



FRED Pt[®] DIODES

PFC Capabilities

FRED Pt[®] Diodes for Power Factor Correction (PFC): DCM, CRM, CCM

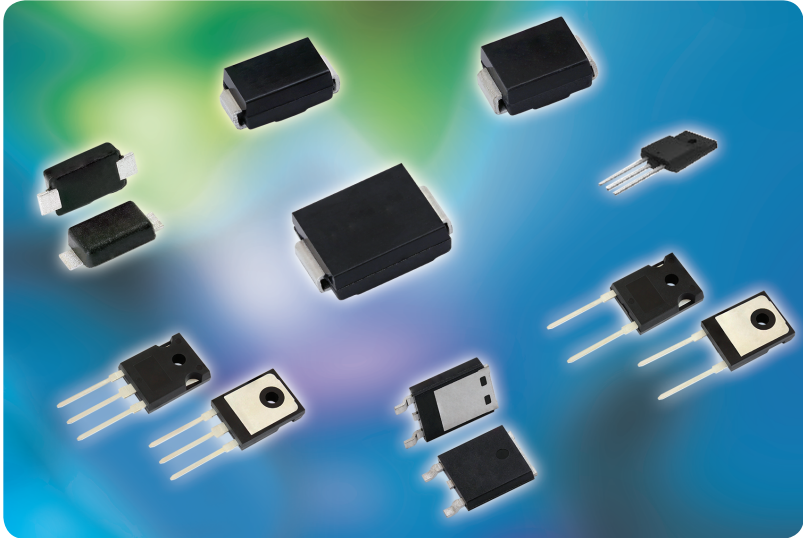


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Introduction

Power factor correction (PFC) can be defined as the reduction of the harmonic content induced in the AC distribution net. An appropriate circuit is often required to reduce this kind of disturbance. PFC can also be thought of as aligning the phase angle of the incoming current with respect to the voltage waveform, thus maximizing the real power drawn from the AC line.

Regulatory Drivers

With widening applicability of the harmonic reduction standard, more power supply designs are incorporating PFC capabilities. Different PFC regulations and standards have recently arisen, resulting in the following regulations:

- Europe – EN 61000-3-2
- UK – BSEN 61000-3-2
- Japan – JIC-C-61000-3-2
- China – CCC (China Compulsory Certificate)

Other standards apply in different ways to PFC circuits, especially in regards to efficiency, such as EPA Energy Star and 80 PLUS[®].

Topology Choices

The active PFC option is a well-established solution, as it allows designers to meet regulatory requirements with minimal effort. Moreover, it provides other benefits such as simplifying the main power conversion stage and eliminating the number of bulky components.

A boost converter provides a natural means for achieving a high power factor because of the inductor being present on the input side. This inductor allows the shaping of the input current to be in phase with the line voltage.

Key Benefits

- Highest system efficiency compared to other hyperfast diodes
- Lowest switching losses for CCM PFC products with reduced ringing up to the highest di/dt to limit EMI
- Lowest V_F conduction losses for DCM PFC dedicated products

Applications

- Server power supplies
- High end desktop power supplies
- Telecom power supplies
- Solar inverters
- Notebook adaptors
- Charging stations



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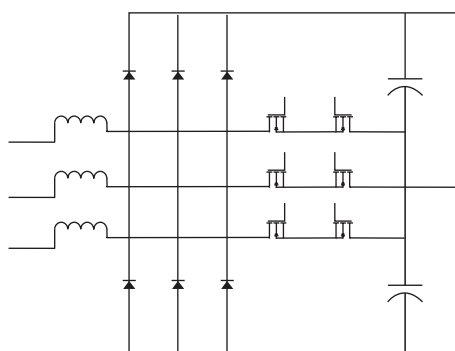
DCM, CRM, or CCM?

A boost converter can operate in two modes: continuous conduction mode (CCM) or discontinuous conduction mode (DCM). The mode is defined by the current flowing into the boost inductor:

- DCM – Suitable for low to medium power applications due to reduced switching losses (forward voltage is a critical parameter)
- CRM – Border mode operation combines high efficiency, maximizing the usage of inductive elements
- CCM – Better suited for medium to high power applications. Peak currents are lower, which reduces switching losses and requires less filtering (reverse recovery charge is a critical parameter)

3-Level T-Type PFC

Featuring a unique combination of low conduction and switching losses, these rectifiers are the right choice for high frequency converters, both hard switched and soft switched / resonant.





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I _{F(AV)} (A)	Part Number	Package		V _{RRM} Range (V)	V _F at I _F		I _R at V _{RRM} (uA)	T _{rr} (ns)	I _{FSM} (A)	T _J max (°C)
		Family	Type		(V)	(A)				
1	VS-1EFU06-M3/I	Plastic SMD	SMF (DO-219AB)	600	0.83	1	3	55	30	175
2	VS-2EFU06-M3/I	Plastic SMD	SMF (DO-219AB)	600	0.95	2	3	55	30	175
3	VS-3EGH06-M3	Plastic SMD	SMB (DO-214AA)	600	1.2	3	3	35	55	175
3	VS-3EGU06-M3	Plastic SMD	SMB (DO-214AA)	600	0.99	3	3	41	55	175
3	VS-3EMH06-M3	Plastic SMD	SMA (DO-214AC)	600	1.2	3	3	35	50	175
3	VS-3EMU06-M3	Plastic SMD	SMA (DO-214AC)	600	0.99	3	3	41	55	175
3	VS-3EJU06-M3	Plastic SMD	SlimSMA (DO-221AC)	600	1.15	3	3	45	43	175
4	VS-4ECH06-M3	Plastic SMD	SMC (DO-214AB)	600	1.15	4	3	30	90	175
4	VS-4ECU06-M3	Plastic SMD	SMC (DO-214AB)	600	0.88	4	3	45	120	175
4	VS-4EGH06-M3	Plastic SMD	SMB (DO-214AA)	600	1.2	4	3	30	55	175
4	VS-4EGU06-M3	Plastic SMD	SMB (DO-214AA)	600	0.94	4	3	45	100	175
5	VS-5ECH06-M3	Plastic SMD	SMC (DO-214AB)	600	1.2	5	3	30	110	175
5	VS-5ECU06-M3	Plastic SMD	SMC (DO-214AB)	600	0.92	5	3	45	130	175
6	VS-6EVL06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	0.98	6	5	34	80	175
6	VS-6EVH06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	1.26	6	5	16	70	175
6	VS-6EVX06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	1.26	6	7	14	60	175
6	VS-6ESH06-M3	Power-Pack SMD	SMPC (TO-277A)	600	1.05	6	5	33	90	175
6	VS-6ESU06-M3	Power-Pack SMD	SMPC (TO-277A)	600	0.95	6	5	42	120	175
6	VS-6EWH06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	1.26	6	5	18	70	175
6	VS-6EWL06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	0.87	6	5	59	80	175
6	VS-6EWX06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	1.65	6	20	14	50	175
8	VS-8ETL06-M3	Plastic Power-Pack	TO-220AC 2L	600	0.81	8	5	60	175	175
8	VS-8ETL06FP-N3	Isolated Power-Pack	TO-220 FullPAK 2L	600	0.81	8	5	60	175	175
8	VS-8ETH06-M3	Plastic Power-Pack	TO-220AC 2L	600	1.3	8	50	18	90	175
8	VS-8ETH06FP-N3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.3	8	50	18	90	175
8	VS-8ETX06-M3	Isolated Power-Pack	TO-220AC 2L	600	1.4	8	50	15	110	175
8	VS-8ETX06FP-N3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.4	8	50	15	110	175
8	VS-8ETL06S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	0.81	8	5	60	175	175
8	VS-8ETH06S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.3	8	50	18	90	175

(1) Bold text = new products

(2) Dual center-tapped device (V_F limit @ I_F is per diode)



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I _{F(AV)} (A)	Part Number	Package		V _{RRM} Range (V)	V _F at I _F		I _R at V _{RRM} (µA)	T _{rr} (ns)	I _{FSM} (A)	T _J max (°C)
		Family	Type		(V)	(A)				
8	VS-8ETX06S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.4	8	50	15	110	175
8	VS-8EWL06FN-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	0.81	8	5	60	140	175
8	VS-8EWH06FN-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.3	8	50	18	90	175
8	VS-8EWX06FN-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.4	8	50	15	90	175
8	VS-8EVL06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	0.98	8	5	94	130	175
8	VS-8EVH06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	1.3	8	20	16	90	175
8	VS-8EVX06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	1.4	8	20	14	80	175
8	VS-ETH0806-M3	Plastic Power-Pack	TO-220AC 2L	600	1.3	8	12	16	80	175
8	VS-ETH0806FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.3	8	12	16	80	175
8	VS-ETL0806-M3	Plastic Power-Pack	TO-220AC 2L	600	0.84	8	9	65	120	175
8	VS-ETL0806FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	0.84	8	9	65	120	175
8	VS-ETX0806-M3	Plastic Power-Pack	TO-220AC 2L	600	1.5	8	30	14	80	175
8	VS-ETX0806FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.5	8	30	14	80	175
10	VS-10CDU06-M3/I	Power-Pack SMD ⁽²⁾	SMPD (TO-263AC)	600	1	5	3	35	110	175
12	VS-12CDU06-M3/I	Power-Pack SMD ⁽²⁾	SMPD (TO-263AC)	600	0.89	6	5	45	200	175
12	VS-12EWH06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	1.34	12	10	18	110	175
15	VS-15AWL06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	0.85	15	10	60	180	175
15	VS-15ETL06-M3	Isolated Power-Pack	TO-220AC 2L	600	0.85	15	10	60	250	175
15	VS-15ETL06FP-N3	Isolated Power-Pack	TO-220 FullPAK 2L	600	0.85	15	10	60	250	175
15	VS-15ETH06-M3	Isolated Power-Pack	TO-220AC 2L	600	1.3	15	50	22	120	175
15	VS-15ETH06FP-N3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.3	15	50	22	120	175
15	VS-15ETX06-M3	Isolated Power-Pack	TO-220AC 2L	600	1.5	15	50	18	170	175
15	VS-15ETX06FP-N3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.5	15	50	18	170	175
15	VS-15ETL06S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	0.85	15	10	60	250	175
15	VS-15ETH06S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.3	15	50	22	120	175
15	VS-15ETX06S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.5	15	50	18	170	175
15	VS-15EWH06FN-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.2	15	50	22	120	175
15	VS-15EWL06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	0.85	15	10	60	180	175
15	VS-15EWX06FN-M3	Power-Pack SMD	DPAK (TO-252AA)	600	1.5	15	50	18	120	175

(1) Bold text = new products

(2) Dual center-tapped device (V_F limit @ I_F is per diode)



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I _{F(AV)} (A)	Part Number	Package		V _{RRM} Range (V)	V _F at I _F		I _R at V _{RRM} (µA)	T _{rr} (ns)	I _{FSM} (A)	T _J max (°C)
		Family	Type		(V)	(A)				
15	VS-15EVL06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	0.98	15	10	38	180	175
15	VS-15EVU06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	1.1	15	20	26	160	175
15	VS-15EVH06-M3	Power-Pack SMD	SlimDPAK (TO-252AE)	600	1.2	15	20	20	120	175
15	VS-C4ZU3006FP-E3	Plastic Power-Pack ⁽²⁾	TO-3PF	600	1.08	15	15	37	180	175
15	VS-ETH1506-M3	Plastic Power-Pack	TO-220AC 2L	600	1.25	15	15	21	160	175
15	VS-ETH1506FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.25	15	15	21	160	175
15	VS-ETH1506S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.25	15	15	21	160	175
15	VS-ETL1506-M3	Plastic Power-Pack	TO-220AC 2L	600	0.85	15	15	60	200	175
15	VS-ETL1506FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	0.85	15	15	60	200	175
15	VS-ETL1506S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	0.85	15	15	60	200	175
15	VS-ETU1506-M3	Isolated Power-Pack	TO-220AC 2L	600	1.1	15	15	24	160	175
15	VS-ETU1506FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.1	15	15	24	160	175
15	VS-ETU1506S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.1	15	15	24	160	175
15	VS-ETX1506-M3	Plastic Power-Pack	TO-220AC 2L	600	1.55	15	36	18	120	175
15	VS-ETX1506FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.55	15	36	18	120	175
15	VS-ETX1506S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.55	15	36	18	120	175
16	VS-16CDU06-M3/I	Power-Pack SMD ⁽²⁾	SMPD (TO-263AC)	600	0.94	8	5	45	200	175
16	VS-16EDU06-M3/I	Power-Pack SMD ⁽²⁾	SMPD (TO-263AC)	600	0.91	16	15	55	160	175
20	VS-E4TU2006FP-N3	Isolated Power-Pack	TO-220 FullPAK	600	1.26	20	15	61	190	175
30	VS-30CDU06-M3/I	Power-Pack SMD ⁽²⁾	SMPD (TO-263AC)	600	0.9	15	15	55	300	175
30	VS-ETU3006-M3	Plastic Power-Pack	TO-220AC 2L	600	1.15	30	30	30	200	175
30	VS-ETU3006FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.15	30	30	30	200	175
30	VS-ETU3006S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.15	30	30	30	200	175
30	VS-ETH3006-M3	Plastic Power-Pack	TO-220AC 2L	600	1.4	30	30	27	180	175
30	VS-ETH3006FP-M3	Isolated Power-Pack	TO-220 FullPAK 2L	600	1.4	30	30	27	180	175
30	VS-ETH3006S-M3	Power-Pack SMD	D ² PAK (TO-263AB)	600	1.4	30	30	27	180	175
30	VS-ETH3007-N3	Plastic Power-Pack	TO-220AC 2L	650	1.4	30	30	37	210	175
30	VS-ETX3007-N3	Plastic Power-Pack	TO-220AC 2L	650	1.6	30	30	35	210	175
30	VS-E5TH3012-N3	Plastic Power-Pack	TO-220AC 2L	1200	1.7	30	50	32	250	175
30	VS-E5TX3012-N3	Plastic Power-Pack	TO-220AC 2L	1200	2.1	30	50	26	210	175

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I _{F(AV)} (A)	Part Number	Package		V _{RRM} Range (V)	V _F at I _F		I _R at V _{RRM} (μA)	T _{rr} (ns)	I _{FSM} (A)	T _J max (°C)
		Family	Type		(V)	(A)				
30	VS-APU3006-N3	Plastic Power-Pack	TO-247AC	600	1.15	30	30	30	220	175
30	VS-APU3006L-N3	Plastic Power-Pack	TO-247AD	600	1.15	30	30	30	250	175
30	VS-EPU3006-N3	Plastic Power-Pack	TO-247AC	600	1.15	30	30	30	220	175
30	VS-EPU3006L-N3	Plastic Power-Pack	TO-247AD	600	1.15	30	30	30	220	175
30	VS-E4PU3006L-N3	Plastic Power-Pack	TO-247AD	600	1.2	30	50	65	240	175
30	VS-APH3006-N3	Plastic Power-Pack	TO-247AC	600	1.4	30	30	27	220	175
30	VS-APH3006L-N3	Plastic Power-Pack	TO-247AD	600	1.4	30	30	26	240	175
30	VS-EPH3006-N3	Plastic Power-Pack	TO-247AC	600	1.4	30	30	27	220	175
30	VS-E4PH3006L-N3	Plastic Power-Pack	TO-247AD	600	1.4	30	50	55	240	175
30	VS-C4PU3006L-N3	Plastic Power-Pack ⁽²⁾	TO-247AD	600	1.35	15	15	60	200	175
30	VS-C4PH3006L-N3	Plastic Power-Pack ⁽²⁾	TO-247AD	600	1.35	15	15	50	200	175
30	VS-C4ZU6006FP-E3	Plastic Power-Pack ⁽²⁾	TO-3PF	600	1.2	30	50	37	255	175
30	VS-EPH3007L-N3	Plastic Power-Pack	TO-247AD	650	1.4	30	30	33	195	175
30	VS-EPX3007L-N3	Plastic Power-Pack	TO-247AD	650	1.6	30	30	27	170	175
30	VS-E5PH3012L-N3	Plastic Power-Pack	TO-247AD	1200	1.7	30	50	32	260	175
30	VS-E5PX3012L-N3	Plastic Power-Pack	TO-247AD	1200	2.1	30	50	26	250	175
60	VS-APU6006-N3	Plastic Power-Pack	TO-247AC	600	1.05	60	30	32	600	175
60	VS-EPU6006L-N3	Plastic Power-Pack	TO-247AD	600	1.1	60	30	32	600	175
60	VS-CPU6006L-N3	Plastic Power-Pack ⁽²⁾	TO-247AD	600	1.1	30	30	26	500	175
60	VS-C4PH6006L-N3	Plastic Power-Pack ⁽²⁾	TO-247AD	600	1.44	30	50	55	480	175
60	VS-C4PU6006L-N3	Plastic Power-Pack ⁽²⁾	TO-247AD	600	1.23	30	50	65	480	175
60	VS-E4PH6006L-N3	Plastic Power-Pack	TO-247AD	600	1.4	60	50	68	425	175
60	VS-E4PU6006L-N3	Plastic Power-Pack	TO-247AD	600	1.33	60	50	74	450	175
60	VS-EPH6007L-N3	Plastic Power-Pack	TO-247AD	650	1.4	60	30	65	520	175
60	VS-EPX6007L-N3	Plastic Power-Pack	TO-247AD	650	1.6	60	30	40	500	175
60	VS-E5PH6012L-N3	Plastic Power-Pack	TO-247AD	1200	1.7	60	50	38	460	175
60	VS-E5PX6012L-N3	Plastic Power-Pack	TO-247AD	1200	2.1	60	50	30	420	175
150	VS-EBU15006-F4	Plastic Power-Pack	PowerTab®	600	1.63	150	8	50	1200	175

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