HT7A6003 Evaluation Board : 19V/65W AC-DC Adapter

D/N：HA0292E

Feature

- Average Efficiency up to 87% at Vac = 90~265 Full Range, Max. Efficiency up to 88.6%
- No-Load/Stand-by Power Consumption below 0.3W @ 115Vac/60Hz and 230Vac/50Hz
- Wide Operating Temperature -40°C ~ 85°C
- 65KHz Operating Frequency at 8.2K External Resister
- Single-sided board
- Output short circuit protection
- Non-audible-noise Green Mode Control

General Description

This Evaluation Board is designed to assist with power system design using the HT7A6003. As the HT7A6003 integrates many enhanced functions which do not require external function pin but operate automatically when the device is powered-on. Power system designers are not required to have extensive knowledge of these funtions but ragher just to focus their attention on peripheral circuit design and components selection issues. This simplifies greatly the power system design process and allows for faster time-to-market solutions.

This Evaluation Board is an AC-DC adapter with a rating of 19V/65W and has an average efficiency of up to 87% at 90~265V. At its full Vac range, the maximum efficiency can be up to 88.6%. Standby power consumes less than 0.3W @ 115V and 230V Vac, and satisfies Energy Star 2.0 Spec.

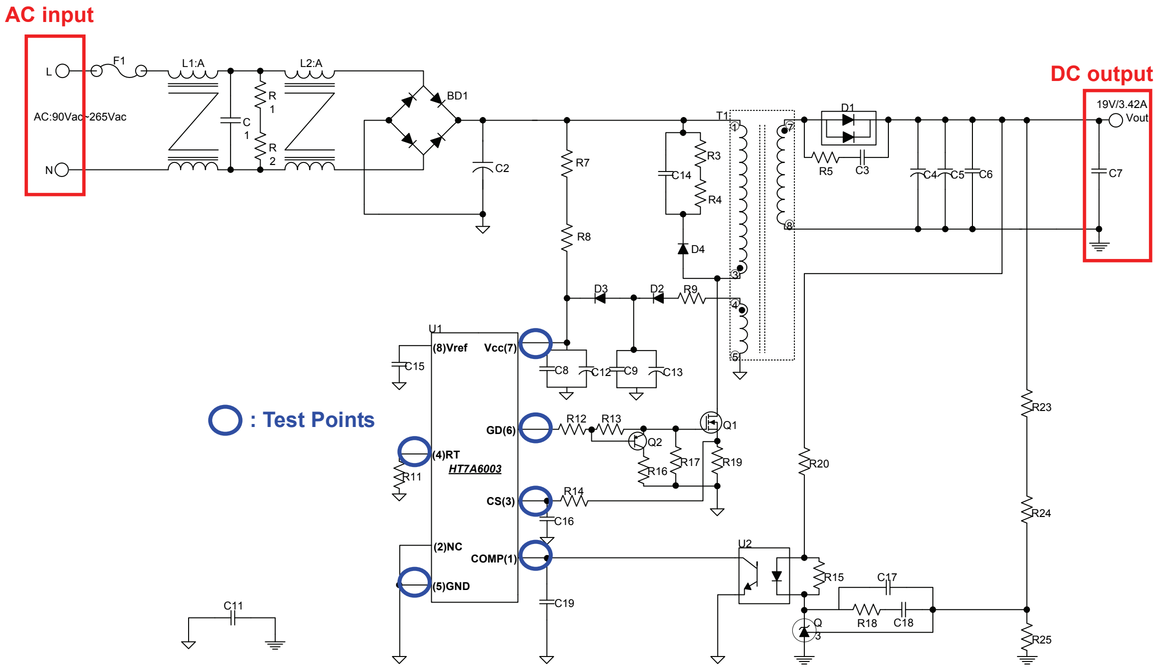
The specification, schematic BOM and PCB layout of the 65W Adapter are all provided in this Application Note.

Operating Conditions

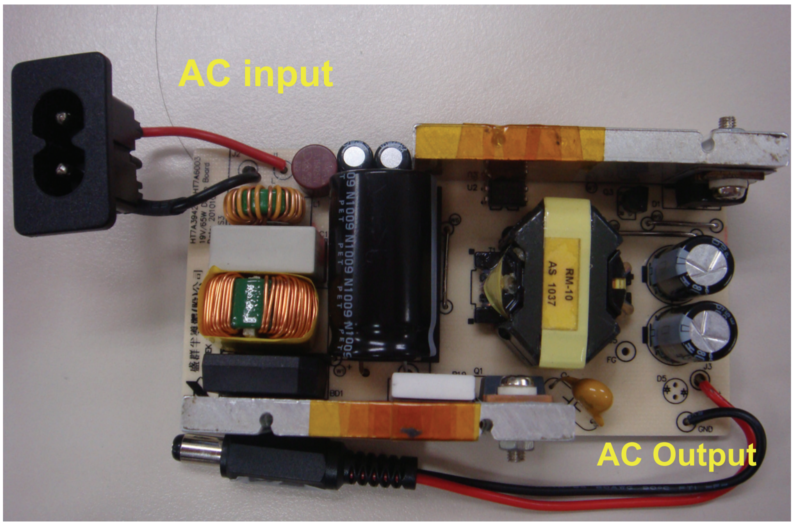
Parameter	Value
Input Voltage Range	90~265 Vac
Input Frequency Range	50/60 Hz
Output Voltage	19V
Max. Output Current	3.42A
Max. Output Wattage	65W
Operating Temperature	-40~85°C
Performance	
Output Ripple Voltage	< 380mV
Average Efficiency @Vac=90~265V	87%
No-Load / Stand-by Power Consumption @115Vac/60Hz and 230Vac/50Hz	< 0.3W

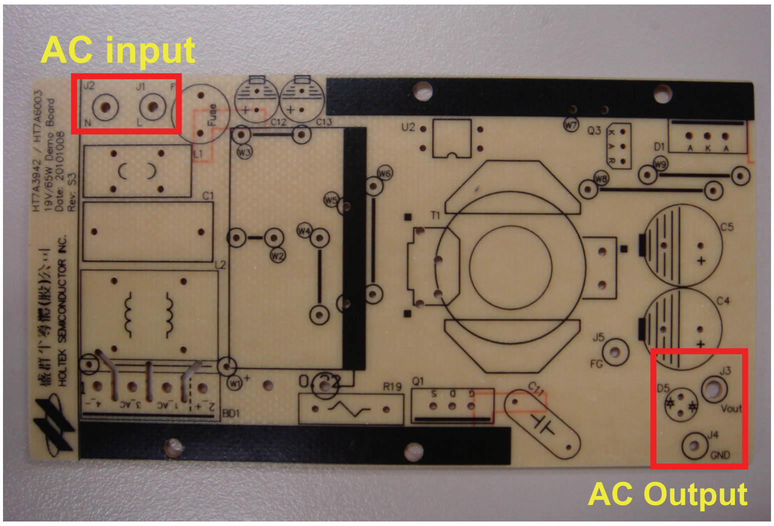
Application Circuit

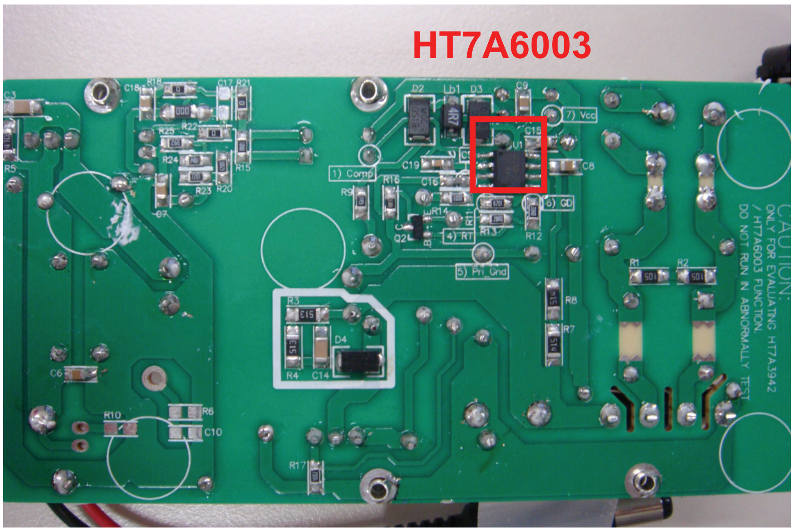
65W Demo Board Schematic

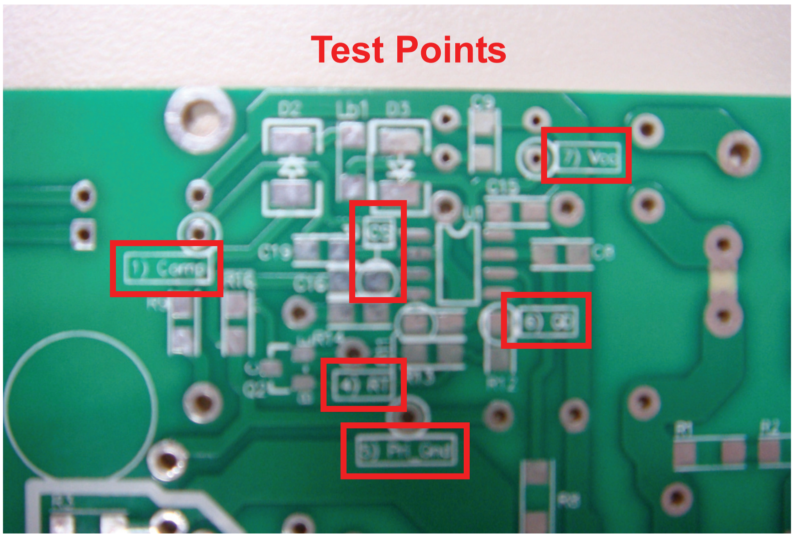


System Board Introduction




AC input
AC Output

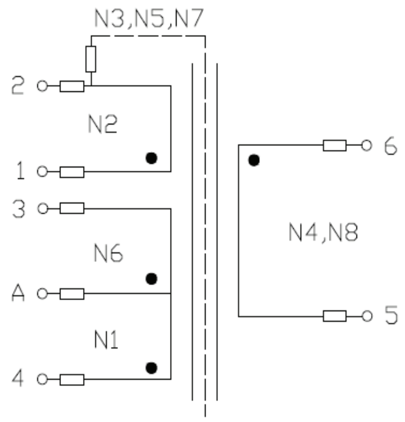

HT7A6003


Test Points

BOM

Location	Qty	Unit	Description	Vendor	Note
BD1	1	EA	BRIDGE DIODE_ GBU1008_10A/800V	DIODES	
C1	1	EA	CAP MKP_275VAC/0.22UF		
C2	1	EA	CAP_KXW_120UF/400V_105℃	RUBYCON	
C3	1	EA	CAP_ 1206_X7R_1000PF/1000V	SHINY SPACE	
C4,C5	2	EA	CAP_ZLH_680UF/25V	RUBYCON	
C6,C7,C8,C9,C15,C18	6	EA	CAP_ 0805_X7R_0.1UF/50V		
C11	1	EA	CAP_ XY1_220PF/250V		
C12,C13	2	EA	CAP_33UF/50V_105℃		
C14	1	EA	CAP_ 1206_X7R_3300PF/1000V	SHINY SPACE	
C16	1	EA	CAP_ 0805_X7R_75PF/50V		
C17					OPEN
C19	1	EA	CAP_ 0805_X7R_0.022UF(22nF)/50V		
D1	1	EA	DIODE_TO220AB_STPS20H100CT_10A*2/100V	ST	
D2,D3	2	EA	DIODE_SMA/DO214AC_GS1G_1A/400V	JGD	
D4	1	EA	DIODE_SMA/DO214AC_S2MA_2A/1000V	WTE	
F1	1	EA	FUSE_T_3.15V/250V		
L1:A	1	EA	CHOKE COMMON MODE_ TC-BIF0.6X13T-1264	3LCOIL	
L2:A	1	EA	CHOKE COMMON MODE_ LFT1608-0.55X56T-MY-SC6Z0	3LCOIL	
Q1	1	EA	MOS_TO220AB_IRFB9N60A_9.2A/600V	IR	
Q2	1	EA	PNP_SOT23_BC807-25_1.2A/-45V	FAIRCHILD	
Q3	1	EA	IC_TO92_TL431_2.5V		
R1,R2	2	EA	RES_1206_RK73B2BTTD J_1.0MOHM	KOA	
R3,R4	2	EA	RES_1206_RK73B2BTTD513J_51KOHM	KOA	
R5	1	EA	RES_1206_RK73B2BTTD470J	KOA	
R7,R8	2	EA	RES_1206_HV732BTTD364J_510KOHM		
R9	1	EA	RES_0805_1.5 OHM		
R11	1	EA	RES_0805_8.2K OHM_±1%		
R12,R13	2	EA	RES_0805_20.0 OHM_±1%		
R14	1	EA	RES_0805_1.0K OHM_±1%		
R15	1	EA	RES_0805_1.0K OHM_±1%		
R16	1	EA	RES_0805_4.7 OHM_±1%		
R17	1	EA	RES_0805_10.0K OHM_±1%		
R19	1	EA	RES_BPR_BPR28CFR22J_0.22 OHM/2W	KOA	
R20	1	EA	RES_0805_120.0 OHM_±1%		
R18	1	EA	RES_0805_0.0 OHM_±1%		
R23	1	EA	RES_0805_2.2K OHM_±1%		
R24	1	EA	RES_0805_24.0K OHM_±1%		
R25	1	EA	RES_0805_3.9K OHM_±1%		
T1	1	EA	TRANS_SMP-C3046	SHANG MING	
U1	1	EA	IC_SOP8_HT7A6003	HOLTEK	
U2	1	EA	PHOTO_DIP4_PC817	SHARP	

Transformer Specification



● Mechanical start winding, ▭ Teflon tube

Fig 1 Schematic Diagram

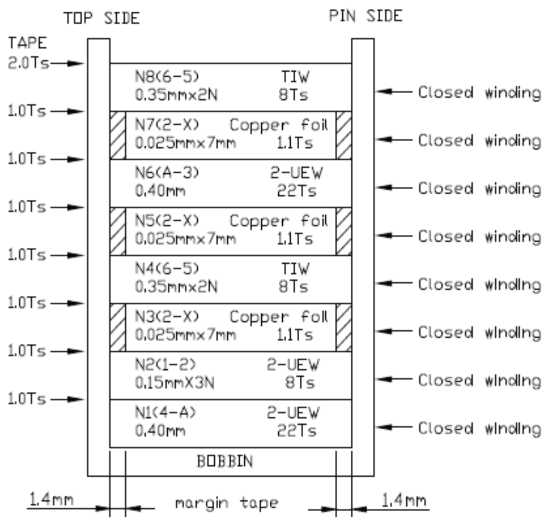


Fig 2 Winding Construction

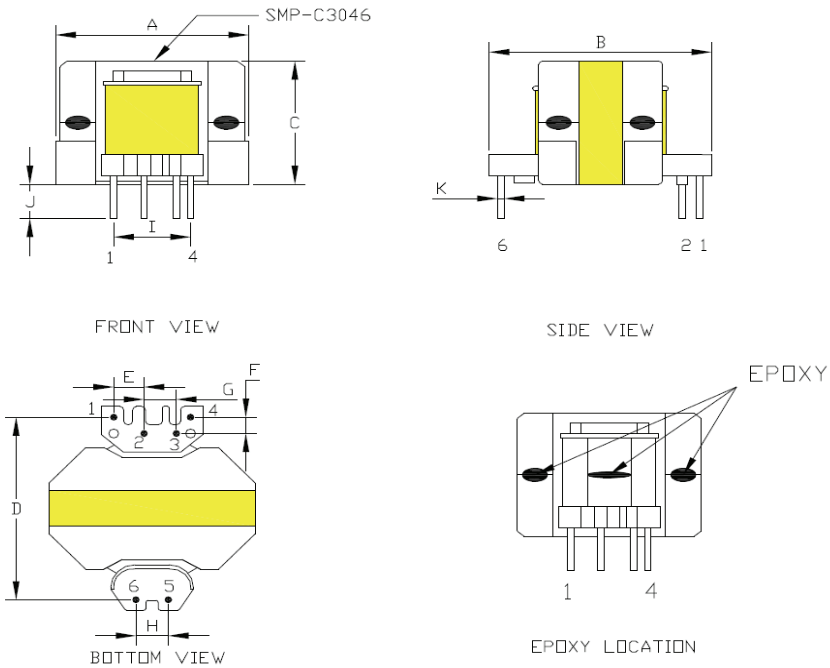


Fig 3 Dimension

Core : RM-10 (Nippon Ceramic, NC-2H or equivalent)

Bobbin : RM-10 (Chang Chun Plastics, Phenolic T375J, T355J

PCB Layout (Not in Scale)

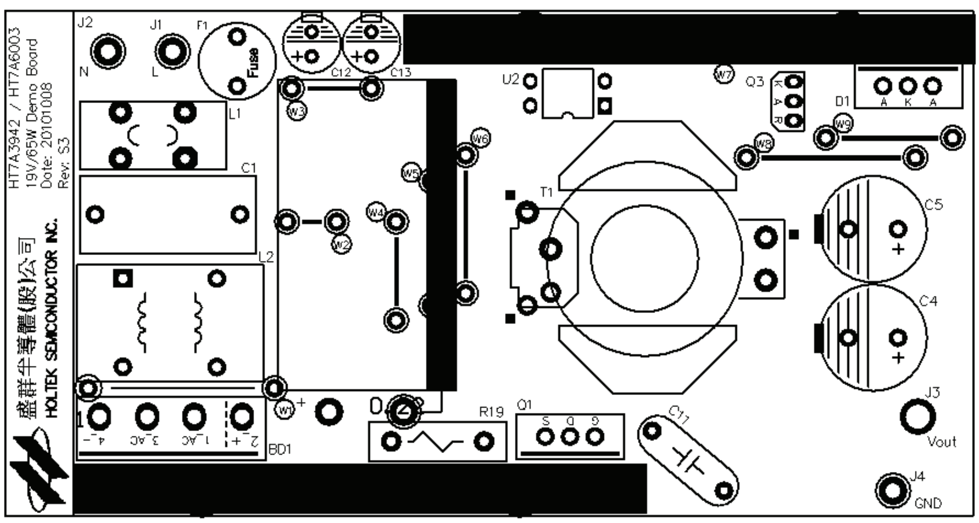


Fig 4 Top Overlay of PCB

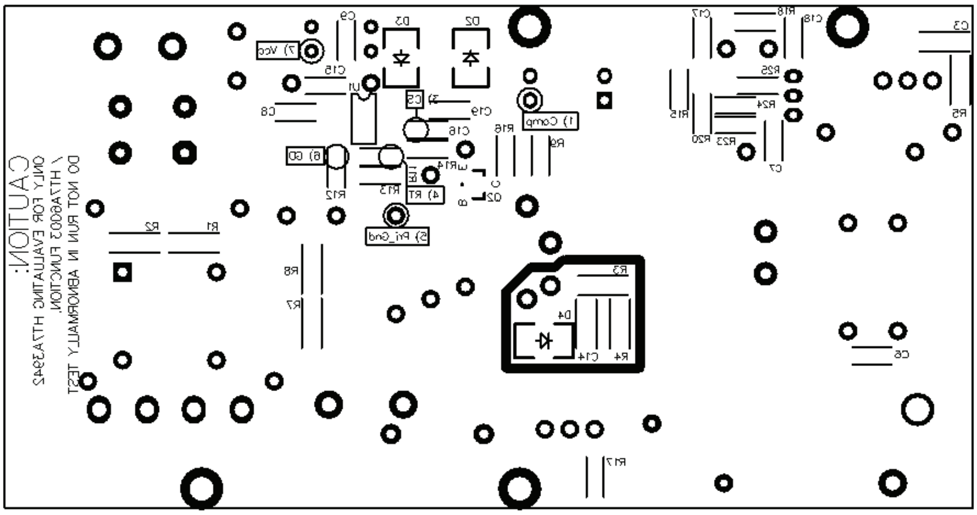


Fig 5 Bottom Overlay of PCB

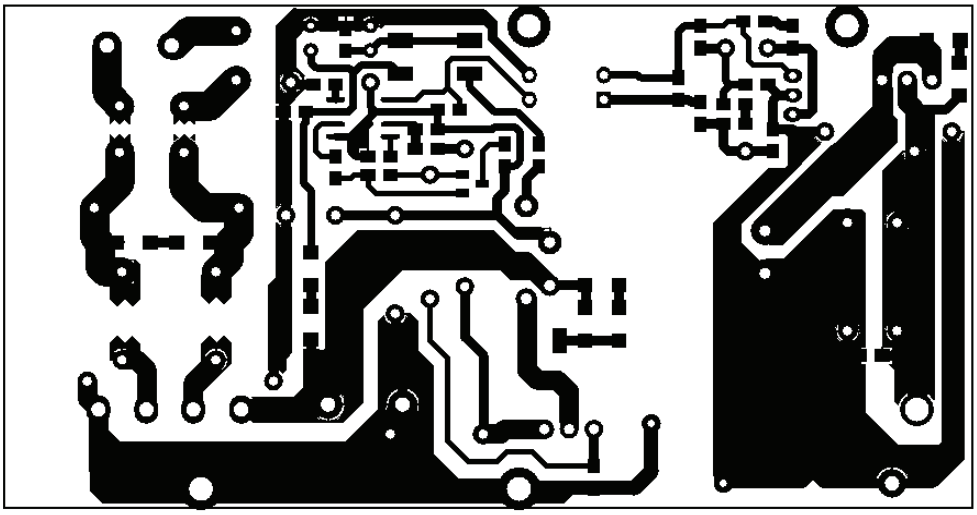


Fig 6 Bottom Layer of PCB

Function Description

This Adapter is implemented using Flyback topology, which is the most familiar architecture in AC/DC power application. Advantages of Flyback topology are simplicity and lower costs, however their efficiencies are not as good as Forward or QR-mode topologies, where average efficiencies of up to about 88%, 90% are possible. The performance of this adapter, implemented using the HT7A6003 is excellent giving an average efficiency of over 87%, and a maximum efficiency of 88.6%, which almost reaches Forward or QR-mode performance levels. The adapter's operating temperature range reaches Industry Levels, from -40~85°C, allowing the adapter to operate in a stable condition even in extreme environments such as ultra low temperature outdoor areas, The detailed specification and design suggestions for this Adapter are shown in the following data.

The input/output specifications are shown as Table 1 and Table 2.

Input Specification

Symbol	Description	Condition	Specification	Unit
Vi	Input Voltage	--	90 to 265	Vac
fi	Input Frequency	--	47 to 63	Hz
$P_{i\ (no\ load)}$	Input Power When no Output	230V, 50Hz	≦300	mW

Table 1 Input Specification

Output Specification

Symbol	Description	Condition	Specification	Unit
Vo	Output Voltage	--	19.5	Vdc
Vo(ripple,p-p)	Peak to Peak Output Ripple Voltage	20MHz Bandwidth	< 380	mV
t_{holdup}	Hold-Up Time	115Vac/60Hz, Full Load	10	ms
--	Line Regulation	--	±5	%
--	Load Regulation	--	±5	%
$t_{start-up}$	Start-Up Time	90Vac/60Hz, Full Load	≦3	s
t_{rise}	Vout Rise Time	90Vac/60Hz, Full Load	≦20	ms
η	Efficiency	Energy Star (EPS2.0)	≧87	%

Table 2 Output Specification

Performance: The Efficiency and Stand-by Power performance data is shown in Table 3 and Table 4.

Efficiency

IC	Condition	Energy Star EPS 2.0 (%)	Efficiency (%)				
			Average	25% Load	50% Load	75% Load	100% Load
HT7A6003	115Vac, 60Hz	≧87	87.2325	87.6855	87.7170	87.0703	87.0571
HT7A6003	230Vac, 50Hz	≧87	88.1354	87.5350	87.9097	88.4238	88.6729

Table-3 Efficiency Result

Note: The voltage measurement point is at the PCB side and output current is made using 6 & 1/2 multi-meter. Measurements were made at 115Vac/60z and 230Vac/50Hz.

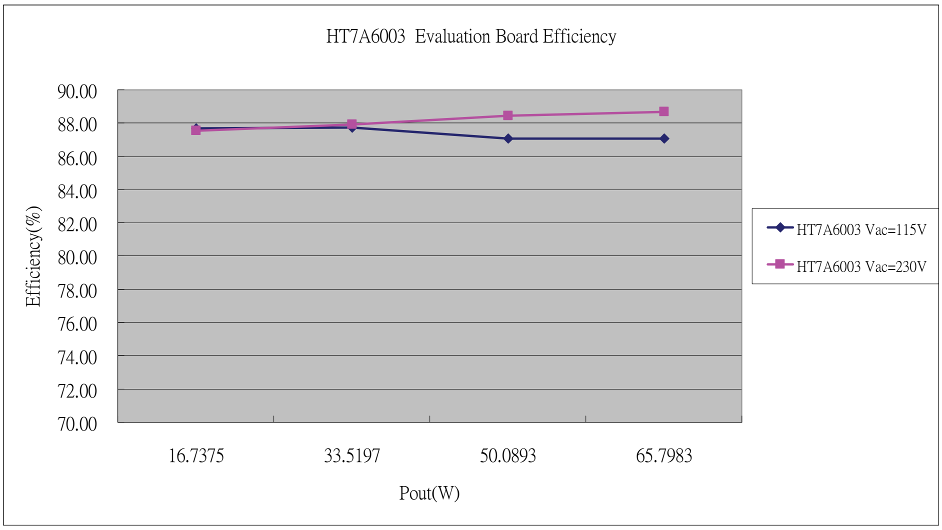


Fig 7 HT7A6003 Efficiency

Stand-by Power

Condition	Energy Star EPS 2.0 (mW)	Output Voltage (Vdc)	No Load Power Consumption (mW)
90Vac, 60Hz	≦300	19.23	183.4
115Vac, 60Hz	≦300	19.31	168.8
230Vac, 50Hz	≦300	19.31	246.5
265Vac, 50Hz	≦300	19.31	288.5

Table 4 Output Voltage and Power Consumption at No-Load/Stand-by Condition

Output Regulation

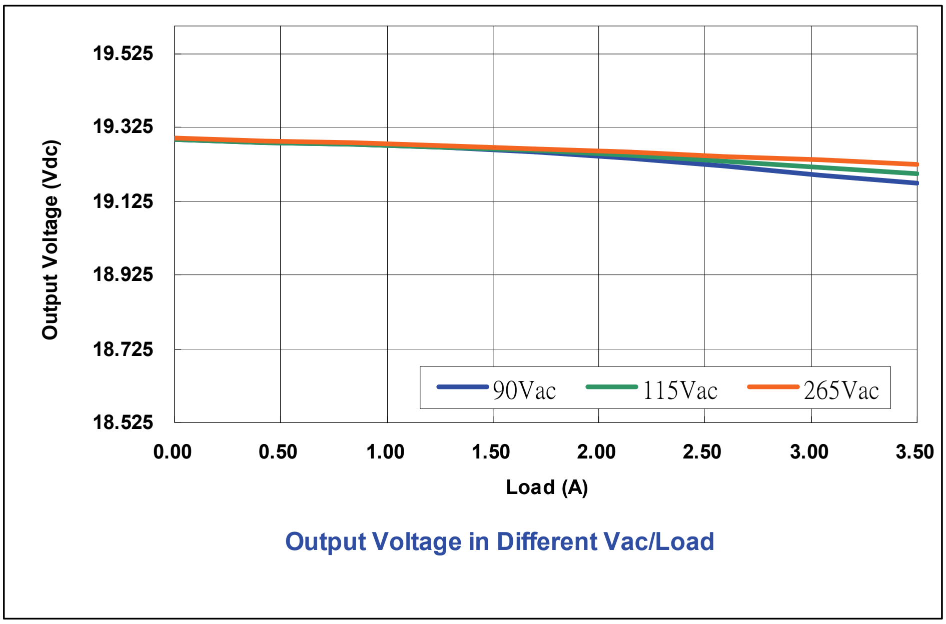


Fig 8 Output Regulation

Start-up Time Output Regulation

Start-Up time was measured for the main input voltage and under full load (3.42A) conditions. When the AC is connected, the start-up current will charge C12 via the R7/R8 resistors. After Vcc exceeds 14V (UVLO_on), the HT7A6003 will send out a PWM signal to turn-on the output.

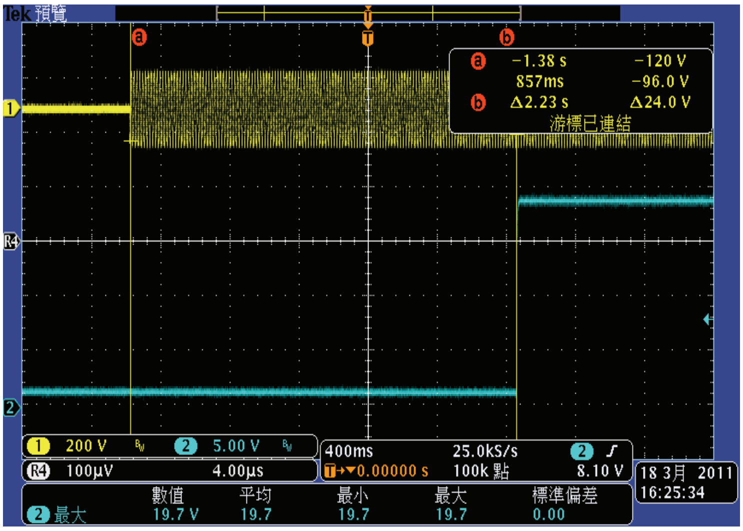


Fig 9 Start-Up Time is 857ms in 90Vac, Full Load

If it is requried to reduce the start-up time:

- The user can decrease the R7/R8 resistor value however the stand-by power consumption will be affected.
- A smaller C12 capacitor value also can improve the start-up time. If use this solution is used, then it is required to ensure that the discharge voltage must be greater than UVLO_off before the system power is ready.

Current Limit

HT7A6003 has a current limit function at the CS pin. When the Vcs is greater than 1Vdc, IC device internal circuitry will limit the PWM duty to avoid excessive currents in the primary side. The current limit can be set by the R19 (Rs) value.

$$V_{cs} = 1V = I_{peak} \times R_s$$

And the $$I_{peak} = \frac{V_{in}}{L_m} \times Duty \times \frac{1}{f_{sw}}$$

The schematic shows a low pass filter (R14/C16) between Rs and CS pin. For a 65kHz switching frequency, the suggested values are 1K ohm and 75pF.

Oscillator Frequency Tuning

By choosing an appropriate external resistor from the RT Pin to GND, a suitable operating frequency can be generated. The relationship between the RT value and the operating frequency is shown in Fig. 11.

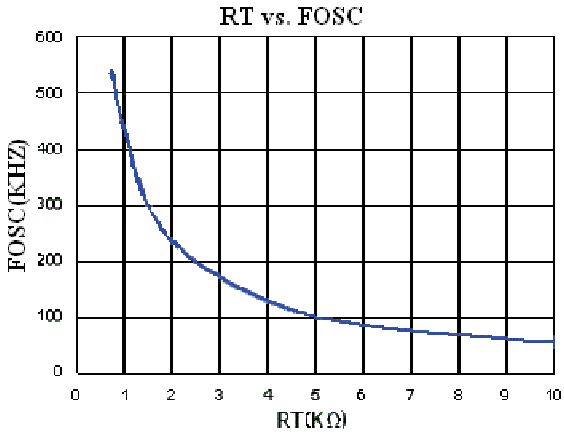


Fig 10 The Mapping Relation between RT and Operating Frequency

Short Circuit Protection - SCP

To protect the device from damage due to under/over loads or short circuit conditions, a smart SCP function is implemented in the device. If the VCOMP increases to the SCP threshold of 4.7V and remains there for longer than 40ms, then the protection circuit will be activated which will turn off the gate output to stop power circuit switching.

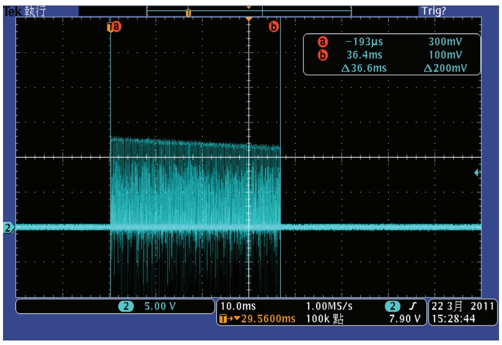


Fig 11 (1). PWM in SCP test when 85Vac

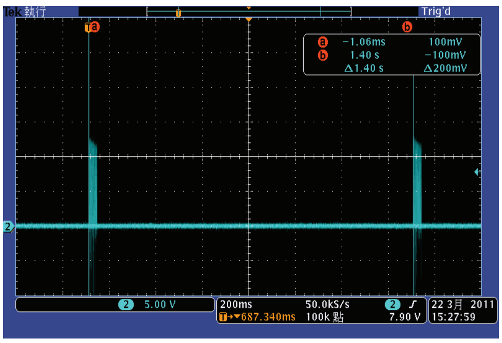


Fig 11 (2). PWM in SCP test when 85Vac

For general Power Supply applications, the Vout rise time is less than 20ms. Therefore the SCP response time of 40ms is enough in actual applications.