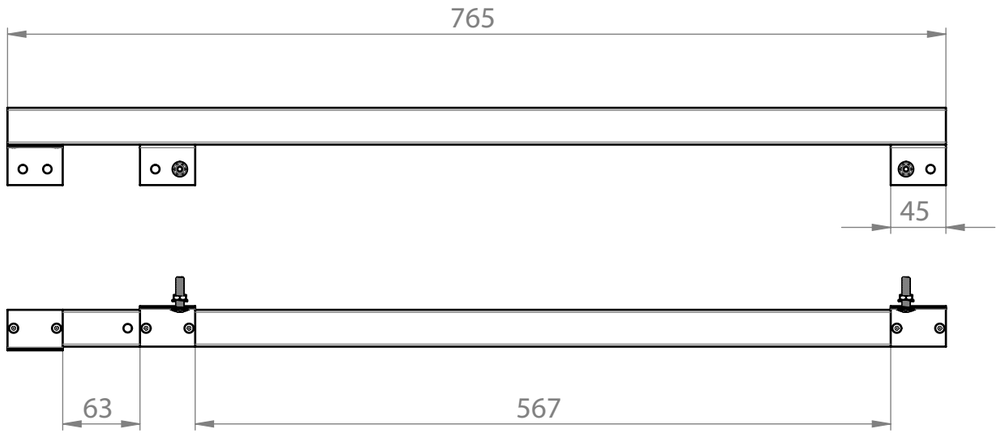
Industrial Design Engineering

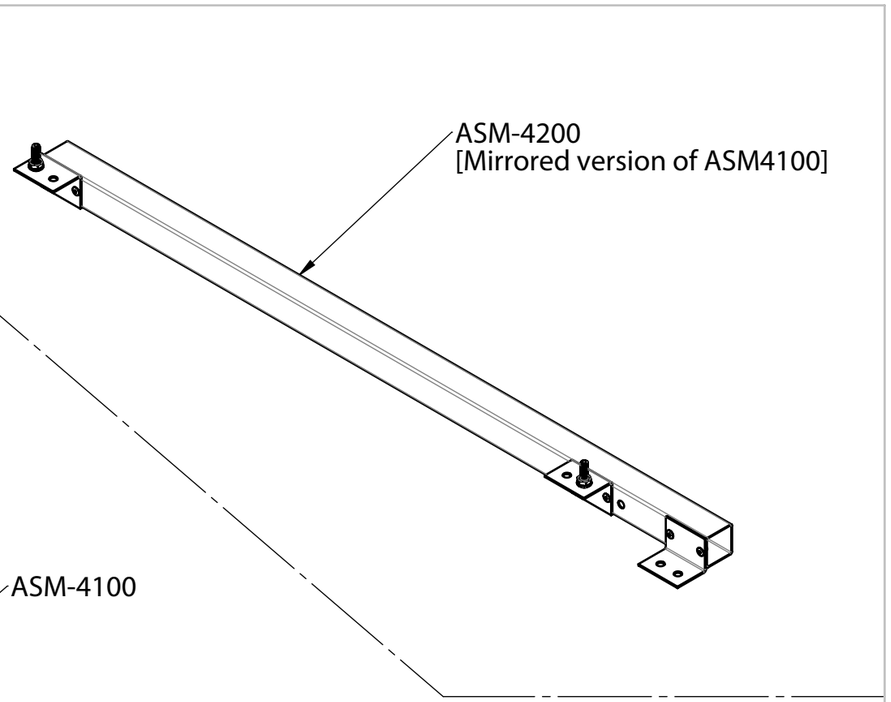
format A3

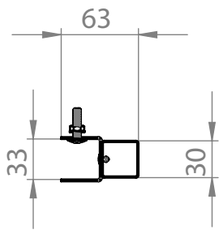
drawing no. PRT-4001

For base assembly mounted with profiles inward
For extensions mounted with profiles outward









Item No.	Qty.	Name	Material	Remarks / Drawing. No.
6	6	3,2x8 Blind Rivet	Aluminium	Bought in local shops PP
5	2	M6 Nut		
4	2	M6 Washer		
3	2	M6x25 Flathead	Galvanized steel	Bought in local shops PP
2	3	PRT-4102-Clip	Galvanized steel	Raw material PP - Produced in SA
1	1	PRT-4101-SupportArm	Galvanized steel	Raw material PP - Produced in SA

scale 1:5		date 18-4-2017	remarks Arms
units mm	weight	grams	
author Kane JA		group -	

name **Solar Panels**

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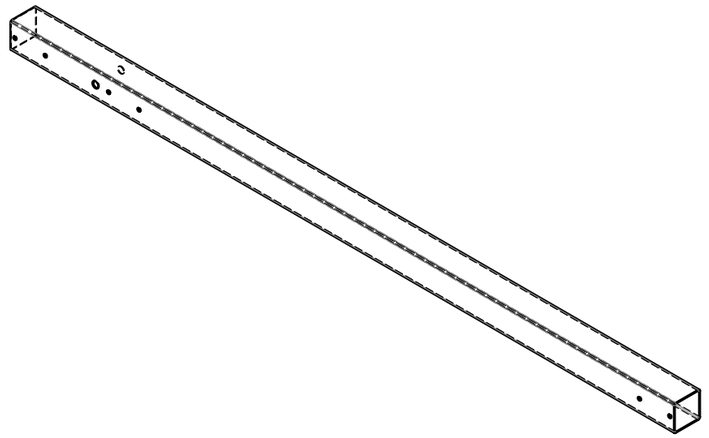
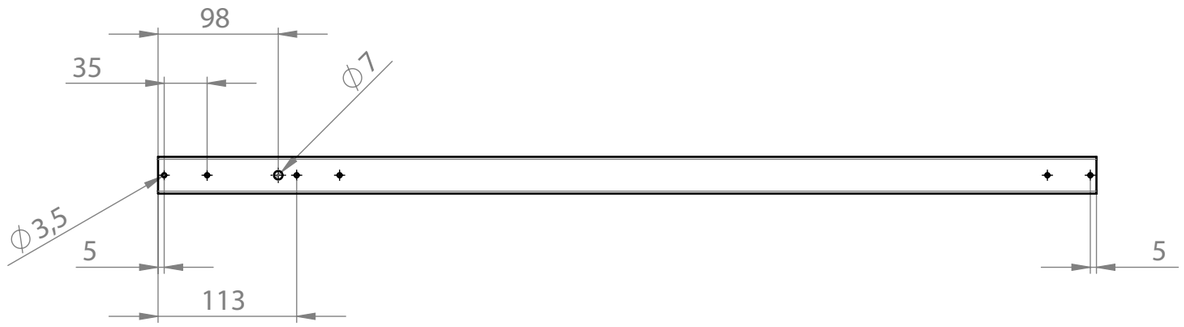
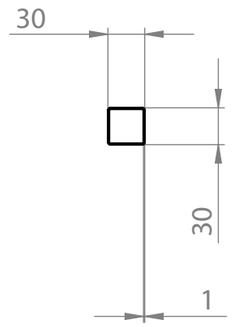
format A3

drawing no. SUB-4100 (4200)







scale 1:5		date 18-4-2017	remarks Support arm
units mm	weight grams		
author Kane JA		group -	

name **Solar Panels**

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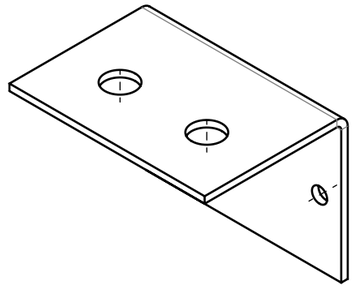
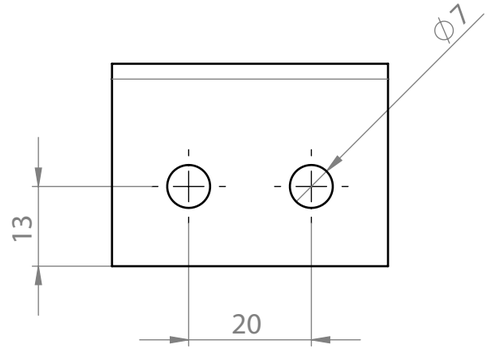
Industrial Design Engineering

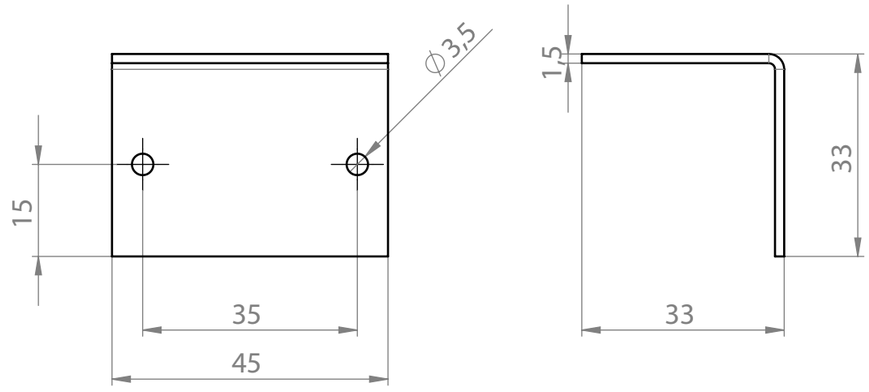
format A3

drawing no. PRT-4101

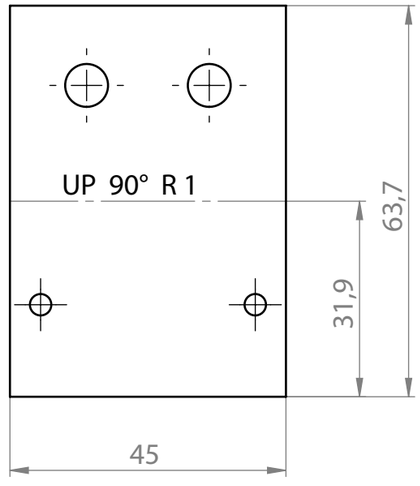
FOLD







FLAT



scale 1:1		date 18-4-2017	remarks Clip arm
units mm	weight grams		
author Kane JA		group -	

name

Solar Panels

56 | 57

TU Delft
Industrial Design Engineering

format A3

drawing no. PRT-4102

L Cost price calculation

On the following pages a calculation of the cost price (for the battery box and the mounting system) is given. It is an estimation of costs for all parts and components. The labour costs, packaging and accessories are not included in the calculation.

Description	Price (Riel)	Price (USD)	Per	Material	Bought in	Remarks	SW-Name	Amount Regular SHS	Cost	Amount Large SHS	Cost
Battery 55 Ah (Ritar)		$ 69,00	Piece		Import		PRT-1001-Ritar55Ah	1	$ 69,00	0	$ -
Battery 100 Ah (Ritar)		$ 96,14	Piece		Import		PRT-2001-Ritar100Ah	0	$ -	1	$ 96,14
Regular Box		$ 6,00	Piece	Fiberglass	Produced SA	Price estimated	PRT-1101-Box-R	1	$ 6,00	0	$ -
Large Box		$ 5,00	Piece	Fiberglass	Produced SA	Price estimated	PRT-2101-Box-L	0	$ -	1	$ 5,00
PCB (Powerboard + USB)		$ 35,00	Set	Electronics	Import china	Price estimated	PRT-0006-PCB-USB & PB-PCB	1	$ 35,00	1	$ 35,00
Cigarette socket		$ 0,71	Piece	Electronics	Local shops	PP	PRT-0004-C-Socket	2	$ 1,42	3	$ 2,13
IEC Socket Female		$ 0,04	Piece	Electronics	Local shops	PP	PRT-0003-IEC-F	1	$ 0,04	1	$ 0,04
IEC Socket Male		$ 0,19	Piece	Electronics	Local shops	PP	PRT-0003-IEC-M	2	$ 0,38	2	$ 0,38
Cooling sheet PCB		$ 0,30	Piece	Aluminium	Produced SA	Raw material PP	PRT-0101-PCBSheet	1	$ 0,30	1	$ 0,30
Bracket PCB		$ 0,02	Piece	Galv Steel	Produced SA	Raw material PP	PRT-0005-BracketPCB	3	$ 0,06	3	$ 0,06
Rivet		$ 0,01	Piece	Aluminium	Local shops		3,2x8 Blind Rivet	6	$ 0,03	6	$ 0,03
Battery holder		$ 0,08	Piece	Galv Steel	Produced SA	Raw material PP	PRT-2002-BracketBattery	0	$ -	2	$ 0,16
M3 Nut		$ 0,00	Piece	Galv Steel			M3 Nut	10	$ 0,03	10	$ 0,03
M3 Spacer 10mm		$ 0,05	Piece	Galv Steel			M3 Spacer 10	4	$ 0,20	4	$ 0,20
M6x16 bolt		$ -	-	Stainless Steel	-	Included in battery	M6x16	2	$ -	0	$ -
M3x20 Countersunk bolt		$ 0,02	Piece				M3x20 CS	10	$ 0,20	10	$ 0,20
Circuit Breaker		$ 2,26	Piece				PRT-0001-CircuitBreaker	1	$ 2,26	1	$ 2,26
M6 spring washer		$ -	-	Stainless Steel	-	Included in battery	M6 Washer s	2	$ -	0	$ -
M8 spring washer		$ -	-	Stainless Steel	-	Included in battery	M8 Washer s	0	$ -	2	$ -
M8x20 bolt		$ -	-	Stainless Steel	-	Included in battery	M8x20	0	$ -	2	$ -
3x12 Self tapping Torx		$ 0,02	Piece	Stainless Steel			3x12 Torx-st	7	$ 0,14	7	$ 0,14
M3 Spacer 3mm		$ 0,03	Piece				M3 Spacer 3	7	$ 0,21	7	$ 0,21
M5x16 Countersunk bolt		$ 0,04	Piece	Galv Steel			M5x16 CS	2	$ 0,08	4	$ 0,16
Faston 6.3 clip (red)		$ 0,01	Piece				6.3 Faston	15	$ 0,08	17	$ 0,09
Faston 6.3 clip (black)		$ 0,01	Piece				6.3 Faston B	15	$ 0,08	17	$ 0,09
Ring terminal M8 (red)		$ 0,01	Piece				M8 Ring Terminal	2	$ 0,02	2	$ 0,02
Ring terminal M8 (black)		$ 0,01	Piece				M8 Ring Terminal B	2	$ 0,02	2	$ 0,02
Closing lid software&configuartion access		$ 0,10	Piece				20.5 End Cap	1	$ 0,10	1	$ 0,10
Cable red 20cm		$ 0,10	Piece				-	7	$ 0,70	8	$ 0,80
Cable black 20cm		$ 0,10	Piece				-	7	$ 0,70	8	$ 0,80
Cable red 40cm		$ 0,20	Piece				-	1	$ 0,20	1	$ 0,20
Cable black 40cm		$ 0,20	Piece				-	1	$ 0,20	1	$ 0,20
									Regular SHS:		**Large SHS:**
							Total costs Battery boxes:		$ 117,44		$ 144,75

Description	Price (USD)	Details
Solar Panel 70W	$ 33,8800	JCN
Solar Panel 130W	$ 60,0600	JCN
Battery 55Ah	$ 69,0000	Ritar RA series
Battery 100Ah	$ 96,1400	Ritar RA series
Battery box Regular	$ 4,0000	Produced in-House
Battery box Large	$ 6,0000	Produced in-House
PCB-Display	$ 10,0000	
PCB-V3	$ 35,0000	
Solar Cable 130W	$ 17,1700	Produced in-House
Solar Cable 70W	$ 10,2700	Imported
LED-9W	$ 3,9700	
LED-5W	$ 2,2500	
Lamp Holder	$ 0,3000	

Description	Price (Riel)	Price (USD)	Per	Material	Bought in
Tube 40 x 20mm		$ 0,9167	meter	Galvanized steel	Local steel shops
Tube 20 x 20mm		$ 0,6667	meter	Galvanized steel	Local steel shops
Tube ø42mm		$ 0,6667	meter	Galvanized steel	Local steel shops
Cable 4,5mm	1.500៛	$ 0,3750	meter	Galvanized steel	Russian market area
Cable Lug HEX10-8		$ 0,1500	piece	Tin-copper	PP General Electrical Shop
Butt-Connector 16HEX 43mm		$ 0,3000	piece	Tin-copper	PP General Electrical Shop
Cable Tensioner no.6		$ 0,5000	piece	Galvanized steel	Russian market area
Threaded rod M6		$ 1,0000	meter	Galvanized steel	Russian market area
Bolt M6x120		$ 0,0300	piece	Galvanized steel	Russian market area
Bolt M6x25mm Flathead		$ 0,0100	piece	Galvanized steel	Russian market area
Bolt M6x50mm		$ 0,0200	piece	Galvanized steel	Russian market area
Rivet 3,2x8mm		$ 0,0050	piece	Galvanized steel	Russian market area
Washer M6		$ 0,0050	piece	Galvanized steel	Russian market area
Nut M6		$ 0,0100	piece	Galvanized steel	Russian market area
Steel Sheet 1,5mm		$ 6,6667	square meter	Galvanized steel	Local steel shops
Bolt M8x50		$ 0,0300	piece	Galvanized steel	Russian market area
Nut M8		$ 0,0200	piece	Galvanized steel	Russian market area
Washer M8		$ 0,0100	piece	Galvanized steel	Russian market area
Woodscrew M8x80		$ 0,0300	piece	Galvanized steel	Russian market area
Tube 30 x 30mm		$ 0,7500	meter	Galvanized steel	Local steel shops

Description	Material	Length (m), Surface (m x m) or Amount	Amount in assembly	Price (USD)		
Vertical support	Tube 30 x 30mm	0,585	2	$ 0,88	$ 3,58	Profiles
Horizontal support	Tube 30 x 30mm	0,95	2	$ 1,43		
Mounting pole	Tube ø42mm	0,95	1	$ 0,63		
Clamp pole	Steel Sheet 1,5mm	0,008	2	$ 0,11		
Bracket pole	Steel Sheet 1,5mm	0,0105	2	$ 0,14		
Rubber cover	Recycled car cover	1	1	$ 0,40		
Cable ASSEMBLY	Cable 4,5mm	0,4	4	$ 0,60	$ 2,90	Cable structure
	Cable Lug HEX10-8	2	4	$ 1,20		
Cable tension ASSEMBLY	Cable Tensioner no.6	2	1	$ 1,00		
	Threaded rod M6	0,1	1	$ 0,10		
Fasteners Base	Bolt M6x120	1	1	$ 0,03	$ 0,68	Fasteners
	Bolt M6x50mm	1	8	$ 0,16		
	Washer M6	1	24	$ 0,12		
	Nut M6	1	9	$ 0,09		
Fasteners Clamps	Bolt M6x50mm	1	4	$ 0,08		
	Nut M6	1	4	$ 0,04		
	Washer M6	1	8	$ 0,04		
	Woodscrew M8x80	1	4	$ 0,12		
			Total Mounting Pole:	$ 7,16		

Description	Material	Length (m), Surface (m x m) or Amount	Amount in assembly	Price (USD)		
Arm	Tube 30 x 30mm	0,77	1	$ 0,58	$ 0,74	Profiles
Solar Support Clamp	Steel Sheet 1,5mm	0,008	3	$ 0,16		
Fasteners	Rivet 3,2x8mm	1	6	$ 0,03	$ 0,26	Fasteners
	Bolt M6x25mm Flathead	1	8	$ 0,08		
	Washer M6	1	8	$ 0,04		
	Bolt M6x120	1	1	$ 0,03		
	Nut M6	1	8	$ 0,08		
Solar Panel	Solar Panel 70W	1	1	$ 33,88	$ 44,35	Panel regular
Solar panel Connection clamp	Steel Sheet 1,5mm	0,0075	4	$ 0,20		
cable	Solar Cable 70W	1	1	$ 10,27		
Solar Panel	Solar Panel 130W	1	1	$ 60,06	$ 77,23	Panel large
cable	Solar Cable 130W	1	1	$ 17,17		
			Extension:	$ 1,00		
			Total Regular Extension:	$ 46,15		
			Total Large Extension:	$ 79,23		

M Three-year repayment schedule redesign

រំសិនហ្វាន់	2,00%
តំលៃ SHS 70W CORE	400 $
បង់រំលោះ២ឆ្នាំ	36 (ខែ)

	បា្រក់ដើមនៅដំពាក់	បា្រក់ដើមត្រូវបង់	ការប្រាក់	បា្រក់សរុបដែលត្រូវបង់	
ខែទី1	400,00	11,11	8,00	**19,11**	
ខែទី2	388,89	11,11	7,78	**18,89**	
ខែទី3	377,78	11,11	7,56	**18,67**	
ខែទី4	366,67	11,11	7,33	**18,44**	
ខែទី5	355,56	11,11	7,11	**18,22**	
ខែទី6	344,44	11,11	6,89	**18,00**	
ខែទី7	333,33	11,11	6,67	**17,78**	
ខែទី8	322,22	11,11	6,44	**17,56**	
ខែទី9	311,11	11,11	6,22	**17,33**	
ខែទី10	300,00	11,11	6,00	**17,11**	
ខែទី11	288,89	11,11	5,78	**16,89**	
ខែទី12	277,78	11,11	5,56	**16,67**	
ខែទី13	266,67	11,11	5,33	**16,44**	
ខែទី14	255,56	11,11	5,11	**16,22**	
ខែទី15	244,44	11,11	4,89	**16,00**	
ខែទី16	233,33	11,11	4,67	**15,78**	
ខែទី17	222,22	11,11	4,44	**15,56**	
ខែទី18	211,11	11,11	4,22	**15,33**	
ខែទី19	200,00	11,11	4,00	**15,11**	
ខែទី20	188,89	11,11	3,78	**14,89**	
ខែទី21	177,78	11,11	3,56	**14,67**	
ខែទី22	166,67	11,11	3,33	**14,44**	
ខែទី23	155,56	11,11	3,11	**14,22**	
ខែទី24	144,44	11,11	2,89	**14,00**	
ខែទី25	133,33	11,11	2,67	**13,78**	
ខែទី26	122,22	11,11	2,44	**13,56**	
ខែទី27	111,11	11,11	2,22	**13,33**	
ខែទី28	100,00	11,11	2,00	**13,11**	
ខែទី29	88,89	11,11	1,78	**12,89**	
ខែទី30	77,78	11,11	1,56	**12,67**	
ខែទី31	66,67	11,11	1,33	**12,44**	
ខែទី32	55,56	11,11	1,11	**12,22**	
ខែទី33	44,44	11,11	0,89	**12,00**	
ខែទី34	33,33	11,11	0,67	**11,78**	
ខែទី35	22,22	11,11	0,44	**11,56**	
ខែទី36	11,11	11,11	0,22	**11,33**	15,22
	សរុប	**400,00**	**148,00**	**548,00**	

រំសិនហាន់	2,00%
តំលៃ SHS 70W CORE	350 $
បង់រំលោះ២ឆ្នាំ	36 (ខែ)

	បា្រាក់ដើមនៅជំពាក់	បា្រាក់ដើមត្រូវបង់	ការប្រាក់	បា្រាក់សរុបដែលត្រូវបង់	
ខែទី1	350,00	9,72	7,00	**16,72**	
ខែទី2	340,28	9,72	6,81	**16,53**	
ខែទី3	330,56	9,72	6,61	**16,33**	
ខែទី4	320,83	9,72	6,42	**16,14**	
ខែទី5	311,11	9,72	6,22	**15,94**	
ខែទី6	301,39	9,72	6,03	**15,75**	
ខែទី7	291,67	9,72	5,83	**15,56**	
ខែទី8	281,94	9,72	5,64	**15,36**	
ខែទី9	272,22	9,72	5,44	**15,17**	
ខែទី10	262,50	9,72	5,25	**14,97**	
ខែទី11	252,78	9,72	5,06	**14,78**	
ខែទី12	243,06	9,72	4,86	**14,58**	
ខែទី13	233,33	9,72	4,67	**14,39**	
ខែទី14	223,61	9,72	4,47	**14,19**	
ខែទី15	213,89	9,72	4,28	**14,00**	
ខែទី16	204,17	9,72	4,08	**13,81**	
ខែទី17	194,44	9,72	3,89	**13,61**	
ខែទី18	184,72	9,72	3,69	**13,42**	
ខែទី19	175,00	9,72	3,50	**13,22**	
ខែទី20	165,28	9,72	3,31	**13,03**	
ខែទី21	155,56	9,72	3,11	**12,83**	
ខែទី22	145,83	9,72	2,92	**12,64**	
ខែទី23	136,11	9,72	2,72	**12,44**	
ខែទី24	126,39	9,72	2,53	**12,25**	
ខែទី25	116,67	9,72	2,33	**12,06**	
ខែទី26	106,94	9,72	2,14	**11,86**	
ខែទី27	97,22	9,72	1,94	**11,67**	
ខែទី28	87,50	9,72	1,75	**11,47**	
ខែទី29	77,78	9,72	1,56	**11,28**	
ខែទី30	68,06	9,72	1,36	**11,08**	
ខែទី31	58,33	9,72	1,17	**10,89**	
ខែទី32	48,61	9,72	0,97	**10,69**	
ខែទី33	38,89	9,72	0,78	**10,50**	
ខែទី34	29,17	9,72	0,58	**10,31**	
ខែទី35	19,44	9,72	0,39	**10,11**	
ខែទី36	9,72	9,72	0,19	**9,92**	13,32
	សរុប	**350,00**	**129,50**	**479,50**	

វិសិនហា្វន់	2,00%
តំលៃ SHS 130W CORE	530 $
បង់រំលោះ២ឆ្នាំ	36 (ខែ)

	បា្រក់ដើមនៅដំពាក់	បា្រក់ដើមតួរបង់	ការប្រាក់	បា្រក់សរុបដែលតួរបង់
ខែទី1	530,00	14,72	10,60	**25,32**
ខែទី2	515,28	14,72	10,31	**25,03**
ខែទី3	500,56	14,72	10,01	**24,73**
ខែទី4	485,83	14,72	9,72	**24,44**
ខែទី5	471,11	14,72	9,42	**24,14**
ខែទី6	456,39	14,72	9,13	**23,85**
ខែទី7	441,67	14,72	8,83	**23,56**
ខែទី8	426,94	14,72	8,54	**23,26**
ខែទី9	412,22	14,72	8,24	**22,97**
ខែទី10	397,50	14,72	7,95	**22,67**
ខែទី11	382,78	14,72	7,66	**22,38**
ខែទី12	368,06	14,72	7,36	**22,08**
ខែទី13	353,33	14,72	7,07	**21,79**
ខែទី14	338,61	14,72	6,77	**21,49**
ខែទី15	323,89	14,72	6,48	**21,20**
ខែទី16	309,17	14,72	6,18	**20,91**
ខែទី17	294,44	14,72	5,89	**20,61**
ខែទី18	279,72	14,72	5,59	**20,32**
ខែទី19	265,00	14,72	5,30	**20,02**
ខែទី20	250,28	14,72	5,01	**19,73**
ខែទី21	235,56	14,72	4,71	**19,43**
ខែទី22	220,83	14,72	4,42	**19,14**
ខែទី23	206,11	14,72	4,12	**18,84**
ខែទី24	191,39	14,72	3,83	**18,55**
ខែទី25	176,67	14,72	3,53	**18,26**
ខែទី26	161,94	14,72	3,24	**17,96**
ខែទី27	147,22	14,72	2,94	**17,67**
ខែទី28	132,50	14,72	2,65	**17,37**
ខែទី29	117,78	14,72	2,36	**17,08**
ខែទី30	103,06	14,72	2,06	**16,78**
ខែទី31	88,33	14,72	1,77	**16,49**
ខែទី32	73,61	14,72	1,47	**16,19**
ខែទី33	58,89	14,72	1,18	**15,90**
ខែទី34	44,17	14,72	0,88	**15,61**
ខែទី35	29,44	14,72	0,59	**15,31**
ខែទី36	14,72	14,72	0,29	**15,02**
	សរុប	**530,00**	**196,10**	**726,10**

20,17

វិសិនហា្វន់	2,00%
តំលៃ SHS 130W EXP	480 $
បង់រំលោះ២ឆ្នាំ	36 (ខែ)

	បា្រក់ដើមនៅដំពាក់	បា្រក់ដើមតា្លបង់	ការបា្រក់	បា្រក់សរុបដែលតា្លបង់
ខែទី1	480,00	13,33	9,60	**22,93**
ខែទី2	466,67	13,33	9,33	**22,67**
ខែទី3	453,33	13,33	9,07	**22,40**
ខែទី4	440,00	13,33	8,80	**22,13**
ខែទី5	426,67	13,33	8,53	**21,87**
ខែទី6	413,33	13,33	8,27	**21,60**
ខែទី7	400,00	13,33	8,00	**21,33**
ខែទី8	386,67	13,33	7,73	**21,07**
ខែទី9	373,33	13,33	7,47	**20,80**
ខែទី10	360,00	13,33	7,20	**20,53**
ខែទី11	346,67	13,33	6,93	**20,27**
ខែទី12	333,33	13,33	6,67	**20,00**
ខែទី13	320,00	13,33	6,40	**19,73**
ខែទី14	306,67	13,33	6,13	**19,47**
ខែទី15	293,33	13,33	5,87	**19,20**
ខែទី16	280,00	13,33	5,60	**18,93**
ខែទី17	266,67	13,33	5,33	**18,67**
ខែទី18	253,33	13,33	5,07	**18,40**
ខែទី19	240,00	13,33	4,80	**18,13**
ខែទី20	226,67	13,33	4,53	**17,87**
ខែទី21	213,33	13,33	4,27	**17,60**
ខែទី22	200,00	13,33	4,00	**17,33**
ខែទី23	186,67	13,33	3,73	**17,07**
ខែទី24	173,33	13,33	3,47	**16,80**
ខែទី25	160,00	13,33	3,20	**16,53**
ខែទី26	146,67	13,33	2,93	**16,27**
ខែទី27	133,33	13,33	2,67	**16,00**
ខែទី28	120,00	13,33	2,40	**15,73**
ខែទី29	106,67	13,33	2,13	**15,47**
ខែទី30	93,33	13,33	1,87	**15,20**
ខែទី31	80,00	13,33	1,60	**14,93**
ខែទី32	66,67	13,33	1,33	**14,67**
ខែទី33	53,33	13,33	1,07	**14,40**
ខែទី34	40,00	13,33	0,80	**14,13**
ខែទី35	26,67	13,33	0,53	**13,87**
ខែទី36	13,33	13,33	0,27	**13,60**
	សរុប	**480,00**	**177,60**	**657,60**

18,27