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New 600V Ultra Fast PFC Boost Diode

Monday, 10 October 2016

Sirect Semiconductor Inc., announced that the new 600V Ultra Fast (FRED, Fast Recovery Epitaxial Diode) Boost Diode family for active Power Factor Correction (PFC) application on the field of high frequency power management. The new Boost Diode to be provided with higher efficiency and lower cost compared with competitors'.

Following is the electronic specification of new 600V Ultra Fast Boost Diode:

Part Number	Type	PFC Mode Application	Io (A)	V_B (V)	T_{RR} (Typ.)	V_F @ rated Current (Typ.)		I_R @ 600V (Typ.)		Package
						25°C	125°C	25°C	125°C	
MUR460(S)	Super-fast	CRM	4	600	30ns	1.25V	0.95V	0.1μA	15μA	DO-201AD
MUR860H	Ultra-fast	CRM, DCM & CCM	8	600	20ns	1.7V	1.4V	0.1μA	15μA	TO-220AC
MUR860LH	Ultra-fast	CRM, DCM & CCM	8	600	24ns	1.5V	1.3V	0.1μA	15μA	TO-220AC
MUR860TH	Ultra-fast	CRM, DCM & CCM	8	600	17ns	2.0V	1.6V	0.1μA	15μA	TO-220AC

Table 1: The New 600V Ultra Fast Boost Diode Family

The new 600V Ultra Fast Boost Diode had the higher efficiency and power factor (PF) on continuous current mode (CCM), discontinuous current mode (DCM) and critical mode (CRM) on PFC topology indeed. The several advantages of new Boost Diode are the most important reason why we suggested put into the high frequency switching application:

-Small Reverse Recovery Time (T_{RR})

-Small Reverse Recovery Charge (Q_{RR}) & Total Capacitive Charge (Qc)

-Low Reverse Current Leakage (I_R) & Maximum Reverse Recovery Current (I_{RRM})

-Low Forward Voltage Drop-down (V_F)

-Small Reverse Recovery Ring-Peak

-High Power Density

-Excellent Softness Recovery Factor (S)

Therefore, the new 600V Boost Diode already had satisfied with any critical requirements on power management, such as active power factor corrector, motor drive circuits, DC/AC inverters and AC/DC converters. The new Boost Diode not only improved the efficiency and reduced the electromagnetic interference (EMI), but also had obtained the higher power density and lower cost for the new energy rules and requirements from the government and related administration for example DOE 6.0 from Department of Energy, United State, EN 61000-3-2 Harmonics test from EU, IEC1000-3-2D from IEC and etc.

One of the obvious characteristic of new 600V Boost Diode is the extraordinary faster Reverse Recovery Time (T_{RR}) and lowest Q_{RR}/Qc under the lower Reverse Current Leakage (I_R) level. Therefore, the switching loss on the high frequency application over 100~1,000 KHz of PFC can be reduced in force. Moreover, we have obtained the higher power factor and total average efficiency including 90 to 277VAC input.

Besides, the characteristic of high temperature reverse recovery is good, especially on the T_{RR} and Q_{RR}. The Reverse Leakage Current (I_R) and H_{TIR} both under lower level and can reducing the loss from Boost Diode and the MOSFET on active PFC topology. Since the typical T_{RR} @ 150°C is still small, and the Q_{RR}/Qc is small like on the room temperature, too. Therefore, the new 600V Boost Diodes especially suitable for CCM & CRM because of the small T_{RR} and Q_{RR} reducing the switching loss on the circuit of high frequency operating.

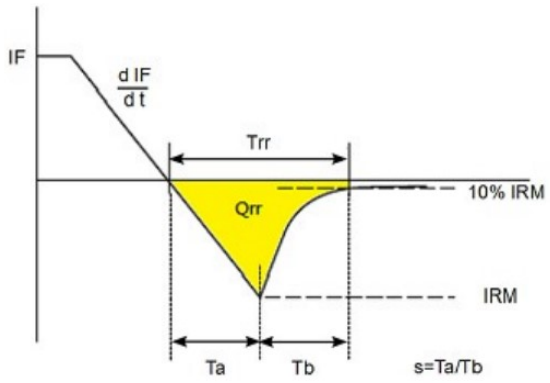


Fig 1: Definition of T_{RR} & Q_{RR} (MIL-STD-750D METHOD 3473)

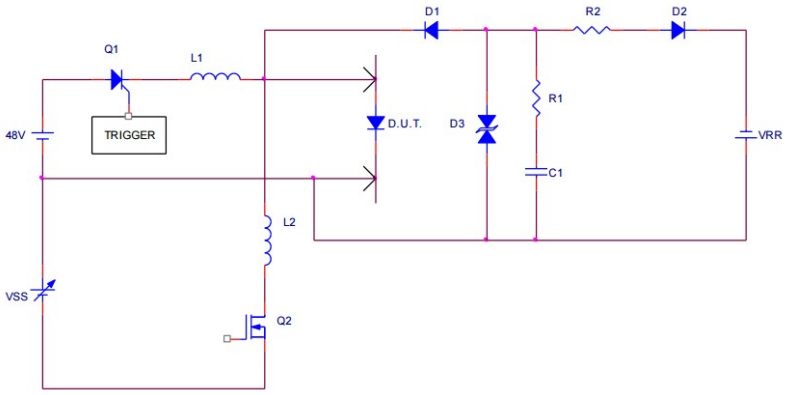


Fig 2: Test circuit of T_{RR} & Q_{RR} (MIL-STD-750D METHOD 3473)

The di/dt is still good especially on the environment of high temperature. The other most important advantage of new 600V Ultra Fast Boost Diode is the very small Ring-Peak on the high temperature and which can reduce the ripple and noise from high frequency switching (Test condition: IF=0.5A, IR=1A, IRR=250mA).

The total power loss of Boost Diodes on PFC topology including Conduction Loss (P_{CON}), Turn-off Loss (P_{OFF}) and Turn-on Loss (P_{ON}) on the continuous current mode and if the di/dt of Diode and MOSFET is the same condition:

$$P_D = P_{COM} + P_{ON} + P_{OFF}$$

$$P_{COM} = V_F \bullet I_{D(AV)} + r_D \bullet I^2_{D(RMS)}$$

$$P_{ON} = 1/2\ fc \bullet I_F \bullet (V_{FR}-V_F) \bullet T_{RR}$$

$$P_{OFF} = 1/4\ fc \bullet I_{D(RM)} \bullet kf \bullet V_R \bullet T_{RR}$$

P_D : Total power loss	P_{COM} : Conduction power loss
P_{ON} : Turn-on power loss	P_{OFF} : Turn-off power loss
V_F : Forward voltage drop-down	$I_{D(AV)}$: Average working current
r_D : Resistance of diode	RMS : Root mean square
fc : switching frequency of MOSFET	I_F : Average forward Current
V_{FR} : Maximum forward recovery voltage	T_{RR} : Reverse Recovery time

By the way, the lowest Reverse Recovery Current (IRM) is the most important benefit which had already reduced Turn-off power loss (P_{OFF}) from Boost Diodes and Turn-on power loss (P_{ON}) from MOSFET.

$$T_{RR} \approx 2\ Q_{RR} / IRM$$

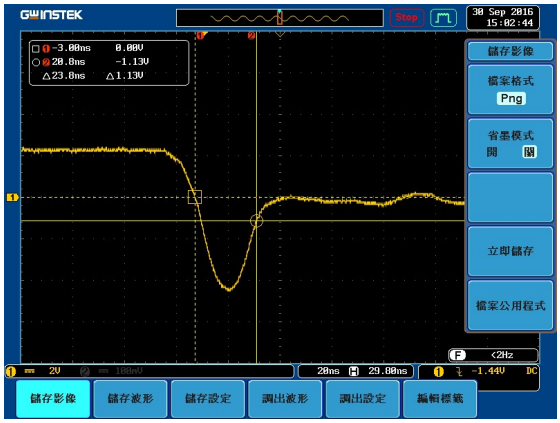
The excellent Softness Recovery Factor (S) on new 600V Ultra Fast Boost Diode is very important for CCM PFC topology since that can reduced the additional switching loss from MOSFET indeed.

Reverse Recovery time, $T_{RR} = Ta + Tb$

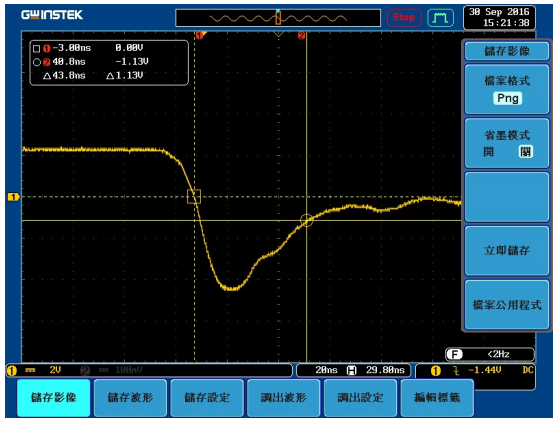
Soft Recovery Factor, $S = Tb / Ta$

The Ta means the remove process of excess minority carrier and the Tb means the setup process of reverse bias voltage barrier on switching from Boost Diode.

The new 600V Ultra Fast Boost Diode series is designed for active PFC topology because of the characteristic of faster T_{RR}, small Q_{RR}/Q_C, small Ring-Peak and lower V_F. Besides, the soft recovery characteristic is also the important advantage which can reduce the noise on PFC circuits.

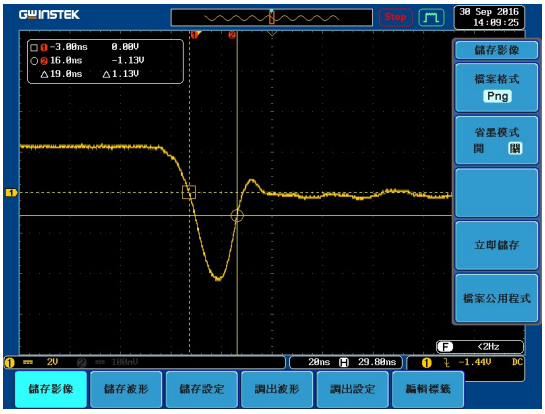


T_{RR} Curve@25°C

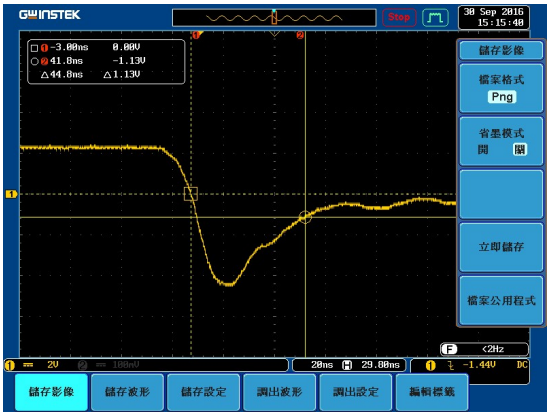


T_{RR} Curve @125°C

Fig 3 & 4: The typical T_{RR} & Q_{RR} Curve without Ring-Peak on new Ultra Fast Boost Diode, MUR860TH @ different temperature

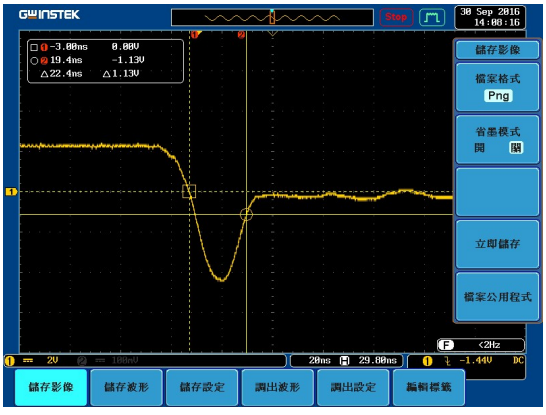


T_{RR} Curve@25°C

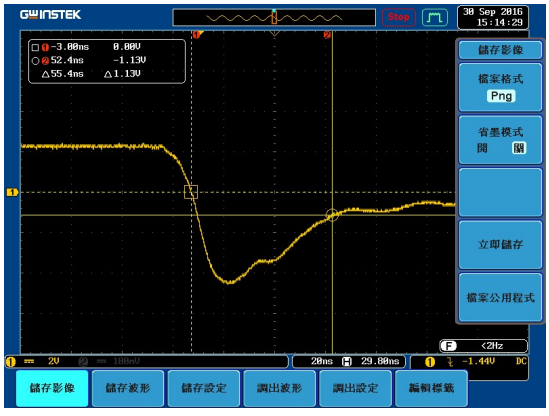


T_{RR} Curve @125°C

Fig 5 & 6: The typical T_{RR} & Q_{RR} Curve with very small Ring-Peak on new Ultra Fast Boost Diode, MUR860H @ different temperature



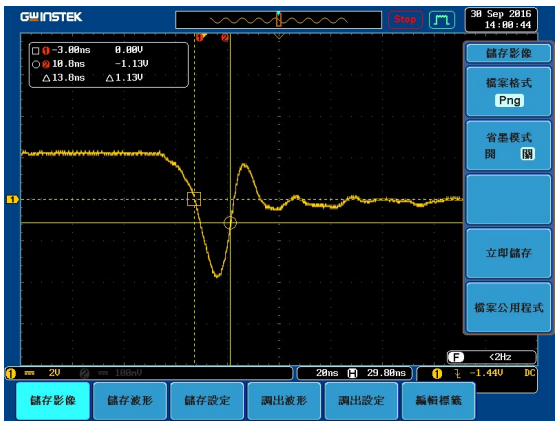
T_{RR} Curve@25°C



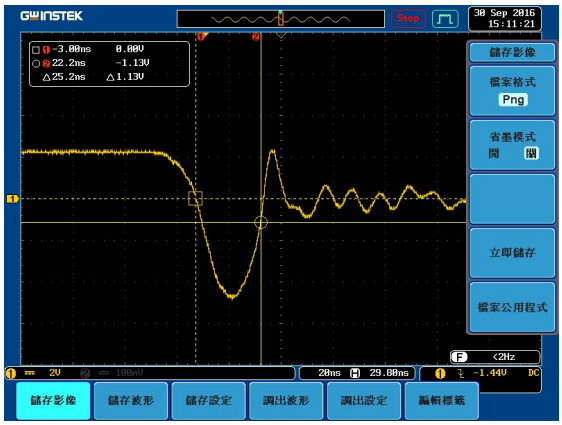
T_{RR} Curve @125°C

Fig 7 & 8: The typical T_{RR} & Q_{RR} Curve without Ring-Peak on new Ultra Fast Boost Diode, MUR860LH @ different temperature

Followings are the several typical TRR & QRR curve characteristic from competitors and will be produced the bigger switching loss and noise and on PFC circuit.

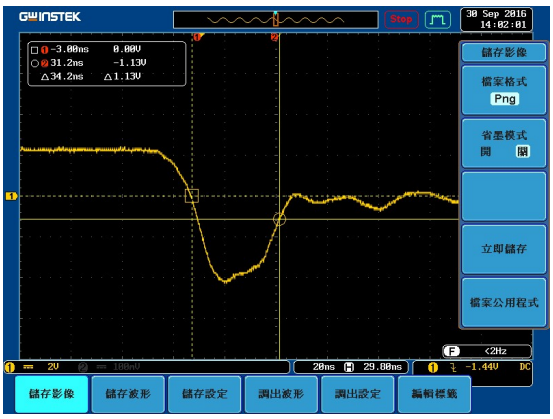


TRR Curve@25°C

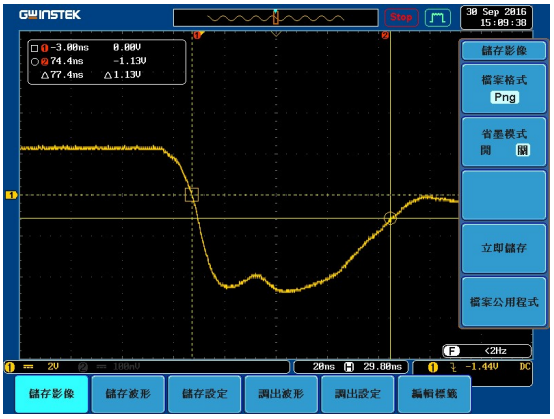


TRR Curve @125°C

Fig 9 & 10: The typical TRR & QRR Curve with bigger Ring-Peak on Ultra Fast Tandem Boost Diode, STTH806TTI @ different temperature

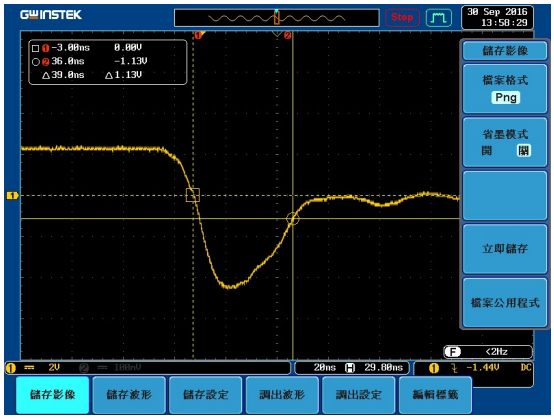


TRR Curve@25°C

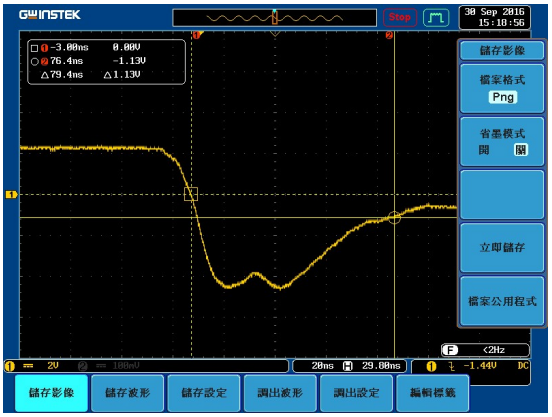


TRR Curve @125°C

Fig 11 & 12: The typical TRR & QRR Curve with bigger TRR & QRR on Ultra Fast Boost Diode, BYV29X-600 @ different temperature



TRR Curve@25°C



TRR Curve @125°C

Fig 13 & 14: The typical TRR & QRR Curve with bigger TRR & QRR on Ultra Fast Boost Diode, MUR460 @ different temperature

On the other hands, the lowest reverse current leakage (I_R) and forward voltage drop (V_F) of new 600V Ultra Fast MUR series Boost Diode are the very important advantages on the critical mode (CRM) of PFC and can obtained the best average efficiency under economic cost.

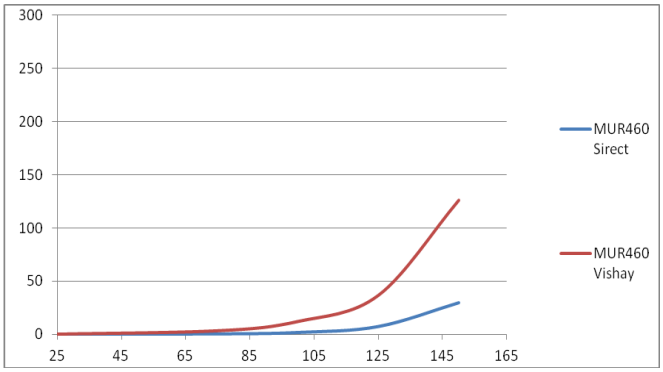


Fig 15: The typical I_R Curve of MUR460 compared with Vishay MUR460, μA vs. °C (@600V)

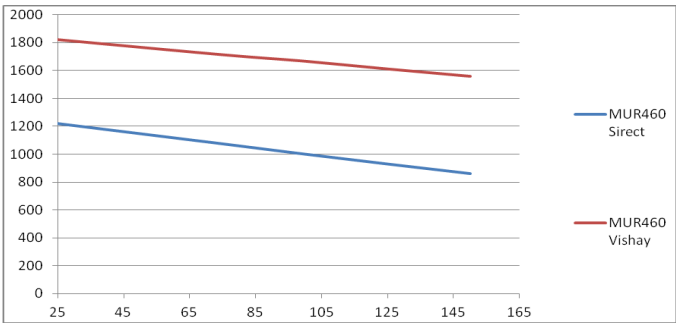


Fig 16: The typical V_F Curve of MUR460 compared with Vishay MUR460, mV vs. °C (@8A)

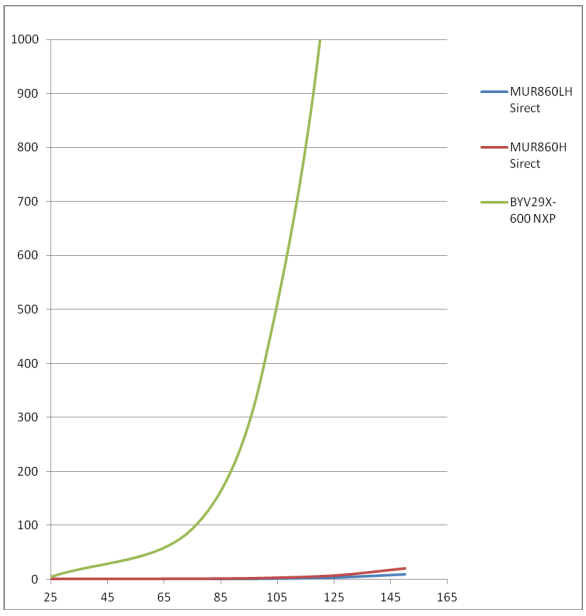


Fig 17: The typical I_R Curve of MUR860 series compared with NXP BYV29-600, μA vs. °C (@600V)

The total average efficiency from 90 to 230VAC input of Switching Mode Power Supply (SMPS) with Power Factor Correction had improved which put into the new 600V Ultra Fast Diode because of the advantages we mentioned. By the way, the Power Factor (PF) had improved too. For example 120 Watt LED 48V AC/DC Adaptor with CRM PFC, the average efficiency of MUR860H and MUR860LH are higher than Ultra Fast BYV29X-600 (9A/600V).

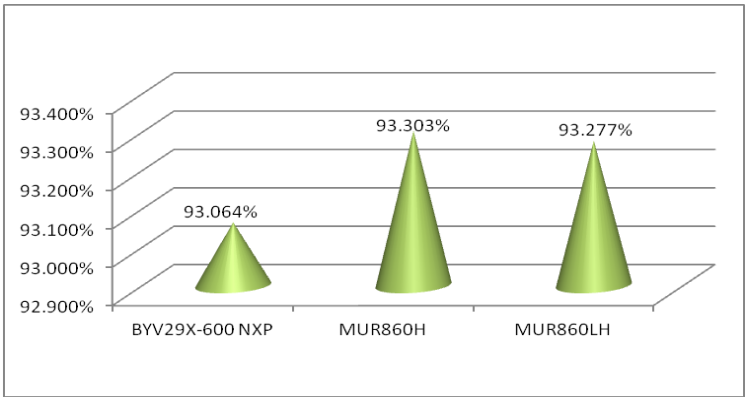


Fig 18: Reference of average efficiency test result (25%, 50%, 75% & 100% loading @ 115V & 230VAC input) on CRM PFC of 120W AC/DC Adaptor (Model No.: GST120A48-P1M, Manufacture: Meanwell)

We had put new 600V Ultra Fast Boost Diode, MUR860H & MUR860LH(8A/600V) into 150 Watt 12V AC/DC Adaptor with CRM PFC instead of used Ultra Fast BYV34-500 (20A/500V) and we still found the higher average efficiency on new 600V Ultra Fast Boost Diode. Therefore, the benefit of high density is the other reason we suggested the new 600V Ultra Fast Boost Diode to you.

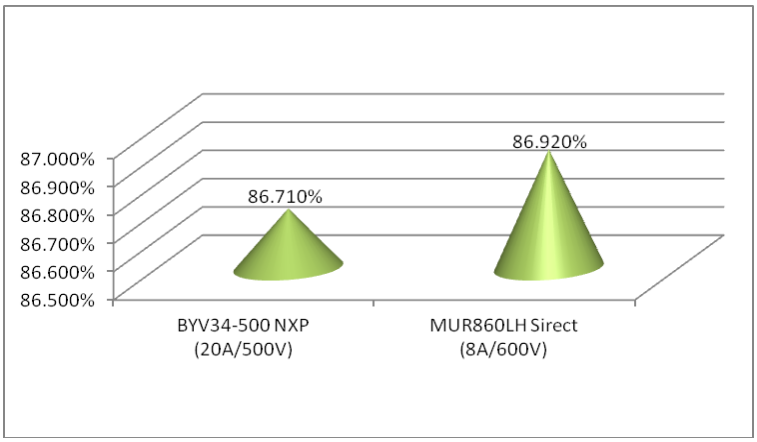


Fig 19: Reference of average efficiency test result (25%, 50%, 75% & 100% loading @ 115V & 230VAC input) on CRM PFC of 150W AC/DC Adaptor (Model No.: ADP-150BB B, Manufacture: Delta)

We had put new 600V Ultra Fast Boost Diode, MUR860LH(8A/600V) into 220 Watt AC/DC Adaptor with CRM PFC instead of used Ultra Fast BYT79X-600 (10A/500V) and we still found the benefit of high density on new 600V Ultra Fast Boost Diode which both under the same average output efficiency level..

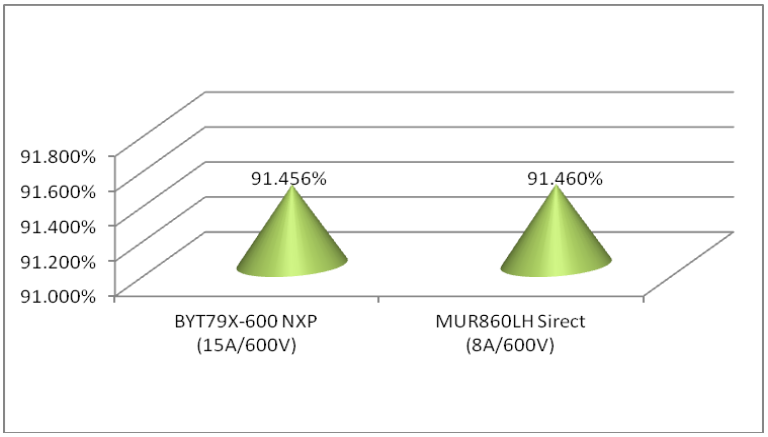


Fig 20: Reference of average efficiency test result (25%, 50%, 75% & 100% loading @ 115V & 230VAC input) on CRM PFC of 220W AC/DC Adaptor (Model No.: GST220A15-R7B, Manufacture: Meanwell)

The high-frequency switching mode power supply had make used widespread to the fields of consumer, household, industrial, communication, national defense and aviation because of the advantages of high density, high efficiency and small weight. Meanwhile, the electromagnetic interference (EMI) from the process of the high speed switching had influenced the system, environment and human health already. On account of the perfect reverse recovery ability of our new 600V Ultra Fast Boost Diode for example T_{RR}, Q_{RR}, Q_C and I_{RRM}, the EMI had reduced and controlled under lower level indeed.

According to the comprehensive benefits which above-mentioned, the new 600V Ultra Fast Boost Diode had already provided a higher efficiency and higher power density on power management field. Besides, the EMI, Ripple and Noise had controlled under lower level. Moreover, that is also the economic choice for SMPS's designer indeed.

For further detail, please contact Sirect at the location nearest you.

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