

Surface Mount Power Device(SMPD) and Mini SMPD Packages

Lighter weight, more power(ultra-low profile, energy efficient, and rugged)

January 2013

SMPD OVERVIEW

IXYS introduces a new packaging technology – the Surface Mount Power Device (SMPD) package. It is an expansion of the ISOPLUS™ package portfolio, which has been providing isolated-package solutions to the power electronics industry for more than a decade. Compared to copper-based lead-frame packages, these devices exhibit better thermal performance, lower weight, and better power cycling capability.

The SMPD package can be easily surface-mounted on a Printed Circuit Board (PCB) using a standard pick-and-place and reflow soldering process. No costly screws, cables, bus-bars or hand soldered contacts are needed. Weighing only 8g, it is much lighter (typically by 50%) than comparable conventional power modules, thereby enabling lower weight power systems for IXYS customers. This is one of the key “Green” initiatives of IXYS Corporation in developing new products for the Cleantech industry that are lighter in weight. Moreover, due to its compact and ultra-low profile package, it is possible to use the same heat sink for multiple devices, saving PCB space. Another added benefit of being smaller and lighter is that it provides a better protection against vibrations and g-forces, especially if used in portable appliances, increasing the life expectancy and reliability of these devices. IXYS is virtually the first power semiconductor company to offer surface-mountable high-voltage Power MOSFETs and IGBTs.

A ceramic isolation of up to 4.5kV is achieved with the Direct Copper Bond (DCB) substrate technology – an electrically isolated tab is provided for heat sinking. The DCB provides low thermal impedance and best-in-class power and temperature cycling capabilities. The ISOPLUS™ advantage also facilitates having multiple die on the same single substrate – buck, boost, phase-leg, full-bridge, half-bridge configurations are implementable.

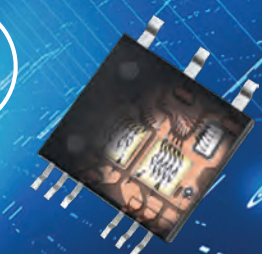
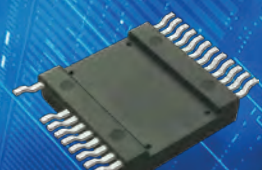
“This unique device is part of our initiative of taking power systems on a diet, literally, with the aim of reducing the weight of the power semiconductors in a typical power system. Weight reduction is a key effort in reducing greenhouse gas emissions in the production, shipment and use of power products,” commented Dr. Nathan Zommer, Founder and CEO of IXYS Corporation, regarding the recently released 1kV/30A Q3 HiperFET™ Power MOSFET in the SMPD package. “Our lighter products use less material, require less energy to ship, and result in lower weight products for our customers, a critical desired feature in a lot of applications, including portable equipment, and for the automotive and transportation industry.”

The new surface-mountable SMPD package is an ideal replacement part for bulky traditional power modules. IXYS is able to offer various SMPD topologies – the MMIX1F44N100Q3 is a single die 1000V/30A HiperFET™ Power MOSFET, the IXA68PF650LB a 1200V/68A dual IGBT with anti-parallel diodes, the DMA90U1800LB a 1800V/99A three phase rectifier diode. Upon request, IXYS can manufacture other customer-specific configurations.

SMPD-X



SMPD-B



SMPD ADVANTAGES

- Ultra-low and compact package profile (5.3mm height x 24.8mm length x 32.3mm width)
- Surface mountable via standard reflow process (Available in Tape & Reel packaging)
- Low package weight (8g)
- Up to 4500V ceramic isolation(DCB)
- Low package inductance
- Excellent thermal performance
- High power cycling capability

CONFIGURATIONS

- Buck
- Boost
- Full-bridge
- Half-bridge
- Phase leg
- Single

APPLICATIONS

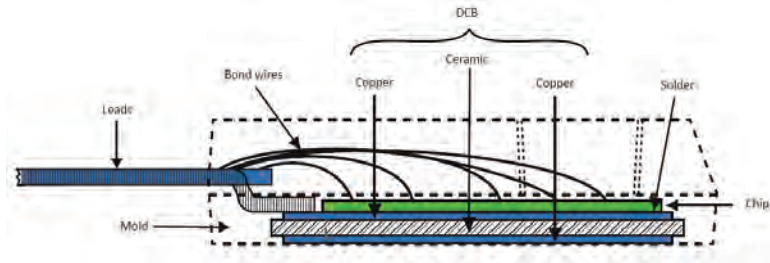
- DC-DC converters
- Battery chargers
- Switching and resonant power supplies
- DC choppers
- Temperature and lighting controls
- Motor drives
- E-bikes and electric and hybrid vehicles
- Solar inverters
- Induction heaters

Ultra-low profile SMPD package



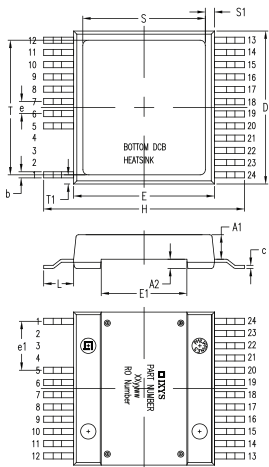
The above accentuates the compact and low profile nature of the device. Compared to a conventional high power package such as the SOT-227, the IXYS SMPD features ¼ the weight and 1/3 the volume and provides similar electrical and thermal characteristics.

Direct Copper Bond (DCB) isolation



- Provides up to 4500V ceramic isolation
- Improves temperature and power cycling capabilities
- Reduces EMI/RFI due to low coupling capacitance between die and heat sink
- Lowers thermal resistance ($R_{th(j-c)}$)
- Allows new circuit configurations

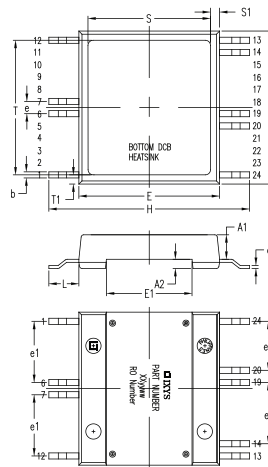
SMPD Package Outlines



SMPD-X

SYM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.209	.224	5.30	5.70
A1	.154	.161	3.90	4.10
A2	.055	.063	1.40	1.60
b	.035	.045	0.90	1.15
c	.018	.026	0.45	0.65
D	.976	.994	24.80	25.25
E	.898	.915	22.80	23.25
E1	.543	.559	13.80	14.20
e	.079 BSC		2.00 BSC	
e1	.315 BSC		8.00 BSC	
H	1.272	1.311	32.30	33.30
L	.181	.209	4.60	5.30
L1	.051	.067	1.30	1.70
L2	.000	.006	0.00	0.15
S	.742	.792	18.85	20.12
S1	.057	.082	1.45	2.08
T	.823	.873	20.90	22.17
T1	.056	.080	1.42	2.03
ØX	0	4"	0	4"

NOTE:
1. Bottom heatsink meets 2.6KV AC isolation to the other pins.
2. All leads are matte pure tin plated.



SMPD-A

SYM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.209	.224	5.30	5.70
A1	.154	.161	3.90	4.10
A2	.055	.063	1.40	1.60
b	.035	.045	0.90	1.15
c	.018	.026	0.45	0.65
D	.976	.994	24.80	25.25
E	.898	.915	22.80	23.25
E1	.543	.559	13.80	14.20
e	.079 BSC		2.00 BSC	
e1	.394 BSC		10.00 BSC	
e2	.315 BSC		8.00 BSC	
H	1.272	1.311	32.30	33.30
L	.181	.209	4.60	5.30
L1	.051	.067	1.30	1.70
L2	.000	.006	0.00	0.15
S	.742	.792	18.85	20.12
S1	.057	.082	1.45	2.08
T	.823	.873	20.90	22.17
T1	.069	.089	1.75	2.25
ØX	0	4"	0	4"

NOTE:
1. Bottom heatsink meets 2.6KV AC isolation to the other pins.
2. All leads are matte pure tin plated.

Heat Sink Mounting Guidelines

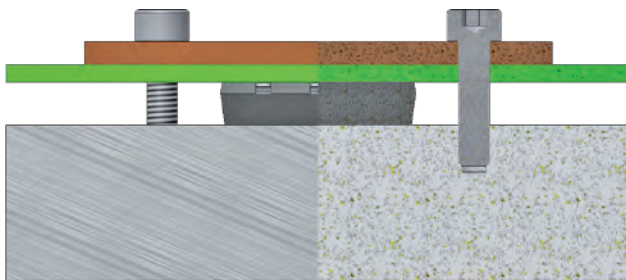


Figure 1: SMPD heat sink assembly

The following points should be considered when attaching a heat sink to the package to ensure a good thermal contact between them. In general the SMPD is soldered to a PCB as shown in Figure 1. The contact surfaces of the heat sink must be flat and free of scratches.

- Two holes (30.48mm apart) should be created on the heat sink surface.
- The recommended depth of thread for an Aluminum (Al) heat sink is 12mm and for a Copper (Cu) one 10mm.
- Unevenness should be less than 50µm over a distance of 100mm and roughness less than 10µm.
- A thin layer of thermal grease (thickness between 60µm and 80µm) should be applied to the surface of the heat sink or the base of the package.
- A recommended mounting screw is M3.5 or 6-32 UNC; tighten the screws clockwise.

SMPD Power MOSFETs Summary Table

Part Number	V _{DSS} max (V)	I _{D(cont)} T _C =25°C (A)	R _{DS(on)} max T _J =25°C (Ω)	C _{iss} typ (pF)	Q _s typ (nC)	t _{rr} (ns)	P _D (W)	R _{th(jc)} max (°C/W)	Package Style
TrenchT2™ GigaMOS™									
MMIX1T600N04T2	40	600	0.0013	40000	590	100	830	0.18	SMPD-X
MMIX1T550N055T2	55	550	0.0013	40000	595	100	830	0.18	SMPD-X
MMIX1F520N075T2	75	500	0.0016	41000	545	150	830	0.18	SMPD-X
MMIX1F360N15T2	150	235	0.0044	47500	715	150	680	0.22	SMPD-X
GigaMOS™ Trench™ HiperFET™									
MMIX1F420N10T	100	334	0.0026	47000	670	140	680	0.22	SMPD-X
MMIX1F230N20T	200	168	0.0083	28000	378	200	680	0.22	SMPD-X
MMIX1F180N25T	250	130	0.013	28000	345	200	570	0.22	SMPD-X
MMIX1F160N30T	300	102	0.02	28000	335	200	570	0.22	SMPD-X
Polar3™ HiPerFET™									
MMIX1F210N30P3	300	108	0.016	16200	268	250	520	0.24	SMPD-X
MMIX1F132N50P3	500	63	0.043	18600	250	250	520	0.24	SMPD-X
Polar3™ HiperFET™ Modules									
MMIX4F20N50P3	500	10	Under development				(Full-bridge)		SMPD-A
MMIX4F16N60P3	600	9	Under development				(Full-bridge)		SMPD-A
Q3-Class HiperFET™									
MMIX1F44N100Q3	1000	24	0.29	19000	310	300	500	0.25	SMPD-X
Polar™ HiperFET™									
MMIX1F40N110P	1100	30	0.245	13600	264	300	694	0.18	SMPD-X

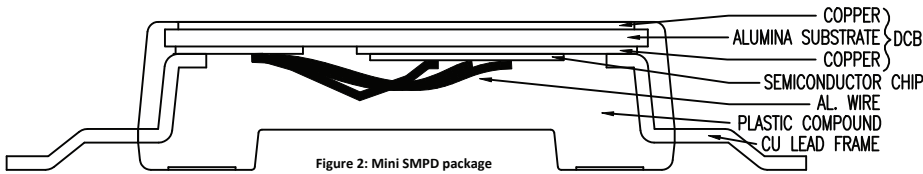
SMPD IGBT Summary Table

Part Number	V _{CES} (V)	I _{C25} (A)	V _{CE(sat)} max T _J =25°C (V)	E _{off} typ T _J =125°C (mJ)	R _{th(jc)} max IGBT (°C/W)	Configuration	Package style
Discrettes							
MMIX1X100N60B3H1	600	105	1.8	2.8 (T _J =150°C)	0.5	Copacked (FRED)	SMPD-X
MMIX1X200N60B3H1	600	175	1.7	3.45 (T _J =150°C)	0.24	Copacked (FRED)	SMPD-X
MMIX1X200N60B3	600	223	1.7	3.45 (T _J =150°C)	0.24	Single	SMPD-X
MMIX1G320N60B3	600	400	1.5	5.4	0.125	Single	SMPD-X
MMIX1Y82N120C3H1	1200	78	3.4	3.7	0.39	Copacked (FRED)	SMPD-X
MMIX1Y100N120C3H1	1200	92	3.5	3.55	0.31	Copacked (FRED)	SMPD-X
MMIX1G120N120A3V1	1200	220	2.2	58	0.31	Copacked (FRED)	SMPD-X
MMIX1G75N250	2500	110	2.9	-	0.29	Single	SMPD-X
Modules							
MMIX2S50N60B4D1	600	50	2	0.86	1.13	Half-bridge	SMPD-A
IGK60Q600LB	600	60	under development			Buck	SMPD-B
IGK60R600LB	600	60	under development			Boost	SMPD-B
IXA27PF650LB	650	27	under development			Phase-leg	SMPD-B
IXA68PF650LB	650	68	under development			Phase-leg	SMPD-B
IXA100XF650ALB	650	2x 50	under development			Dual	SMPD-B
IXA20PG1200DHGLB	1200	23	2.1	1.7	1	Phase-leg	SMPD-B
IXA20RG1200DHGLB	1200	32	1.8	1.7	1	Boost	SMPD-B
IXA30PG1200DHGLB	1200	43	2.2	3	0.85	Phase-leg	SMPD-B
IXA30RG1200DHGLB	1200	43	1.8	3	0.85	Boost	SMPD-B
IXA40RG1200DHGLB	1200	61	1.8	4.1	0.58	Boost	SMPD-B
IXA40PG1200DHGLB	1200	63	2.15	4.1	0.55	Phase-leg	SMPD-B
MMIX4G20N250	2500	23	3.1	-	1.25	Full-bridge	SMPD-A
BiMOSFETs							
MMIX4B12N300	3000	26	3.2	-	1	Full-bridge	SMPD-A
MMIX4B20N300	3000	34	3.2	-	0.83	Full-bridge	SMPD-A

Mini SMPD Overview

To help make even lighter, more efficient, and compact power conversion systems possible, IXYS offers a smaller version of the SMPD package – the Mini SMPD, which is illustrated in Figure 2 below. Just like in the SMPD, an electrical isolation of 4500V between the semiconductor chip and base copper is achieved with the Direct Copper Bond (DCB) technology, which is a well-known technique for high-voltage isolation and provides excellent thermal conductivity and high-current carrying capability. The structure consists of three layers (Copper, Alumina substrate, and Copper); the Alumina substrate is a ceramic layer situated between the two copper layers and supports the necessary voltage isolation. The expansion coefficient of the DCB is close to that of Silicon, resulting in reliable high-temperature cycling. Compared to standard packages, the Mini SMPD exhibits better electromagnetic interference (EMI) performance due to its lower parasitic capacitances and inductances and reduced current loops.

The IXYS Mini SMPD package can be utilized in a wide variety of industrial, consumer, medical, and green-energy applications, including inverters, battery chargers, switch-mode and resonant power supplies, temperature and lighting controls, high-frequency plasma generators, motor drives, E-bikes, and electric and hybrid vehicles.



Mini SMPD ADVANTAGES

- High-voltage electrical isolation (4500V)
- Lower thermal resistance compared to standard packages (TO-247, TO-264, SOT-227B)
- High component density/flexible configurations (H-bridge, half-bridge, boost, buck, phase-leg)
- High current carrying capability
- Low parasitic capacitances and inductances
- Low package weight (5g)
- Better protection against vibrations and g-forces

Light and compact Mini SMPD package



Mini-SMPD
Height=5.3mm

SMPD
Height=5.3mm

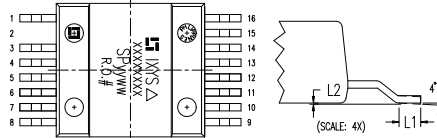
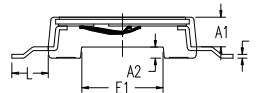
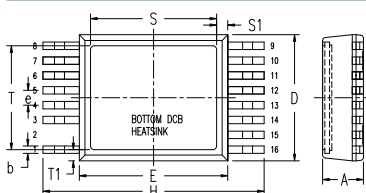
SOT-227
Height=8.92mm

TO-264
Height=4.8mm

PLUS247
Height=4.8mm

The figure above illustrates a comparison of the Mini-SMPD with other industry standard packages. The volume of it (3cm^3) is only at 60% of that of the SMPD (1.8cm^3). But the Mini SMPD is able to maintain a high voltage isolation of 4.5kV and weighs just 5g.

Mini SMPD Package Outlines



SYM	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.209	.224	5.30	5.70
A1	.154	.161	3.90	4.10
A2	.055	.063	1.40	1.60
b	.035	.045	0.90	1.15
c	.018	.026	0.45	0.65
D	.661	.677	16.80	17.20
E	.780	.795	19.80	20.20
E1	.425	.441	10.80	11.20
e	.079	.BSC	2.00	BSC
H	1.161	1.185	29.50	30.10
L	.181	.209	4.60	5.30
L1	.051	.067	1.30	1.70
L2	.000	.006	0.00	0.15
S	.661	.677	16.80	17.20
S1	.051	.067	1.30	1.70
T	.543	.559	13.80	14.20
T1	.051	.067	1.30	1.70

- NOTE:
1. ALL LEADS ARE WHITE PURE TIN PLATED.
 2. CU SURFACE OF BOTTOM DCB IS PRE-NI PLATED UNLESS OTHERWISE.
 3. CU SURFACE OF BOTTOM DCB IS ELECTRICALLY ISOLATED 2500V AC FROM ALL OTHER LEADS.
 4. UNLESS OTHER SPECIFIED, PIN OUT ARE AS FOLLOWS.
 PIN #1 – GATE
 PIN #3 – GATE RETURN OR SOURCE
 PIN #4 THROUGH #8 – SOURCE (EMITTER)
 PIN #9 THROUGH #16 – DRAIN (COLLECTOR)