How to use the 3 kW three-channel interleaved PFC based on the STNRGPF01 digital controller

Introduction

The STEVAL-IPFC01V1 3 kW interleaved PFC reference design is based on the STNRGPF01 digital controller and includes a separate power board, control board and programming board. The STNRGPF01 is a digital configurable ASIC developed by STMicroelectronics, which can drive up to three channels in an interleaved PFC for industrial applications.

The STNRGPF01 digital controller on the control board implements mixed signal (analog/digital) average current mode control in CCM at fixed frequency. The analog section ensures cycle-by-cycle current regulation, while digital control manages the non-time critical operations. You can use the eDesignSuite software available on the ST website to configure the STNRGPF01 to satisfy the specifications of each interleaved PFC.

Figure 1. STEVAL-IPFC01V1 3 kW interleaved PFC reference design

1 Safety instructions

Danger:

The evaluation board uses voltage levels that can cause serious injury and even death.

Do not touch any of the boards immediately after disconnecting the input power supply as the charged capacitors need time to discharge.

Due to the high power density, the board components and the heat sink can become very hot and cause severe burns when touched.

This board is intended for use by skilled technical personnel who are suitably qualified and familiar with the installation, use and maintenance of power electronic systems. The same personnel must be aware of and must apply national accident prevention rules.

The electrical installation shall be completed in accordance with the appropriate requirements (e.g., cross-sectional areas of conductors, fusing, and GND connections).

2 STEVAL-IPFC01V1 evaluation kit overview

Figure 2. STEVAL-IPFC01V1 block diagram

1. I/O measurement signals
2. Analog circuitry
3. Power stage
4. Digital control section with STNRGPF01 digital controller

The STEVAL-IPFC01V1 implements mixed signal (analog/digital) control, so the converter can manage a range of input and output conditions and still remain highly responsive to fast transients in input signals. The inner current loop is a hardware analog proportional-integral (PI) compensator that ensures the highest possible bandwidth and cycle-by-cycle sensing and regulation. The outer voltage loop is performed by a digital PI controller with fast dynamic response.

2.1 Features

- Input voltage range: 90 to 265 V_{AC}
- Line frequency range: 47 to 63 Hz
- Maximum output power: 3 kW at 230 V
- Output voltage: 400 V
- Power factor: > 0.98 at 20% load
- Total Harmonic Distortion: <5% at 20% load
- Mixed-signal average current mode control, CCM fixed frequency operation
- Switching Frequency: 111 kHz
- Cycle-by-cycle regulation (analog current control loop)
- Input voltage and load feed-forwards
- Phase shedding
- Burst-mode operation
- Overvoltage protection
- Thermal protection
- Status indicator LEDs
- Inrush current limiter function
- Cooling function

3 How to use the STEVAL-IPFC01V1 evaluation board

To perform functional and efficiency testing, you need the following equipment:

- Programmable AC source with power > 3 kW
- DC electronic load/or load resistor > 3 kW
- Power analyzer
- Digital oscilloscope

The STEVAL-IPFC01V1 board can be tested at up to 3 kW at 230 V_{RMS} and 1.5 kW at 115 V_{RMS}, in a frequency range between 47 and 63 Hz.

Note: Any load or passive oscilloscope probe must be isolated from the input source for the PFC.

3.1 How to connect and start the STEVAL-IPFC01P1 power board

Step 1. Insert the STEVAL-IPFC01C1 control board in connector J301 on the STEVAL-IPFC01P1 power board.

Figure 3. STEVAL-IPFC01C1 insertion in STEVAL-IPFC01P1 J301 connector

Step 2. Connect a 230 V/50 Hz or 115 V/60 Hz AC source to the J2 connector on the STEVAL-IPFC01P1 power board.

Figure 4. STEVAL-IPFC01V1 AC source connection

Step 3. Connect the load wires to the J1 output terminals on the STEVAL-IPFC01P1 power board.

The actual load (electronic dc load, load resistors, inverter, etc.) must remain disconnected until the soft startup sequence has completed.

The correct polarity is indicated on the board.

Figure 5. STEVAL- IPFC01V1 DC output connection

Step 4. Supply one of the following input voltage and frequency ranges while no load is connected on the output:

- 185 – 265 V_{AC} at 47 - 53 Hz
- 90 – 140 V_{AC} at 57 – 63 Hz

Step 5. Wait for the green LED D2 on the STEVAL-IPFC01C1 control board to light up.

The LED indicates that the startup sequence has finished.

Step 6. Connect the load.

Do not connect the load before the green LED indicates that the board is ready or you may damage the board.

3.1.1 STEVAL-IPFC01P1 power board startup sequence

1. The appropriate AC input voltage is applied under a no load condition.
   - 185 – 265 V_{AC} at 47 - 53 Hz
   - 90 – 140 V_{AC} at 57 – 63 Hz)
2. When the input voltage rises above 60 V, the auxiliary power supply starts and generates the auxiliary voltages (15 V_{DC} and 5 V_{DC}) for the drivers and the signal conditioning circuitry.
3. Once the auxiliary voltages are nominal, the inrush current limiter phase begins by charging the output capacitor until the DC voltage reaches the peak input voltage. The charge current is limited by resistor R101.

Figure 6. STEVAL-IPFC01V1 DC input connection

1. The STNRGPF01 then checks for any output current flow:
   – If there is no current, the STNRGPF01 closes the contacts of a mechanical relay in parallel with resistor R101.
   – If any current is detected, the STNRGPF01 will keep the relay contacts on R101 open (so the board cannot start) until the current falls to zero.
2. After the inrush limiter phase, the soft startup is activated and the output voltage rises up to 436 V_{DC}, at which point the PFC enters burst mode to regulate the output voltage between 416 and 436 V_{DC}.
3. The green LED D2 on the control board indicates that the sequence has finished and the PFC is ready for the load to be connected:
   – the output voltage is regulated to 400 V ±2 V.
   – for 185 – 265 V 50 Hz mains, the maximum output power is 3000 W
   – for 90 – 140 V 60 Hz mains, the maximum output power is 1500 W

Warning:

If the load is connected before the Inrush current limiter phase, a very high current will flow into the PFC and possibly damage the board when the relay closes the contacts across resistor R101.

4 PFC controller customization with eDesign Suite

The eDesignSuite suite software tool developed by STMicroelectronics helps you configure ST products power conversion applications. You can use it to customize the PFC controller for a specific application: you start by entering the main specifications for your design and then generate an automatic design or follow a sequential process to build a highly customized design.

Figure 7. PFC specifications

Figure 8. PFC step-by-step design

RELATED LINKS

See RM0446 for details on how to use eDesignSuite to generate specialized firmware

5 Status LEDs and fault conditions

The STEVAL-IPFC01C1 control board has a green LED and a red LED connected to STNRGPF01 pin 15 (PFC_OK) and pin 14 (PFC_FAULT), respectively.

5.1 Normal operation

During normal operation, the green LED (D1) on the STEVAL-IPFC01C1 control board remains lit to indicate that the PFC is operating under allowable conditions.

5.2 Fault conditions

When a fault is detected, the red LED (D2) on the STEVAL-IPFC01C1 control board is lit and the green LED (D1) is switched off. The device stops all switching activities and turns off the fan.

After a fault condition, the board must be reset by switching off the AC input voltage and discharging the output capacitors.

Warning:
Do not short the output terminals to discharge the capacitors as the high discharge current may damage the output current sensing circuitry.

The following conditions will trigger fault protection:

- Frequency or voltage out of range or highly irregular input voltage waveforms that inhibit frequency measurement. For example, if the input voltage is 230 Vrms but the mains frequency is 60 Hz, or if the input voltage is 115 Vrms and the mains frequency is 50 Hz.
- Overcurrent condition on at least one PFC channel. This protection prevents PFC inductor saturation.
- Overvoltage protection on output voltage if the output voltage exceeds 450 V_{DC}
- Overvoltage protection on input voltage:
  - for 115 V nominal supply: above 140 V
  - for 230 V nominal supply: above 265 V
- Over-temperature protection when the ambient temperature of the board exceeds the threshold setting.

5.3 Wait conditions

The following conditions are signaled when both the green LED (D1) and the red LED (D2) on the STEVAL-IPFC01C1 control board switched off:

- Undervoltage condition on the output when the DC bus voltage falls below 340 V.
- Undervoltage condition on input when the input rms voltage falls below 90 V at 60 Hz or 185 V at 50 Hz.
- Input voltage dropout when the input voltage signal disappears for more than 25 ms.

Under these conditions, the STNRGPF01 will drive both LEDs on the control board off and will wait until the conditions have cleared before repeating the startup sequence.

6 STEVAL-IPFC01P1 power board schematics

Figure 9. STEVAL-IPFC01P1 schematic - input section

Figure 10. STEVAL-IPFC01P1 schematic - auxiliary power supply

Figure 11. STEVAL-IPFC01P1 schematic - boost interleaving section

7 STEVAL-IPFC01C1 control board schematic

Figure 12. STEVAL-IPFC01C1 schematic

8 STEVAL-IPFC01A1 adapter board schematic

Figure 13. STEVAL-IPFC01A1 schematic

9 STEVAL-IPFC01V1 3 kW interleaved PFC bill of materials

Table 1. STEVAL-IPFC01V1 bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	1	-	STEVAL-IPFC01P1	Power board	ST	not available separately
2	1	-	STEVAL-IPFC01C1	Control board	ST	not available separately
3	1	-	STEVAL-IPFC01A1	adapter board	ST	not available separately

9.1 STEVAL-IPFC01P1 power board bill of materials

Table 2. STEVAL-IPFC01P1 bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	1	C100	100nF, 275Vac, ±20%	POLYPROPILENE FILM CAP, through hole lead spacing 15mm	PANASONIC	ECQUAAF104MA
2	1	C101	100nF, 50V, ±10%	0603	ANY	ANY
3	1	C102	1nF, 500Vdc, ±20%	Ceramic disc cap, through hole lead spacing 7.5mm	VISHAY BC COMPONENTS	VY1102M35Y5UG63V0
4	3	C200, C204, C208	470nF, 50V, ±20%	X7R Ceramic Capacitor, 0805	TDK	CGA4J3X7R1H474M125AE
5	3	C201, C202, C203	470µF, 25V, ±20%	Electrolytic capacitor +105°, TH 8mm diameter, 3.5mm lead spacing	ANY	ANY
6	1	C205	10µF, 25V, ±20%	Electrolytic capacitor +105°, through hole lead spacing 2.5mm	ANY	ANY
7	2	C206, C207	4.7µF, 50V, ±10%	Ceramic Capacitor, 1210	MULTICOMP	MULTICOMP
8	1	C209	4.7nF, 50V, ±10%	X7R Ceramic Capacitor, 0603	ANY	ANY
9	2	C210, C340	1nF, 50V, ±10%	X7R Ceramic Capacitor, 0603	ANY	ANY
10	4	C300, C301, C302, C303	470µF, 450V, ±20%	Electrolytic capacitor +105°, through hole lead spacing 10mm	Nichicon	LGL2W471MELC35
11	1	C304	0.56µF, 450V, ±10%	POLYPROPILENE FILM CAP, through hole lead spacing 22.5mm	EPCOS	B32673P6564K000
12	1	C305	1µF, 520V, ±10%	POLYPROPILENE FILM CAP, through hole lead spacing 22.5mm	EPCOS	B32673Z5105K000

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
13	11	C306, C328, C329, C330, C334, C307, C323, C324, C325, C332, C339	10nF, 50V, ±10%	X7R Ceramic Capacitor, 0603	ANY	ANY
14	3	C308, C309, C310	100pF, 630 Vdc, ±5%	POLYPROPILENE FILM CAP, through hole lead spacing 5mm	KEMET	PFR5101J630J11L4BULK
15	4	C311, C312, C313, C326	100pF, 50V, ±5%	COG Ceramic Capacitor, 0603	ANY	ANY
16	11	C316, C317, C319, C322, C331, C335, C336, C337, C338, C318, C320	100nF, 50V, ±10%	X7R Ceramic Capacitor, 0603	ANY	ANY
17	1	C327	3.3nF, 50V, ±5%	C0G Ceramic Capacitor, 0603	ANY	ANY
18	3	C328, C329, C330	150 pF, 50V, ±5%	C0G Ceramic Capacitor, 0603	ANY	ANY
19	1	C333	1nF, 50V, ±5%	C0G Ceramic Capacitor, 0603	ANY	ANY
20	18	D100, D203, D303, D304, D305, D306, D307, D308, D309, D310, D311, D312, D313, D314, D316, D317, D318, D319	30V, 1A	Power schottky diode, SMA	ST	STPS1L30A
21	1	D101	50A, 1000V, 50A	Single Phase Bridge Rectifier, GBJ	HY Electronic Corp	GBJ5010
22	3	D102, D103, D104	GF1M, 1000V, 1A	General Purpose Rectifier Diode, SMA	ON Semiconductor	GF1M
23	1	D200	220V	TRANSIL, SMB	ST	SM6T220A
24	1	D201	150V, 2A	Power schottky diode, SMA	ST	STPS2150A
25	1	D202	1000V, 1A	Turbo 2 ultrafast high voltage rectifier, SMA	ST	STTH1L06A
26	1	D204	100V, 150mA	Small signal Schottky diode, SMD Minimelf	ST	TMMBAT46FILM
27	3	D300, D301, D302	600V, 12A	Silicon carbide high voltage rectifier, TO220AC	ST	STPSC12065D
28	1	D315	100V, 150mA	Small signal Schottky diode, SOD-323	ST	BAT46JFILM
29	1	F100	20A, 250Vac, 20A, 0%	Cylindrical Fuse Class gG/gL and aM, SMD 10x3 mm	Bel Fuse Inc.	SMM 20

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
30	1	ISO100	80V, 50mA , 0%	Optocoupler, SMD	Toshiba	TLP385
31	1	J100	VIN, 630V, 17.5A	PCB terminal block, through hole lead spacing 7.5mm	Phoenix Contact	1717033
32	1	J300	VOUT, 300Vac, 25A	PCB terminal block, through hole lead spacing 7.62mm	RS Pro	790-1130
33	1	J301	CON40A, 550Vca, 6.9A	PCB terminal block female, through hole lead spacing 2.54 mm	Samtec	ESQ12037GD
34	1	L100	2x 4.5 mH, 250V, 18A, ±20%	Common Mode Power Line Choke, through hole	WURTH ELEKTRONIK	7448051804
35	1	L200	4.7uH, 1.7A, ±20%	SMD Inductor, SMD 4.5x4mm	NIC COMPONENTS	NPI43C4R7MTRF
36	1	L201	2.2mH, 0.47A, ±10%	Switch Mode Transformer, through hole	AQ Magnetica OR Würth Elektronik	2198.0037 OR 750 318 675
37	3	L300, L301, L302	±10%	Power inductor, through hole PQ32	AQ Magnetica OR Würth Elektronik	2083.0011 OR 750316867
38	2	Q100, Q304	18V, 1A	N-channel 20 V, Power MOSFET, SO8	ST	STS6NF20V
39	3	Q300, Q301, Q302	600V, 40A	MDmesh II Plus™ low Qg, TO-247	ST	STW40N60M2
40	1	Q303	45V, 200 mA	BJT NPN small signal transistor, SOT-23	ON Semiconductor	MMBT6429LT1G
41	1	RL100	250Vac-16A, 250V, 16A, 0%	RELAY SPST, through hole	SCHRACK - TE CONNECTIVITY	RT314018
42	1	RV100	S14K275, 275Vac, ±10%	METAL OXIDE VARISTORS, through hole lead spacing 6mm	EPCOS	B72214S0271K101
43	2	R100, R360	22, 200V, ±1%	Metal film resistor, 1206	ANY	ANY
44	1	R101	150, 350V, ±5%	High power ceramic resistors, through hole	TE Connectivity	SQMW5150RJ
45	4	R102, R203, R362	33k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
46	7	R103, R104, R112, R113, R301, R304, R308	470k, 200V, ±1%	Metal film resistor, 1206	ANY	ANY
47	3	R105, R108, R109	33k, 200V, ±1%	Metal film resistor, 1206	ANY	ANY
48	1	R106	100k, 200V, ±1%	Metal film resistor, 1206	ANY	ANY

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
49	2	R107, R111	10M, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
50	1	R110	47k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
51	1	R114	3k ±0.1%, 50V, 0%	Metal film resistor, 0603	ANY	ANY
52	1	R200	3.3k, 200V, ±1%	Metal film resistor, 1206	ANY	ANY
53	1	R202	100, 200V, ±1%	Metal film resistor, 1206	ANY	ANY
54	1	R204	12k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
55	1	R205	24k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
56	2	R206, R207	2.7, 200V, ±1%	Professional MELF Resistors, MELF 0204	Vishay	MMA02040C2708FB300
57	1	R208	24k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
58	1	R300	30m, ±1%	Ultra Precision Current Sensing Chip Resistor, SMD 4527	Stackpole Electronics Inc.	CSS4527FT30L0
59	11	R302, R303, R332, R334, R336, R339, R341, R343, R351, R352, R367	100, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
60	3	R305, R306, R307	510, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
61	10	R309, R310, R333, R335, R337, R340, R342, R344, R356, R358	2.2k ±0.1%, 75V, 0%	Metal film resistor, 0603	ANY	ANY
62	2	R311, R325	10k ±0.1%, 50V, 0%	Metal film resistor, 0603	ANY	ANY
63	3	R312, R313, R314	33, 200V, ±1%	High Power Thick Film Resistor, 1206	ANY	ANY
64	2	R315, R316	10, 200V, ±1%	High Power Thick Film Resistor, 1206	ANY	ANY
65	1	R317	10, 200V, ±1%	High Power Thick Film Resistor, 1206	ANY	ANY
65	3	R318, R322, R320	10k, 200V, ±1%	High Power Thick Film Resistor, 1206	ANY	ANY
67	3	R319, R321, R323	10m, ±1%	Wirewound Res., Precision, SMD 2512	OHMITE	MCS3264R010FER
68	1	R324	3.3k ±0.1%, 75V, 0%	Metal film resistor, 0603	ANY	ANY
69	1	R326	4m, ±1%	Metal film resistor, SMD 3921	Vishay	WSLP39214L000FEA

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
70	6	R327, R328, R329, R346, R347, R348	62k ±0.1%, 75V, 0%	Metal film resistor, 0603	ANY	ANY
71	2	R330, R353	6.8k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
72	1	R331	2k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
73	1	R338	4.7k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
74	1	R345	47k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
75	1	R349	3.3k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
76	1	R350	10k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
77	1	R354	330k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
78	2	R355, R359	82k ±0.1%, 75V, 0%	Metal film resistor, 0603	ANY	ANY
79	1	R357	470, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
80	1	R361	11k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
81	1	R363	10k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
82	3	R364, R365, R366	0, 200V, ±1%	Metal film resistor, 1206	ANY	ANY
83	3	R368, R369, R370	1k, 50V, ±1%	Metal film resistor, 0603	ANY	ANY
84	1	U200	5V, 0.25A	Very low drop voltage regulators with inhibit, SO8	ST	L4931ABD50, TR
85	1	U201	900V	Off-line all-primary-sensing switching regulator, SO16N	ST	ALTAIR05T, 800
86	5	U300, U301, U302, U303, U305	-	rail to rail input/ output 5V CMOS Op-Amp, SOT23-5L	ST	TSV911ILT
87	1	U304	-	Rail-to-rail high-speed comparator, SOT23-5L	ST	TS3011ILT
88	1	U306	5V	Ultra-low current 2.4 V precision analog temperature sensor, SOT323-5L	ST	STLM20W87F
89	3	U307, U308, U309	18V, 4A	4 A dual low side MOSFET driver, SO8	ST	PM8834TR
90	2	Y100, Y101	2.2nF, 250V, ±20%	Ceramic disc cap, T H lead spac. 7.5 mm	MURATA	DE2E3KH222MA3B

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
91	1	Y300	FAN2, 12V, 0.25A	DC Axial Fan, through hole 40X40X20	ARX	FD1240-A0241D0AL
92	1	HEATSINK	-	HEATSINK 220mm, standard finishing size length: 220 mm	PADA	8411
93	1	PLEXIGLASS SPACER	-	PLEXIGLASS SPACER, DIM: 240X40x3mm	ANY	ANY
94	6	SPACER	-	Nylon spacer 10mm M3	-	-
95	6	NUT	-	Nylon NUT M3	-	-
96	3	INSULATOR KIT 1	-	INSULATOR KIT TO-220	MULTICOMP	MK3306/S
97	3	INSULATOR KIT 2	-	INSULATOR TO-247	-	-
98	2	Screw M3	-	M3 steel screws - 10 mm length	-	-
99	7	Screw M2.5	-	M2.5 steel screws - 20 mm length	-	-
100	7	NUT	-	M2.5 STEEL NUT	-	-
101	7	Plain Washer	-	M2.5 Steel Plain Washer	-	-

9.2 STEVAL-IPFC01C1 control board bill of materials

Table 3. STEVAL-IPFC01C1 bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	1	C1	4.7µF, 0805, 16 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
2	2	C2, C5	100nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
3	4	C3, C4, C15, C17	10nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
4	1	C6	47µF, 1206, 6.3 V, 20 %	Polarized tantalum chip capacitor	AVX	TAJA476K006RNJ
5	1	C7	1µF, 0603, 25 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
6	6	C8, C21, C22, C25, C26, C27	100pF, 0603, 25 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
7	3	C9, C19, C20	150pF, 0603, 25 V, 5 %	C0G Ceramic Capacitor	ANY	ANY
8	2	C10, C37	33pF, 0603, 50 V, 5 %	C0G Ceramic Capacitor	ANY	ANY
9	1	C11	100nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
10	1	C12	15nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
11	4	C13, C38, C39, C40	220nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
12	2	C14, C16	100nF, 0603, 25 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
13	3	C18, C24, C32	100nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
14	2	C23, C33	10nF, 0603, 25 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
15	1	C28	1.5nF, 0603, 25 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
16	1	C29	100pF, 0603, 25 V, 5 %	COG Ceramic Capacitor	ANY	ANY
17	1	C30	10pF, 0603, 50 V, 5 %	COG Ceramic Capacitor	ANY	ANY
18	1	C31	15nF, 0603, 50 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
19	1	C34	1nF, 0603, 25 V, 10 %	X7R Ceramic Capacitor	ANY	ANY
20	1	C35	2.2nF, 0603, 25 V, 10 %	C0G Ceramic Capacitor	ANY	ANY
21	1	C36	330pF, 0603, 50 V, 5 %	COG Ceramic Capacitor	ANY	ANY
22	1	D1	RED, 0805, N.A. %,	High efficiency red diffused LED 2mA 3mm	Kingbright	KP-2012SRC-PRV
23	1	D2	GREEN, 0805, N.A. %,	High efficiency green diffused LED 2mA 3mm	Kingbright	KPHCM-2012CGCK
24	1	J1	CON40A, /, / V, / %,	Right angle connector 2 ways 2.54mm	Stelvio Kontek	4.74975E+12
25	1	J2	SWIM I/F,	generic male strip line connector	ANY	ANY
26	1	J3	CON4,	generic male strip line connector	ANY	ANY
27	1	L1	WE-CBF,	SMD Inductor, 0603	Wurth Elektronik	74279262
28	2	R1, R2	1k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
29	3	R4, R7, R36	10k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
30	2	R6, R35	3.3k, 50 V, 1 %	Metal film resisto, 0603r	ANY	ANY
31	3	R8, R9, R32	10k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
32	4	R10, R11, R16, R17	100, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
33	4	R12, R13, R18, R19	N.M., 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
34	2	R14, R15	10k, 50 V, 0.1 %,	Metal film resistor, 0603	ANY	ANY
35	2	R20, R30	22k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
36	1	R21	10k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
37	1	R22	2.2k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
38	1	R23	7.5k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
39	1	R24	2.4k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
40	1	R25	220K, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
41	2	R26, R27	56k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
42	1	R28	6.2k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
43	2	R29, R31	0, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
44	1	R33	N.M., 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
45	1	R34	15k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
46	1	R37	5.1k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
47	3	R38, R39, R40	100k, 50 V, 1 %	Metal film resistor, 0603	ANY	ANY
48	1	U1	-	Three-channel interleaved CCM PFC digital controller, TSSOP38	ST	STNRGPF01
49	2	U2,U3	-	Quad 2-Input Schmitt NAND Gate, SO14	ST	M74HC132YRM13TR
50	1	U4	-	rail to rail input/ output 5V CMOS Op-Amp, SOT23-5L	ST	TSV911ILT
51	1	U5	-	Low power rail-to-rail input/output op-amp, SO8	ST	LMV358IDT

9.3 STEVAL-IPFC01A1 adapter board bill of materials

Table 4. STEVAL-IPFC01A1 bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	1	D400	LED	High Efficiency Red LED 3mm, through hole	Kingbright	L-7104ID
2	1	J400	CON4	4-contact 2.54mm female SIL Board-to-board Socket, through hole	HARWIN	M20-7890446

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
3	1	J401	CON6	Right angle male connector 1 way 6 circuits 2.54mm, through hole	ANY	ANY
4	1	Q400	40 V, 0.6 A	General Purpose Transistors, NPN Silicon	ON Semiconductor	SMMBT2222ALT1G
5	1	R401	330	Metal film resistor, 0805	ANY	ANY
6	1	R402	470k	Metal film resistor, 0805	ANY	ANY
7	1	R403	1K	Metal film resistor, 0805	ANY	ANY

Revision history

Table 5. Document revision history

Date	Version	Changes
18-Dec-2018	1	Initial release.
09-Sep-2019	2	Throughout document: minor text edits Updated Figure 10. STEVAL-IPFC01P1 schematic - auxiliary power supply Updated Table 2. STEVAL-IPFC01P1 bill of materials
11-Oct-2019	3	Updated Table 2. STEVAL-IPFC01P1 bill of materials

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