ADVANCED POWER TECHNOLOGY®

Discrete Power Products & Power Modules 2004

Advanced Power Technology

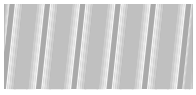
Technology… Beginning in 1984 with the introduction of Power MOS IV®, APT has maintained a position at the forefront of power semiconductor technology. Our focus is on the high voltage, high power and high performance segments of this market. Our commitment is to maintain and enhance this position as a technological leader in MOS controlled devices and Diodes and to deliver products which contribute to our customers' success in delivering higher performance power systems.

Service… Outstanding technology is only part of the story. A global network of stocking distributors, representatives, applications engineers, and web tools are in place to support all phases of your product design, evaluation and procurement activities. In a world which demands superior execution, we've won numerous awards as a service leader.

Quality… Our commitment is to excellence in all things we do. Whether you are evaluating the quality of our products, our technical assistance, our customer service or the quality of our internal communications systems, excellence is our standard. Continuous improvement is fundamental to our business!

CONTENTS

A Full Line-Up of the very best in High Voltage, High Power, High Performance Transistors for Your SMPS Applications

Product Type	up to 200 kHz PT Type IGBTs	NPT Type IGBTs	Conventional MOSFETs	Super Junction MOSFETs
Product Family	• Power MOS 7 The Coolest FET Yet!	• **Fast**–50 kHz Max • **Thunderbolt®** –100 kHz Max	• **Power MOS V** • Power MOS 7 The Coolest FET Yet!	• **COOLMOS™**
Description	Our fastest IGBTs that can replace MOSFETs in many high frequency SMPS applications including soft switching	Short circuit rated IGBTs for moderate to high frequency SMPS, UPS, and motor drive applications	Best-in-class for on-resistance, gate charge and noise immunity	Lowest specific on-resitance of any MOSFETs
Blocking Voltage, volts	300, 600, 900, 1200	600, 1200	100-1400	600, 800
Fast Anti-Parallel Diode Operation	**Combi**	**Combi**	**FREDFET**	**Add APT FRED & series Schottky**
Metal Gate/Planar Stripe 	**YES**		**YES**	
Poly Gate/Planar Cell 		**YES**		**YES**

Design Tools available at www.advancedpower.com

- **Transistor Quick Pick web tool** to choose the right transistor for your application
- **Application Notes** - Examples Include:
  - IGBT, MOSFET, and Diode Tutorial
  - Parallel Connection of Power Electronic Devices
  - Making Use of Gate Charge Information In MOSFET and IGBT Data Sheets
  - Optimizing MOSFET and IGBT Gate Current to Minimize dv/dt Induced Failures in SMPS Circuits

Insulated Gate Bipolar Transistors (IGBTs)

The IGBT (Insulated Gate Bipolar Transistor) is the combination of a MOSFET and a Bipolar Transistor in a single chip and as such combines the best attributes of each type of transistor... The Bipolar Transistor attributes portion allows operation at high on-state current densities with a low on-state voltage drop and the MOSFET structure attributes allows for ease of gate control. The IGBT advantage in current density over MOSFETs facilitates higher output power at equal chip size, provides for smaller and lower cost components, and allows for smaller more compact and higher power density designs. The die size for the IGBT is often 1 or 2 die sizes smaller than a MOSFET at equal current solution which means **lower cost than MOSFETs.**

The characteristics of the IGBT are determined by the technology used (materials, process, design). **IGBTs can generally be classified into two basic technologies PT (Punch Through) and NPT (Non-Punch Through).**

There are 3 APT Product Families of IGBTs:

PT 1) **Power MOS 7® PT IGBT Family**… These devices are available in 300, 600, 900, and 1200 volt for operation up to 200 kHz hard switching.

NPT 2) **Thunderbolt® NPT IGBT Family**… 600 volt only, these devices are capable of operation 100 kHz Max in hard switching applications.

3) **Fast NPT IGBT Family**… 600 and 1200 volt devices, designed for operation 50 kHz Max in hard switching applications.

For soft switching topologies these maximum operating frequencies will be higher.

IGBT products offered by APT utilize offers both NPT and PT technologies to cover the widest range of applications and design requirements. They IGBTs can be used as a cost effective alternative to MOSFETs in many applications with high efficiency, improved power density, and lower cost.

POWER MOS 7® IGBTs

Our latest generation of 300, 600, 900, and 1200 volt PT-Type IGBTs utilizing our advanced proprietary POWER MOS 7® Technology. The 300V parts are designed to replace 200-300V MOSFETs in PDP and alternative energy inverters. The 600 volt IGBTs are designed to replace 500V/600V MOSFETs, the 900 volt IGBTs to replace 800 volt MOSFETs, and the 1200 volt IGBTs are designed to replace 1000V/1200V MOSFETs in switch mode power supply (SMPS), power factor correction (PFC), and other high-power applications. For all IGBT's, the gate-drive voltage requirement is similar to a MOSFET. This allows larger die size power MOSFETs, or multiple MOSFETs in parallel to be replaced with just one POWER MOS 7® IGBT.

Features and Benefits of POWER MOS 7® Technology IGBTs

Metal Gate… these IGBTs utilize a proprietary planar stripe metal gate design providing internal chip gate resistance one to two orders of magnitude lower than comparable industry standard polysilicon gate devices. This enables very uniform and fast switching across the entire chip with uniform heat distribution. The metal gate minimizes chip gate resistance variation from batch to batch providing the user with more consistent switching performance. In addition, the low chip gate resistance allows the designer maximum range of switching speed and increases the immunity to dv/dt induced turn-on.

Higher Threshold Voltage and Reduced "Miller Capacitance"… this provides for increased noise and spurious turn-on immunity and eliminates the need for a negative gate voltage supply for turn-off. This eliminates the need for an auxiliary power supply and simplifies the use of gate driver ICs.

Low On-State Voltage… conduction losses are dramatically lower, especially at high temperatures and high currents. Conduction losses at operating currents and temperatures are ~1/8 that of a conventional MOSFET and ~1/3 that of a superjunction MOSFET.

Low Gate Charge… this reduces gate drive power losses and enables fast switching.

Low Thermal Resistance… this maximizes power dissipation capabilities or lowers junction temperature for improved reliability.

Short Tail Current Ideal for Soft Switching…

Combis… POWER MOS 7® IGBTs are available co-packaged with a fast-recovery, antiparallel diode optimized for low reverse recovery charge, further enhancing performance in power switching applications. Co-packaging the POWER MOS 7® IGBTs with these rectifiers reduces EMI, switching losses, and conduction losses, while reducing component count and cost.

Low Switching Energies… this enables very low switching losses. In combination with the low conduction losses and the low thermal resistance, new levels of high frequency capability for a given current are achieved. Data sheets now include a graph of frequency vs. current for an IGBT Combi. This graph comprehends both conduction and switching losses and allows the designer to properly select the best device for the application.

SiC Combi's.. Power MOS 7® IGBTs are now available co-packaged with SiC schottky diodes for the ultimate in performance. Switching energies are up to 50% lower for the SiC/IGBT combi than those parts using conventional Si diodes.

In many applications these IGBTs can be used in moderate to high frequency SMPS applications. Also, the NPT technology has some added benefits over the PT type IGBTs.

THUNDERBOLT® & FAST IGBTs

Features and Benefits of NPT IGBTs

Ruggedness… NPT Technology is more rugged due to the wider base and lower gain of the PNP bipolar transistor. APT NPT IGBTs are short circuit, avalanche energy, and RBSOA rated while PT POWER MOS 7® IGBTs with higher switching frequency capability are RBSOA rated.

Paralleling… This is easier with NPT technology due to the positive temperature coefficient of $V_{CE(ON)}$ similar to a MOSFET. PT POWER MOS 7® IGBTs from APT have a slightly negative temperature coefficient and can be paralleled but may require added precautions, such as careful thermal matching or $V_{CE(ON)}$ sorting.

High Temperature Operation…

NPT - The turn-off speed and switching losses remain relatively constant over the entire operating temperature range.

PT - The turn-off speed and switching losses increase with temperature, but are extremely low due to the short tail current.

NEW!

Up To 200 kHz

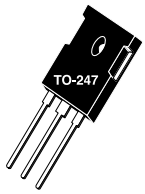
Insulated Gate Bipolar Transistors (IGBTs)

POWER MOS 7®

- PT Technology
- Ultralow Gate Resistance and Charge
- Highest Frequency IGBTs
- Ultralow Switching Losses
- Hard and Soft Switching
- Low Cost Alternative to MOSFETs
- Excellent Noise Immunity
- Single Supply Gate Drive
- Combi with High Speed Diode

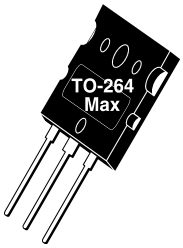
BV_{CES} Volts	$V_{CE(ON)}$ 25°C (Typ)	I_{C2} 100 - 110° C	Part Number	Package Style
SINGLE				
1200	3.3	20	APT13GP120K	TO-220
900	3.2	21	APT15GP90K	
600	2.2	27	APT15GP60K	
	2.2	20	APT11GP60K	
300	1.6	32	APT32GU30K	
1200	3.3	20	APT13GP120B	TO-247
	3.3	33	APT25GP120B	
	3.3	46	APT35GP120B	
	3.3	54	APT45GP120B	
900	3.2	21	APT15GP90B	
	3.2	36	APT25GP90B	
	3.2	50	APT40GP90B	
600	2.2	27	APT15GP60B	
	2.2	49	APT30GP60B	
	2.2	62	APT40GP60B	
	2.2	72	APT50GP60B	
300	1.6	32	APT32GU30B	
	1.6	60	APT60GU30B	
	1.6	83	APT83GU30B	
1200	3.3	91	APT75GP120B2	T-MAX™
600	2.2	96	APT65GP60B2	
	2.2	100	APT80GP60B2	
1200	3.3	29	APT35GP120J	ISOTOP®
	3.3	34	APT45GP120J	
	3.3	57	APT75GP120J	
900	3.2	32	APT40GP90J	
600	2.2	40	APT40GP60J	
	2.2	46	APT50GP60J	
	2.2	60	APT65GP60J	
	2.2	68	APT80GP60J	
Combi (IGBT & "DF Series" FRED)				
1200	3.3	20	APT13GP120BDF1	TO-247
	3.3	33	APT25GP120BDF1	
900	3.2	21	APT15GP90BDF1	
	3.2	36	APT25GP90BDF1	
600	2.2	27	APT15GP60BDF1	
	2.2	49	APT30GP60BDF1	
1200	3.3	46	APT35GP120B2DF2	T-MAX™
	3.3	54	APT45GP120B2DF2	
900	3.2	50	APT40GP90B2DF2	
600	2.2	62	APT40GP60B2DF2	
	2.2	72	APT50GP60B2DF2	
600	2.2	96	APT65GP60L2DF2	264-MAX™
1200	3.3	29	APT35GP120JDF2	ISOTOP®
	3.3	34	APT45GP120JDF2	
	3.3	57	APT75GP120JDF3	
900	3.2	32	APT40GP90JDF2	
600	2.2	31	APT30GP60JDF1	
	2.2	40	APT40GP60JDF1	
	2.2	46	APT50GP60JDF2	
	2.2	60	APT65GP60JDF2	
	2.2	68	APT80GP60JDF3	
COMBI (IGBT & SILICON CARBIDE SCHOTTKY DIODE)				
1200	3.3	20	APT13GP120BSC	TO-247
600	2.0	15	APT15GT60BSC	
	2.2	27	APT15GP60BSC	
	2.2	49	APT30GP60BSC	

TO-220[K]



TO-247[B]

T-MAX™[B2]



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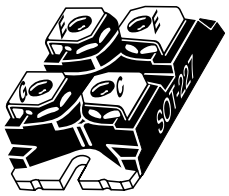
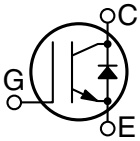


ISOTOP®[J]
SOT-227



Insulated Gate Bipolar Transistors (IGBTs)

THUNDERBOLT®

100 kHz Max

- NPT Technology
- Short Circuit Rated
- Moderate to High Frequency
- Easy Paralleling
- Single Supply Gate Drive
- Combi with low V_F Diode

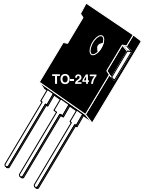
FAST

50 kHz Max

- NPT Technology
- Short Circuit Rated
- Low to Moderate Frequency
- Lowest Conduction Loss
- Easy Paralleling
- Single Supply Gate Drive
- Combi with low V_F Diode

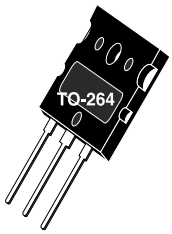
BV_{CES} Volts	$V_{CE(ON)}$ 25°C (Typ)	I_{C2} 90-110° C	Part Number	Package Style
SINGLE				
600	2.0	8	APT8GT60KR	TO-220
	2.0	12	APT12GT60KR	
	2.0	15	APT15GT60KR	
	1.75	20	APT20GT60KR	
	2.0	30	APT30GT60KR	
600	2.0	12	APT12GT60BR	TO-247
	2.0	15	APT15GT60BR	
	2.0	20	APT20GT60BR	
	2.0	30	APT30GT60BR	
	2.15	40	APT40GT60BR	
	2.2	60	APT60GT60BR	
600	2.0	60	APT60GT60JR	ISOTOP®
Combi (IGBT & "D" Series FRED)				
600	2.0	15	APT15GT60BRD	TO-247
	2.0	30	APT30GT60BRD	
600	2.0	60	APT60GT60JRD	ISOTOP®
SINGLE				
1200	2.5	11	APT11GF120KR	TO-220
	2.7	20	APT20GF120KR	
1200	2.7	20	APT20GF120BR	TO-247
	2.7	33	APT33GF120BR	
600	2.1	50	APT50GF60BR	
1200	2.9	50	APT50GF120B2R	T-MAX™
600	1.6	100	APT100GF60B2R	
1200	3.5	50	APT50GF120LR	TO-264
600	1.6	100	APT100GF60LR	
600	1.6	100	APT100GF60JR	ISOTOP®
Combi (IGBT & "D" Series FRED)				
1200	2.5	11	APT11GF120BRD1	TO-247
	2.7	20	APT20GF120BRD	
1200	2.7	33	APT33GF120B2RD	T-MAX™
600	2.1	50	APT50GF60B2RD	
1200	2.7	33	APT33GF120LRD	TO-264
600	2.1	50	APT50GF60LRD	
1200	2.9	40	APT40GF120JRD	ISOTOP®
	2.9	50	APT50GF120JRD	
	2.1	60	APT60GF120JRD	
600	1.6	100	APT100GF60JRD	

TO-220[K]



TO-247[B]

T-MAX™[B2]



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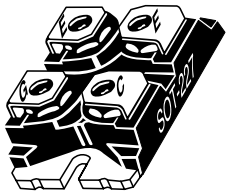
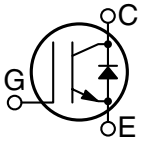


ISOTOP®[J]
SOT-227



Power MOS 7 The Coolest FET Yet!

Our latest generation of conventional MOSFETs with the lowest on-resistance, gate charge, and total losses for a given footprint. .... Designed to meet the most advanced SMPS design requirements for higher reliability, power density, and efficiency, this new generation of MOSFETs dramatically lowers the two largest contributors of power losses in SMPS applications....

LOW CONDUCTION LOSSES…
On-Resistance ($R_{DS(ON)}$) has been lowered by up to 30% and thermal resistance lowered by up to 10% for any given chip size.

LOW SWITCHING LOSSES…
Combining ultra low gate charge and our proprietary aluminum metal gate structure results in a MOSFET capable of extremely fast switching and very low switching losses. Total gate charge (Q_g) and "Miller" gate charge (Q_{gd}) have been reduced by up to 60%. Like all APT Power MOSFETs, Power MOS 7® utilizes a low resistance aluminum metal gate structure. This allows for faster gate signal propagation than is possible with conventional polysilicon gate structures. In addition, Power MOS 7® employs new gate design layouts for extremely low internal chip equivalent gate resistances (EGR) that are up to an order of magnitude lower than competitive devices and provides for very uniform switching across the entire chip. This provides for faster switching speeds, up to 50% faster than our previous generation of Power MOSFETs.

THE RESULT… higher efficiency, and more power in less space. The lowest power loss Figure of Merit (FOM) for conventional high power MOSFETs in the industry -
$FOM = R_{DS(ON)} \times Q_g$

In addition, like all APT Power MOSFETs, Power MOS 7® devices are extremely rugged…

AVALANCHE ENERGY RATED… All Power MOS 7® MOSFETs are 100% tested and guaranteed for avalanche energy.

HIGH GATE RUPTURE VOLTAGE… Thick high quality gate oxide allows for specification of ± 30V continuous operation and ± 40V transient operation gate voltage.

and Power MOS 7® provides ***industry leading spurious turn-on immunity…***

HIGH NOISE IMMUNITY… Higher Gate Threshold voltage - $V_{gs(th)}$, 3 volts minimum.

REDUCED SHOOT THROUGH SUSCEPTIBILITY…
increased gate threshold voltage -Vgs(th), ultralow equivalent gate resistance (EGR) and high input capacitance ratio (Q_{gs}/Q_{gd}) results in an Industry leading high figure of Merit (FOM) -

FOM = Vgs(th) X Qgs/Qgd

HIGH COMMUTATING dv/dt CAPABILITY… from defect tolerant linear cell design and very low parasitic bipolar base resistance.

550 AND 1100 VOLT PRODUCTS for added voltage headroom to reduce SEB failures and minimize conduction loss tradeoff. Ideal for higher power designs of existing converter topologies where increased field failure rates are a concern and for existing topologies and power levels where converter field failure rates need to be reduced.

Two families of POWER MOS 7® MOSFETs are offered:

MOSFETs–for applications not utilizing the intrinsic body drain diode

FREDFETs–for applications utilizing the intrinsic body drain diode. These MOSFETs have the body drain diode optimized for fast reverse recovery time (t_{rr}) and improved commutating dv/dt capability by special silicon lifetime control processes.

APT POWER MOS 7® FREDFETs have all the improved features and benefits of APT POWER MOS 7® MOSFETs and in addition…

- Faster Intrinsic Diode Reverse Recovery…The reverse recovery time (trr) has been reduced thereby eliminating the external FRED and Schottky rectifiers in certain circuit configurations.

- Improved Ruggedness… The ruggedness of the intrinsic diode has also been improved, allowing for improved commutating dv/dt ratings.

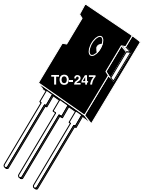
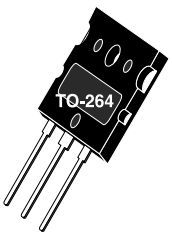
CUSTOM FREDFETS FOR HIGH TEMPERATURE OPERATION…
The lifetime process utilized for the FREDFETs in this catalog is a proven industry standard. In some designs there are requirements for improved high temperature device performance and this can be made available using our proprietary platinum lifetime control process. Our platinum process provides the high temperature advantages of soft recovery, lower leakage current, and more temperature independent performance.

APPLICATIONS FOR FREDFETs… Power MOS 7® FREDFETs should be specified under the following conditions:

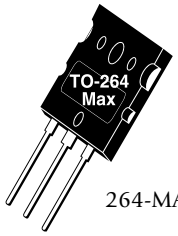
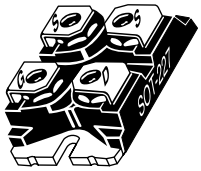
- Whenever the intrinsic body drain diode of the MOSFET is expected to carry forward current.

- In soft switched circuits, where the body diode carries current.

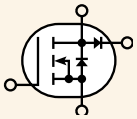
Power MOS 7® MOSFETs / FREDFETs

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	FREDFET P/N (low t_{rr} MOSFET)	Package Style
1200	4.700	3.5	- - -	APT1204R7KFLL	 TO-220[K]
1000	3.000	4	APT1003RKLL	APT1003RKFLL	
1200	4.700	3.5	- - -	APT1204R7BFLL	 TO-247[B]
	1.400	9	- - -	APT1201R4BFLL	
	1.200	12	- - -	APT1201R2BFLL	
1100	1.200	10	- - -	APT1101R2BFLL	
	1.000	13	- - -	APT1101RBFLL	
1000	3.000	4	APT1003RBLL	APT1003RBFLL	
	1.600	8	- - -	APT1001R6BFLL	
	0.900	12	APT10090BLL	APT10090BFLL	
	0.780	14	APT10078BLL	APT10078BFLL	
800	0.520	15	APT8052BLL	APT8052BFLL	 D³ PAK[S] TO-268
	0.430	20	APT8043BLL	APT8043BFLL	
600	0.380	17	APT6038BLL	APT6038BFLL	
	0.290	21	APT6029BLL	APT6029BFLL	
	0.250	24	APT6025BLL	APT6025BFLL	
	0.210	29	APT6021BLL	APT6021BFLL	
550	0.310	19	- - -	APT5531BFLL	
	0.230	24	- - -	APT5523BFLL	
	0.180	31	- - -	APT5518BFLL	
500	0.240	22	APT5024BLL	APT5024BFLL	
	0.180	27	APT5018BLL	APT5018BFLL	
	0.160	30	APT5016BLL	APT5016BFLL	
	0.140	35	APT5014BLL	APT5014BFLL	
300	0.061	54	APT30M61BLL	APT30M61BFLL	Part Numbers for D³ packages - replace "B" with "S" in part number
	0.075	44	APT30M75BLL	APT30M75BFLL	
200	0.036	65	APT20M36BLL	APT20M36BFLL	
	0.034	74	APT20M34BLL	APT20M34BFLL	
1200	0.670	18	- - -	APT12067B2FLL	 T-MAX™[B2]
	0.570	22	- - -	APT12057B2FLL	
1100	0.580	20	- - -	APT11058B2FLL	
	0.440	26	- - -	APT11044B2FLL	
1000	0.450	23	APT10045B2LL	APT10045B2FLL	
	0.350	28	APT10035B2LL	APT10035B2FLL	
800	0.240	31	APT8024B2LL	APT8024B2FLL	
	0.200	38	APT8020B2LL	APT8020B2FLL	
600	0.170	35	APT6017B2LL	APT6017B2FLL	 TO-264[L]
	0.130	43	APT6013B2LL	APT6013B2FLL	
	0.100	54	APT6010B2LL	APT6010B2FLL	
550	0.130	41	- - -	APT5513B2FLL	
	0.100	49	- - -	APT5510B2FLL	
	0.085	59	- - -	APT55M85B2FLL	
500	0.100	46	APT5010B2LL	APT5010B2FLL	
	0.075	57	APT50M75B2LL	APT50M75B2FLL	
	0.065	67	APT50M65B2LL	APT50M65B2FLL	
300	0.036	84	APT30M36B2LL	APT30M36B2FLL	
	0.030	100	APT30M30B2LL	APT30M30B2FLL	
200	0.020	100	APT20M20B2LL	APT20M20B2FLL	Part Numbers for TO-264 packages - replace"B2" with "L" in part number
	0.016	100	APT20M16B2LL	APT20M16B2FLL	

Power MOS 7® MOSFETs / FREDFETs

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	FREDFET P/N (low t_{rr} MOSFET)	Package Style
1200	0.400	30	- - -	APT12040L2FLL	 264-MAX ™[L2]
1000	0.260	38	APT10026L2LL	APT10026L2FLL	
800	0.140	52	APT8014L2LL	APT8014L2FLL	
600	0.075	73	APT60M75L2LL	APT60M75L2FLL	
550	0.065	78	- - -	APT55M65L2FLL	
500	0.050	89	APT50M50L2LL	APT50M50L2FLL	
1200	0.670	17	- - -	APT12067JFLL	
	0.570	19	- - -	APT12057JFLL	
	0.400	24	- - -	APT12040JFLL	
	0.310	30	- - -	APT12031JFLL	
1100	0.580	18	- - -	APT11058JFLL	
	0.440	22	- - -	APT11044JFLL	
	0.260	30	- - -	APT11026JFLL	
1000	0.450	21	APT10045JLL	APT10045JFLL	
	0.350	25	APT10035JLL	APT10035JFLL	
	0.260	30	APT10026JLL	APT10026JFLL	
	0.210	37	APT10021JLL	APT10021JFLL	
800	0.240	29	APT8024JLL	APT8024JFLL	
	0.200	33	APT8020JLL	APT8020JFLL	
	0.140	42	APT8014JLL	APT8014JFLL	
	0.110	51	APT8011JLL	APT8011JFLL	
600	0.170	31	APT6017JLL	APT6017JFLL	
	0.130	39	APT6013JLL	APT6013JFLL	
	0.100	47	APT6010JLL	APT6010JFLL	
	0.075	58	APT60M75JLL	APT60M75JFLL	
	0.060	70	APT60M60JLL	APT60M60JFLL	
550	0.130	35	- - -	APT5513JFLL	 ISOTOP®[J] SOT-227 (ISOLATED BASE)
	0.100	44	- - -	APT5510JFLL	
	0.085	51	- - -	APT55M85JFLL	
	0.065	63	- - -	APT55M65JFLL	
	0.050	77	- - -	APT55M50JFLL	
500	0.100	44	APT5010JLL	APT5010JFLL	
	0.075	51	APT50M75JLL	APT50M75JFLL	
	0.065	58	APT50M65JLL	APT50M65JFLL	
	0.050	71	APT50M50JLL	APT50M50JFLL	
	0.038	91	APT50M38JLL	APT50M38JFLL	
300	0.036	76	APT30M36JLL	APT30M36JFLL	
	0.030	88	APT30M30JLL	APT30M30JFLL	
	0.017	135	APT30M17JLL	APT30M17JFLL	
200	0.020	104	APT20M20JLL	APT20M20JFLL	
	0.011	176	APT20M11JLL	APT20M11JFLL	

MOSFET/FRED ("Combi Products")

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	BOOST CONFIGURATION
500	0.100	44	APT5010JLLU2	
	0.075	51	APT50M75JLLU2	

Power MOS V® MOSFETs / FREDFETs

Introduced in 1997 and designed to meet the most advanced SMPS design requirements for higher reliability, power density, and efficiency at that time, Power MOS V® can still provide the best trade-off between performance and cost in some applications. Like all APT Power MOSFETs, Power MOS V® utilizes a low resistance aluminum metal gate structure. This allows for faster gate signal propagation than is possible with conventional polysilicon gate structures. The result is extremely low internal chip equivalent gate resistances (EGR) that are up to an order of magnitude lower than competitive devices which enables uniform high speed switching across the entire chip.

Two families of POWER MOS V® MOSFETs are offered:

- MOSFETs – for applications not utilizing the intrinsic body drain diode
- FREDFETs - for applications utilizing the intrinsic body drain diode. These MOSFETs have the body drain diode optimized for fast reverse recovery time (t_{rr}) and improved commutating dv/dt capability by special silicon lifetime control processes.

APT POWER MOS V® FREDFETs have all the improved features and benefits of APT POWER MOS V® MOSFETs and in addition…

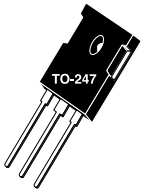
- Faster Intrinsic Diode Reverse Recovery .... The reverse recovery time (trr) has been reduced thereby eliminating the external FRED and Schottky rectifiers in certain circuit configurations.
- Improved Ruggedness… The ruggedness of the intrinsic diode has also been improved, allowing for improved commutating dv/dt ratings.

CUSTOM FREDFETS FOR HIGH TEMPERATURE OPERATION… The lifetime process utilized for the FREDFETs in this catalog is a proven industry standard. In some designs there are requirements for improved high temperature device performance and this can be made available using our proprietary platinum lifetime control process. Our platinum process provides the high temperature advantages of soft recovery, lower leakage current, and more temperature independent performance.

APPLICATIONS FOR FREDFETS… Power MOS V® FREDFETs should be specified under the following conditions:

- Whenever the intrinsic body drain diode of the MOSFET is expected to carry forward current.
- In soft switched circuits, where the body diode carries current.

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	FREDFET P/N (low t_{rr} MOSFET)	Package Style
1200	1.600	8	- - -	APT1201R6BVFR	
	1.500	10	- - -	APT1201R5BVFR	
1000	1.000	11	APT1001RBVR	APT1001RBVFR	
	0.860	13	APT10086BVR	APT10086BVFR	
800	0.750	12	APT8075BVR	APT8075BVFR	
	0.650	13	APT8065BVR	APT8065BVFR	
	0.560	16	APT8056BVR	APT8056BVFR	
600	0.400	16	APT6040BVR	APT6040BVFR	
	0.350	18	APT6035BVR	APT6035BVFR	
	0.300	21	APT6030BVR	APT6030BVFR	
	0.250	25	APT6025BVR	APT6025BVFR	
500	0.280	20	APT5028BVR	APT5028BVFR	
	0.240	22	APT5024BVR	APT5024BVFR	
	0.200	26	APT5020BVR	APT5020BVFR	
	0.170	30	APT5017BVR	APT5017BVFR	
	0.150	32	APT5015BVR	APT5015BVFR	



TO-247[B]

D³ PAK[S]
TO-268

Part Numbers for D³ packages - replace "B" with "S" in part number

Power MOS V® MOSFETs / FREDFETs

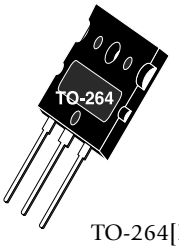
BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	FREDFET P/N (low t_{rr} MOSFET)	Package Style
400	0.200	23	- - -	APT4020BVFR	
	0.160	27	- - -	APT4016BVFR	
	0.140	28	- - -	APT4014BVFR	
	0.120	37	- - -	APT4012BVFR	
300	0.085	40	APT30M85BVR	APT30M85BVFR	
	0.070	48	APT30M70BVR	APT30M70BVFR	
200	0.045	56	APT20M45BVR	APT20M45BVFR	
	0.040	59	APT20M40BVR	APT20M40BVFR	
	0.038	67	APT20M38BVR	APT20M38BVFR	
100	0.025	75	APT10M25BVR	APT10M25BVFR	
	0.019	75	APT10M19BVR	APT10M19BVFR	
1200	0.800	16	- - -	APT12080B2VFR	
	0.600	20	- - -	APT12060B2VFR	
1000	0.500	21	APT10050B2VR	APT10050B2VFR	
	0.400	26	APT10040B2VR	APT10040B2VFR	
800	0.300	27	APT8030B2VR	APT8030B2VFR	
	0.240	33	APT8024B2VR	APT8024B2VFR	
600	0.200	30	APT6020B2VR	APT6020B2VFR	
	0.150	38	APT6015B2VR	APT6015B2VFR	
	0.110	49	APT6011B2VR	APT6011B2VFR	
500	0.140	37	APT5014B2VR	APT5014B2VFR	
	0.100	47	APT5010B2VR	APT5010B2VFR	
	0.085	56	APT50M85B2VR	APT50M85B2VFR	
	0.080	58	APT50M80B2VR	APT50M80B2VFR	
400	0.070	57	- - -	APT40M70B2VFR	
300	0.040	76	APT30M40B2VR	APT30M40B2VFR	
200	0.022	100	APT20M22B2VR	APT20M22B2VFR	
	0.018	100	APT20M18B2VR	APT20M18B2VFR	
100	0.011	100	- - -	APT10M11B2VFR	
	0.009	100	- - -	APT10M11B2VFR	
1200	0.450	26	- - -	APT12045L2VFR	
1000	0.300	33	APT10030L2VR	APT10030L2VFR	
800	0.180	43	APT8018L2VR	APT8018L2VFR	
600	0.080	65	APT60M80L2VR	APT60M80L2VFR	
500	0.060	77	APT50M60L2VR	APT50M60L2VFR	
1400	0.500	23	- - -	APT14050JVFR	
1200	0.800	15	- - -	APT12080JVFR	
	0.400	26	- - -	APT12040JVFR	
1000	0.500	19	APT10050JVR	APT10050JVFR	
	0.430	22	APT10043JVR	APT10043JVFR	
	0.250	34	APT10025JVR	APT10025JVFR	
800	0.300	25	APT8030JVR	APT8030JVFR	
	0.280	28	APT8028JVR	APT8028JVFR	
	0.150	44	APT8015JVR	APT8015JVFR	
600	0.150	35	APT6015JVR	APT6015JVFR	
	0.130	40	APT6013JVR	APT6013JVFR	
	0.075	62	APT60M75JVR	APT60M75JVFR	
500	0.100	44	APT5010JVR	APT5010JVFR	
	0.085	50	APT50M85JVR	APT50M85JVFR	
	0.060	63	APT50M60JVR	APT50M60JVFR	
	0.050	77	APT50M50JVR	APT50M50JVFR	

TO-247[B]

D³ PAK[S]

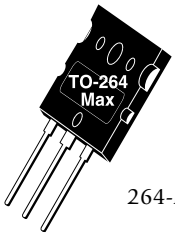
Part Numbers for D³ packages - replace "B" with "S" in part number

T-MAX™[B2]

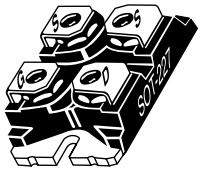


TO-264[L]

Part Numbers for TO-264 packages - replace"B2" with "L" in part number

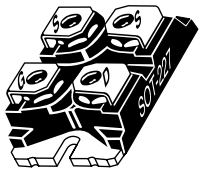


264-MAX ™[L2]



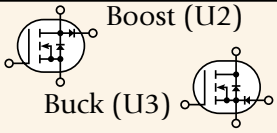
ISOTOP®[J]
SOT-227
(ISOLATED BASE)

Power MOS V® MOSFETs / FREDFETs

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	FREDFET P/N (low t_{rr} MOSFET)	Package Style
400	0.070	53	- - -	APT40M70JVFR	
	0.035	93	- - -	APT40M35JVFR	
300	0.040	70	APT30M40JVR	APT30M40JVFR	
	0.019	130	APT30M19JVR	APT30M19JVFR	
200	0.022	97	APT20M22JVR	APT20M22JVFR	
	0.019	112	APT20M19JVR	APT20M19JVFR	
	0.011	175	APT20M11JVR	APT20M11JVFR	
100	0.011	144	- - -	APT10M11JVFR	
	0.007	225	- - -	APT10M07JVFR	

ISOTOP®[J]
SOT-227
(ISOLATED BASE)

MOSFET/FRED ("Combi Products")

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	CONFIGURATION
500	0.100	44	APT5010JVRU2	 Boost (U2)
	0.100	44	APT5010JVRU3	Buck (U3)

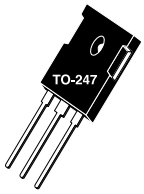
COOLMOS™ Power Semiconductors

COOLMOS™ MOSFETs

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	MOSFET P/N	Package Style
800	0.450	11	APT11N80KC3	TO-220
800	0.450	11	APT11N80BC3	TO-247
	0.290	17	APT17N80BC3	
600	0.190	21	APT20N60BC3	
	0.095	40	APT40N60BC3	
	0.070	47	APT47N60BC3	
800	0.290	17	APT17N80SC3	D3
600	0.190	20	APT20N60SC3	
	0.070	47	APT47N60SC3	
800	0.145	34	APT34N80B2C3	T-MAX™
800	0.145	34	APT34N80LC3	TO-264
800	0.145	31	APT31N80JC3	ISOTOP®
600	0.035	77	APT77N60JC3	

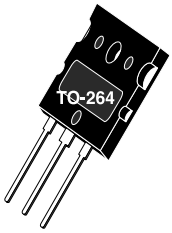
TO-220[K]

D³ PAK[S]
TO-268

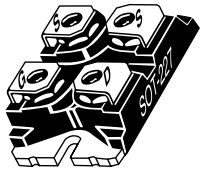


TO-247[B]

T-MAX™[B2]



TO-264[L]



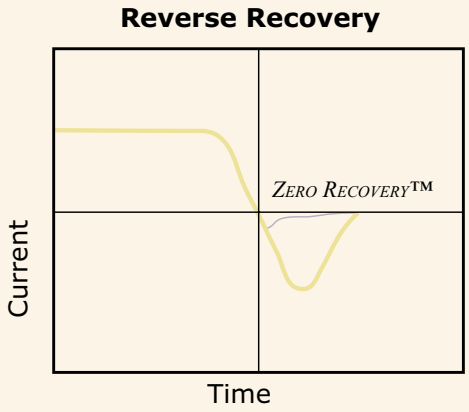
ISOTOP®[J]
SOT-227
(ISOLATED BASE)

"COOLMOS" comprise a new family of transistors developed by Infineon Technologies AG.
"COOLMOS" is a trademark of Infineon Technologies AG"

NEW!

Silicon Carbide Schottky Diodes

Silicon Carbide (SiC) Schottky Diodes are the latest development in high power diode technology. SiC offers superior dynamic and thermal performance over conventional silicon power diodes. The SiC has essentially no reverse recovery and stable switching characteristics over a wide temperature range. With a 175°C T_J rating, positive V_F temperature coefficient, and extremely fast switching, enables designs with superior efficiencies and reduced size. When co-packaged with APT's Power MOS7® IGBTs switching energies are up to 50% lower than those parts using Si diodes.



APPLICATIONS -

- PFC and Forward Topologies
- Hard or Soft Switched Topologies
- High Frequency, High Performance

FEATURES	BENEFITS
Schottky Barrier–Majority Carrier Only	Switching Losses Nearly Eliminated -ZERO RECOVERY™ Greatly Reduced Turn-On Loss In Switch Improved Overall Efficiency Enables Higher Frequency Operation Simplify or Eliminate Snubber Circuits
Wide Energy Gap	High Temperature Operation Low Leakage Current Radiation Hardness
High Breakdown Electric Field	Low Resistance–High Power Density
High Termal Conductivity High Pulse Capability	Reliable High Power Operation
Positive V_F Temperature Coefficient	Thermally Stable Paralleling

ZERO RECOVERY™ is a trademark of Cree Inc.

Silicon Carbide

- Custom Configurations Available
- Hermetic Packages Available
- See Page 5 for SiC Combi's

Volts	I_F Amps	V_F (volts) Typ 25°C	Part Number	Configuration	Package Style
1200	5	1.6	APT5SC120K	Single	TO-220
	5	1.6	APT10SC120KCT	Center Tap	
	10	1.6	APT5SC120K	Single	
600	6	1.6	APT6SC60K	Single	TO-220
	6	1.6	APT6SC60KCT	Center Tap	
	10	1.6	APT10SC60K	Single	
	10	1.6	APT10SC60KCT	Center Tap	
	20	1.6	APT20SC60K	Single	
	6	1.6	APT6SC60SA	Single	D-2
	10	1.6	APT10SC60SA	Single	

Fast Recovery Epitaxial Diodes (FREDs)

Figure 1 below shows the typical tradeoff between reverse recovery switching times (t_{rr}) and forward voltage drop (V_F) for a FRED – lower switching times (faster switching speeds) result in higher forward voltage drop. The specific process and design define the curve. A critical part of the manufacturing process is the lifetime control – the lower the material lifetime the lower the switching times (move left and up the curve). For APT the lifetime control technique is a proprietary platinum diffusion process – the more platinum the faster the switching times. The reverse recovery times are directly related to the reverse recovery charge. APT offers three families or "series" of high performance FRED products which are represented by specific points on the trade off curve of Figure 1.

Figure 1

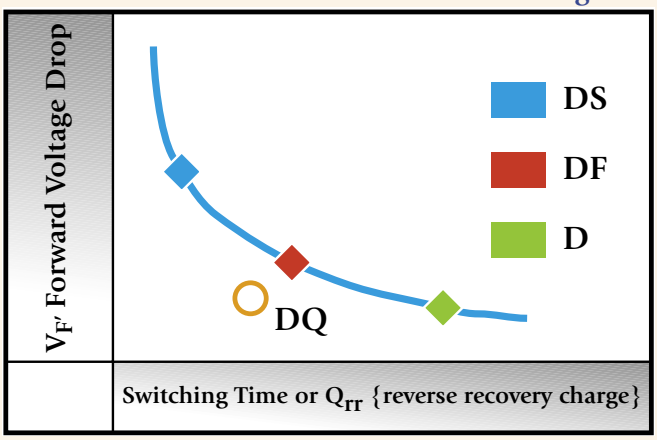


Figure 2

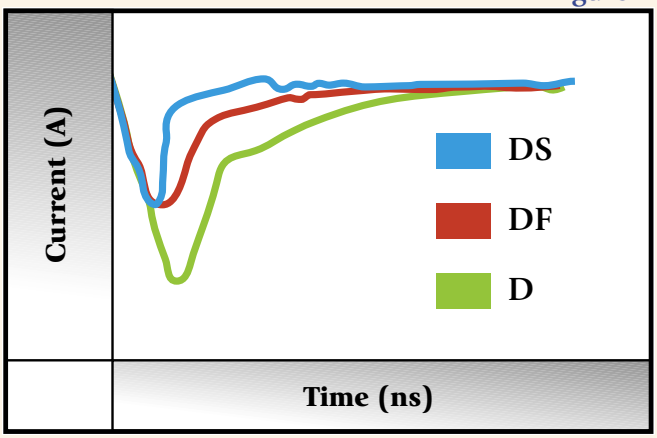


Figure 2 shows a relative comparison of the reverse recovery waveforms for each of the 3 "series" of products.

Our proprietary platinum lifetime control process results in performance advantages compared to FREDs built with alternative processes for lifetime control:

- High Temperature Capability - less degradation of performance at high temperatures allowing for increased maximum junction temperature for safe operation. Junction temperature maximum is 150 °C without concern for excessively high leakage currents and thermal runaway.
- Softer Recovery – to minimize EMI
- Very Fast switching times (t_{rr}) along with extremely low reverse recovery current (I_{RRM}) and reverse recovery charge (Q_{rr}) for a given forward voltage (V_F).

The "D" and "DS" series of FREDs are currently offered as discrete products. The "DF" series FREDs are only offered in the Power MOS 7® IGBT combis.

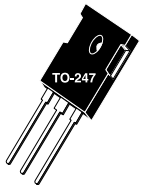
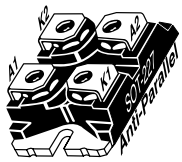
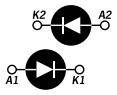
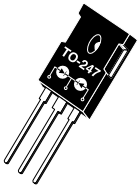
NEW!

Coming in 2nd Half of 2004: New DQ Series of FREDs

APT is pleased to announce the next step forward in FRED technology. The DQ series of products is optimized for continuous conduction mode PFC and other hard switched high performance power supplies. Ultra low reverse recovery charge circumvents high power loss in the PFC switch, enabling higher frequency operation for lower system cost. A well balanced tradeoff between forward voltage and reverse characteristics result in low power loss in the diode as well. The DQ series diodes have very soft recovery under all operating conditions, greatly reducing EMI and the losses and cost associated with filters and snubbers required with snappy diodes. High leakage current that plagues some low recovery charge diodes is eliminated with APT's proprietary platinum minority carrier life time control. APT's proprietary platinum processing results in superior temperature stability, enabling easy paralleling and safe operation up to the 175 °C rated maximum junction temperature.

The first DQ series products available will be 600 Volt followed by other voltages. The current ratings are 8, 15, 30, 60, and 100 Amperes. These products will be available in all of the standard package configurations of APT's existing D series FRED products.

"D" Series FREDs

Volts	I_F Amps	V_F (volts) Typ 25°C	t_{rr} (ns) Typ 25°C	Part Number	Package Style
1200	30 60	2.0 2.0	370 400	APT30D120B APT60D120B	 TO-247[B]
1000	30 60	1.9 1.9	300 280	APT30D100B APT60D100B	 D³ PAK[S] TO-268
600	15 30 60	1.6 1.6 1.6	80 85 130	APT15D60B APT30D60B APT60D60B	
400	30 60	1.3 1.3	32 37	APT30D40B APT60D40B	
300	60	1.2	38	APT60D30B	Part Numbers for D³ packages - replace "B" with "S" in part number
200	30 60	1.1 1.1	24 31	APT30D20B APT60D20B	
1200	15	2.0	260	APT15D120K	
1000	15	1.9	260	APT15D100K	
600	15	1.6	80	APT15D60K	 TO-220[K]
400	15	1.3	35	APT15D40K	
300	15	1.2	32	APT15D30K	
1200	27 53 93	2.0 2.0 2.0	370 400 420	APT2X30D120J APT2X60D120J APT2X100D120J	
1000	28 55 95	1.9 1.9 1.9	300 280 300	APT2X30D100J APT2X60D100J APT2X100D100J	
600	30 60 100	1.6 1.6 1.6	85 130 180	APT2X30D60J APT2X60D60J APT2X100D60J	ISOTOP®[J] SOT-227 Antiparallel Configuration (ISOLATED BASE) 
400	30 60 100	1.3 1.3 1.3	32 37 50	APT2X30D40J APT2X60D40J APT2X100D40J	
300	30 60 100	1.2 1.2 1.2	25 38 47	APT2X30D30J APT2X60D30J APT2X100D30J	Part Numbers for Parallel Configuration replace 30, 60, or 100 with 31, 61, or 101. Example: 2X30D120J becomes 2X31D120J
200	30 60 100	1.1 1.1 1.1	24 31 60	APT2X30D20J APT2X60D20J APT2X100D20J	
1200	15 30	2.0 2.0	260 370	APT15D120BCT APT30D120BCT	
1000	15 30	1.9 1.9	80 85	APT15D100BCT APT30D100BCT	
600	15 30	1.6 1.6	35 32	APT15D60BCT APT30D60BCT	
400	15 30	1.3 1.3	32 25	APT15D40BCT APT30D40BCT	
300	15 30	1.2 1.2	32 25	APT15D30BCT APT30D30BCT	 TO-247[BCT] *Common Cathode
200	15 30	1.1 1.1	41 24	APT15D20BCT APT30D20BCT	

* Current rating per leg for common cathode configuration

"D" Series FREDs

Volts	I_F Amps	V_F (volts) Typ 25°C	t_{rr}(ns) Typ 25°C	Part Number	Package Style
1000	60	1.9	280	APT60D100LCT	TO-264[LCT] *Common Cathode
600	60	1.6	130	APT60D60LCT	
400	60	1.3	37	APT60D40LCT	
300	60	1.2	38	APT60D30LCT	
200	60	1.1	31	APT60D20LCT	
1000	15 30	1.9 1.9	260 300	APT15D100BHB APT30D100BHB	TO-247[BHB] Half Bridge
600	30	1.6	85	APT30D60BHB	
1000	30	1.9	300	APT30D100BCA	TO-247[BCA] Common Anode
600	15 30	1.6 1.6	80 85	APT15D60BCA APT30D60BCA	
200	30	1.1	24	APT30D20BCA	

"DS" Series FREDs

Two - 300V FREDs in Series

Volts	I_F Amps	V_F (volts) Typ 25°C	t_{rr}(ns) Typ 25°C	Part Number	Package Style
600	30 15	4.0 4.5	20 12.5	APT30DS60B APT15DS60B	TO-247

Schottky Diodes

These Schottky Diodes offer several dramatic improvements over currently used Fast Recovery Epitaxial Diodes (FREDs):

- lower forward voltage drop (V_F) to minimize conduction loss enabling higher power conversion efficiencies.
- softer reverse recovery characteristics resulting in reduced EMI
- avalanche energy rated (EAS) offering improved reliability.

Power supply designers can use these new schottky diodes to improve cost, power density, and efficiency of their designs. Designs with these schottky diodes can experience 10-15% lower losses than FRED's with the same voltage ratings. These cost effective Schottky Diodes can replace FRED's as output rectifiers in high power 48 volt telecom rectifiers and DC-DC converters and as free wheeling and anti-parallel diodes in low voltage converters.

I_F Amps	V_F (volts) Typ 25°C "200V"	t_{rr}(ns) Typ 25°C "200V"	Part Number	Configuration	Package Style
15	0.80	80	APT15S20K		TO-220
15	0.80	80	APT15S20KCT	*common cathode	
60	0.83	55	APT60S20S		D^3 PAK
30	0.80	55	APT30S20S		
100	0.89	70	APT100S20B		TO-247
60	0.83	55	APT60S20B		
30	0.83	55	APT30S20B		
30	0.80	55	APT30S20BCT	*common cathode	
15	0.80	80	APT15S20BCT	*common cathode	
60	0.83	55	APT60S20B2CT	*common cathode	T-MAX™
100	0.89	70	APT100S20LCT	*common cathode	TO-264
100	0.89	70	APT2X101S20J		ISOTOP®
60	0.83	55	APT2X61S20J		
30	0.80	55	APT2X31S20J		

* Current rating per leg for common cathode configuration

Linear MOSFETs

What is a Linear MOSFET?

A MOSFET specifically designed to be more robust than a standard MOSFET when operated with both high voltage and high current near DC conditions (>100msecs).

The Problem with SMPS MOSFETs

MOSFETs optimized for high frequency SMPS applications have poor high voltage DC SOA. Most SMPS type MOSFETs overstate SOA capability at high voltage on the data sheets. Above ~30V and DC conditions, SOA drops faster than is indicated by P_D limited operation.

For pulsed loads (t<10ms) there is generally no problem using a standard MOSFET.

APT Technology Innovation

Introduced in 1999, APT modified its proprietary patented self-aligned metal gate MOSFET technology for enhanced performance in high voltage, linear applications. These Linear MOSFETs typically provide 1.5-2.0 times the DC SOA capability at high voltage compared to other MOSFET technologies optimized for switching applications.

Designers will need Linear MOSFETs when…

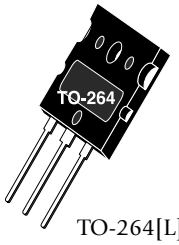
- High Current & > 200V >100msec
- Used as a variable power resistor
- Soft start application (limit surge currents)
- Linear amplifier circuit

Typical Applications…

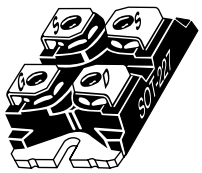
- Active loads above 200 volts such as DC dynamic loads for testing power supplies, batteries, fuel cells, etc.
- High voltage, high current constant current sources.

BV_{DSS} Volts	$R_{DS(ON)}$ Ohms	$I_{D(Cont)}$ Amps	SOA Watts	Part Number	Package Style
600	0.125	49	325	APL602B2	
500	0.090	58	325	APL502B	
1000	0.600	18	325	APL1001J	
600	0.125	43	325	APL602J	
500	0.090	52	325	APL502J	

T-MAX™[B2]



TO-264[L]



ISOTOP®[J]
SOT-227
(ISOLATED BASE)

Part Numbers for TO-264 packages - replace "B2" with "L" in part number

Custom Products

In addition to the broad line of leading edge products in this catalog, APT is dedicated to providing innovative solutions for our customers. This means working with our customers to solve their procurement, manufacturing or application problems. We are known as the supplier that provides solutions that others cannot, or will not, provide. These include, but are not limited to:

- Custom silicon and packaging
- Supply chain management requirements
- Strategic inventories to allow for unexpected changes in demand
- Special testing
- Thermal and power management
- Hi-Rel Testing/Screening

Hermetic and Hi-Rel

Advanced Power Technology manufactures a broad range of discrete power semiconductors for industrial, military, and space applications. Our focus is on the high voltage, high power, and high performance segment of this market. APT's technology leadership allows us to offer the latest high performance power **MOSFETs, FREDFETs, IGBTs, and Diodes**. ***All products listed in this catalog can be provided in hermetic packages.*** APT is ISO9001-2000 registered, MIL-PRF-19500 certified and can offer TX, TXV, Space Level processing, Custom testing and screening as well as Plastic Up-Screening. Contact your local representative or APT directly for a copy of the current Hi-Rel Capabilities Brochure.

Die Products

Advanced Power Technology's products are available in die form. Die information can be requested from our website at www.advancedpower.com or contact APT directly for a copy of the current Die Product Catalog.