# HT7A3942 Evaluation Board : 19V/65W AC-DC Adapter

**D/N：HA0293E**

## Feature

- Average Efficiency up to 87% at Vac = 90~265 Full Range, Max. Efficiency up to 88.1%
- No-Load/Stand-by Power Consumption less than 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 protected
- Non-audible-noise Green Mode Control

## General Description

This Evaluation Board is designed to offer assistance with power system designs which use the HT7A3942. The HT7A3942 integrates many enhanced functions which do not require external function pin control but operate automatically when the device is powered-on. Power system designers are not required to have extensive knowledge of these functions but rather just to focus their attention on peripheral circuit design and component selection issues. This simplifies greatly the power system procedure and allows for faster time-to-market solutions.

This Evaluation Board is a AC-DC type 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 88.1%. Standby power consumes less than 0.3W @ 115V and 230V Vac, and satisfies Energy Star 2.0 Spec.

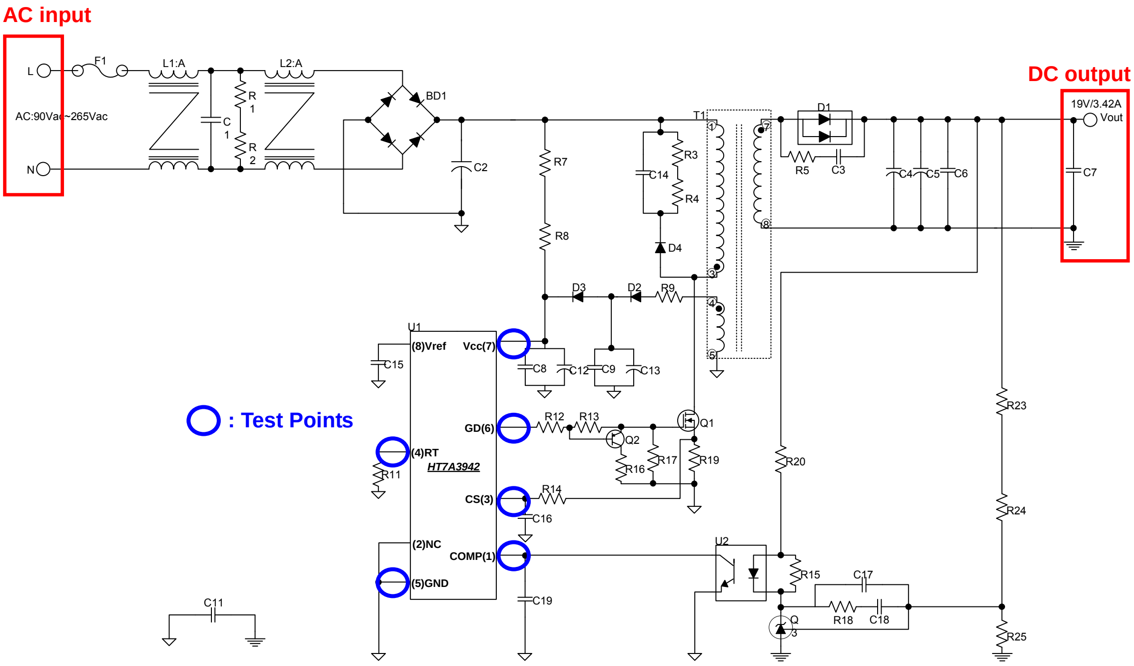
The specification, schematic BOM and PCB layout of the 65W Adapter are all provided in this Application Note.

## Operating Conditions

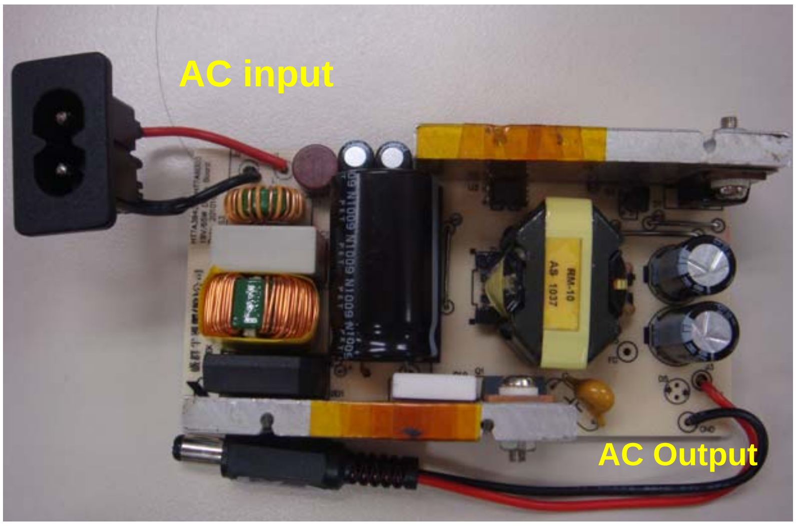
| Parameter | Value |
|---|---|
| Input Voltage Range | 90~265Vac |
| Input Frequency Range | 50/60Hz |
| Output Voltage | 19V |
| Max. Output Current | 3.42A |
| Max. Output Wattage | 65W |
| Operating Temperature | -40~85˚C |
| **Performance** | |
| Output Ripple Voltage | < 380mV |
| Average Efficiency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

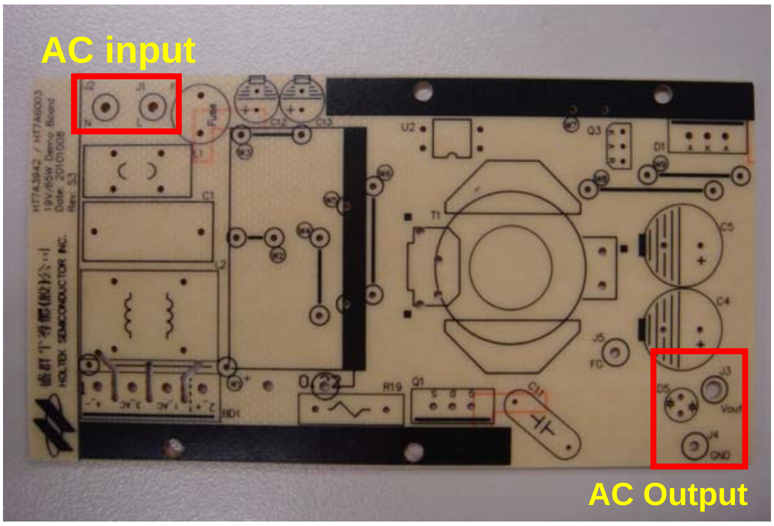
# Application Circuit

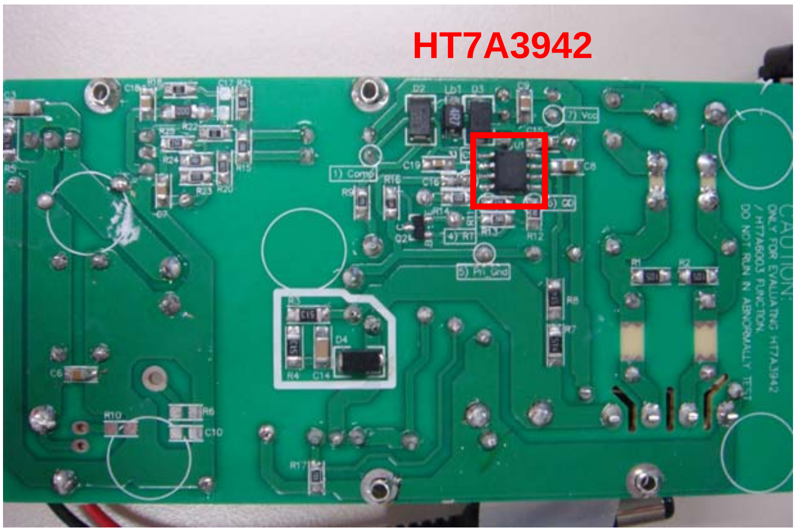
### 65W Demo Board Schematic

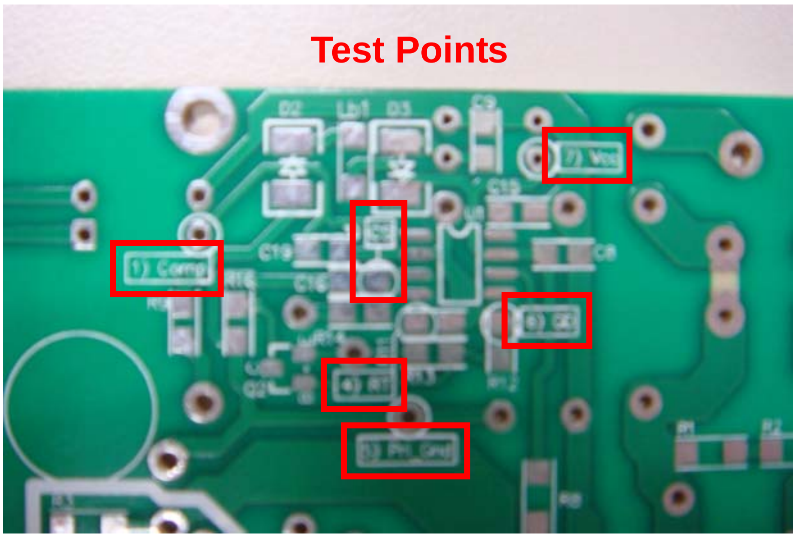



### System Board Introduction




AC input
AC Output


HT7A3942


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°C | 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°C | | |
| 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_HT7A3942 | HOLTEK | |
| U2 | 1 | EA | PHOTO_DIP4_PC817 | SHARP | |

# Transformer Specification

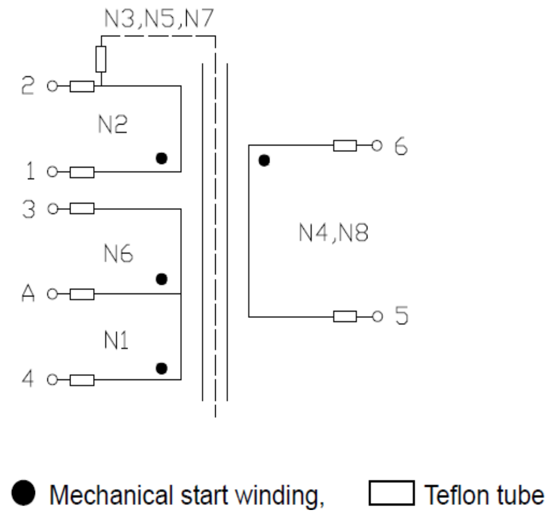



**Fig 1 Schematic Diagram**

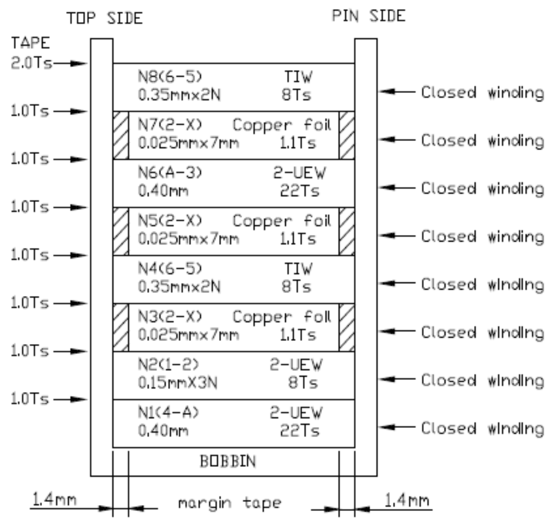



**Fig 2 Winding Construction**

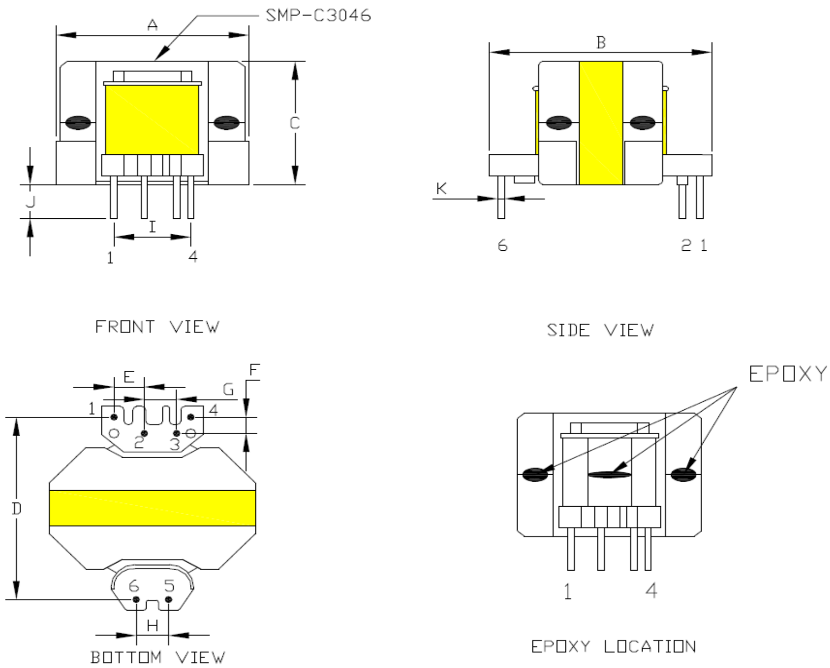



**Fig 3 Dimension**

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

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

## PCB Layout (Not in Scale)

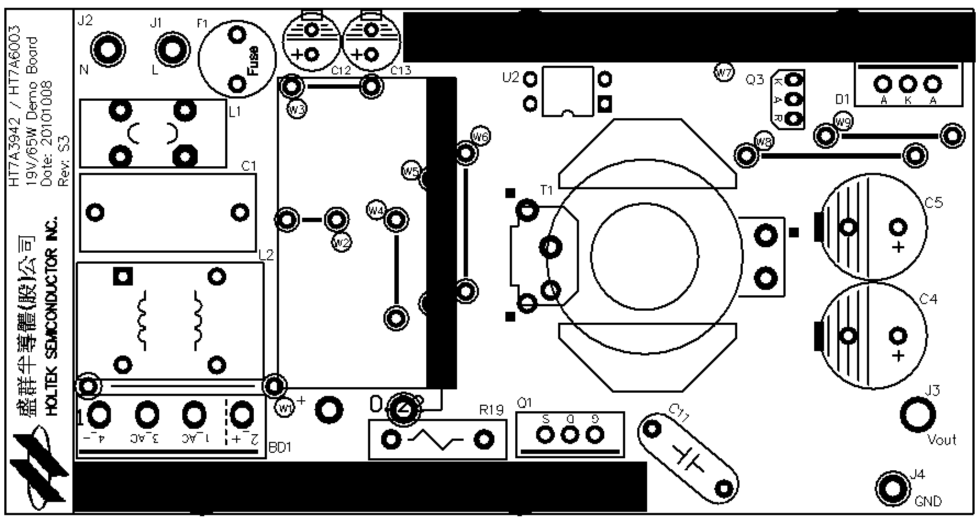



**Fig 4 PCB Top Overlay**

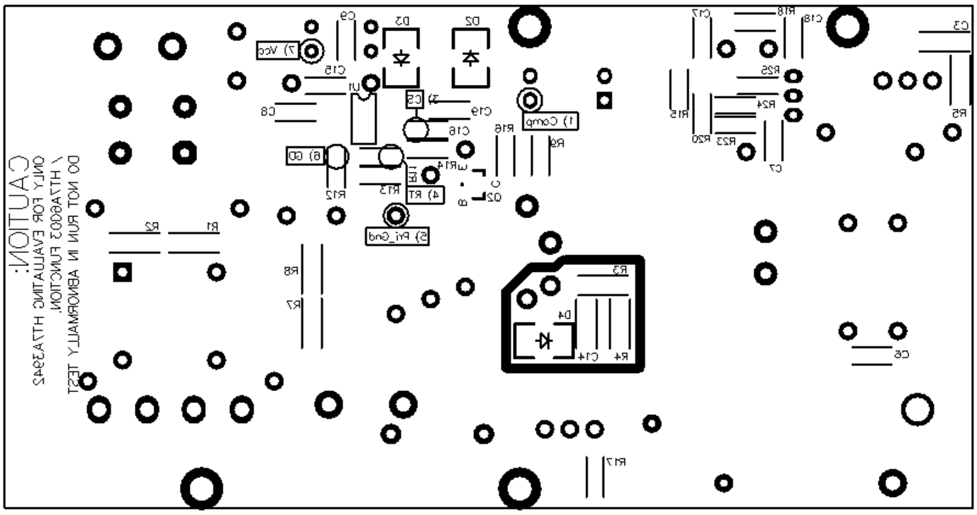


**Fig 5 PCB Bottom Overlay**

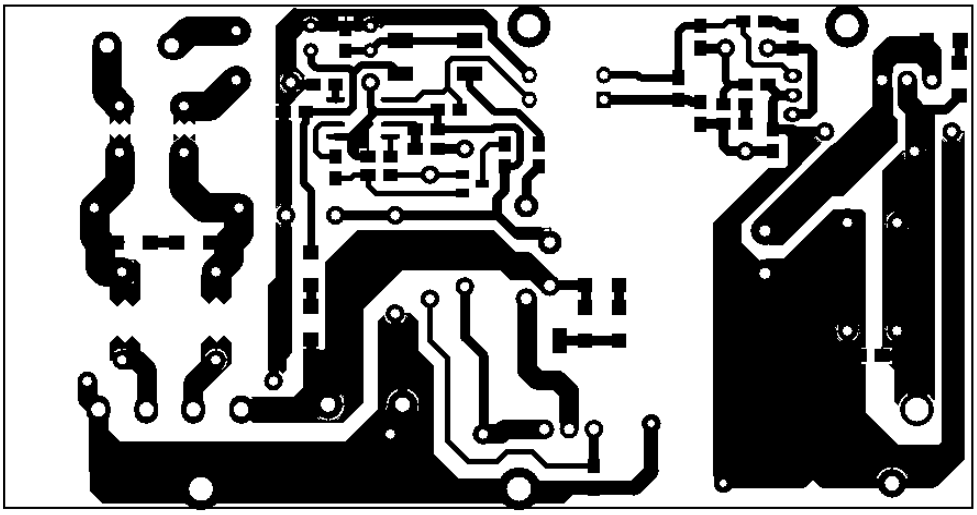


**Fig 6 PCB Bottom Layer**

# Function Description

This Adapter is implemented using Flyback topology, which is the most familiar architecture in AC/DC power applications. 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 HT7A3942, is excellent, giving an average efficiency of over 87% and a maximum efficiency of 88.1%, 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 in 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 with no Output | 230V, 50Hz | ≦300 | mW |

**Table 1 Input Specifications**

## 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 Specifications**

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 |
| HT7A3942 | 115Vac, 60Hz | ≧87 | 87.6588 | 87.0307 | 88.1982 | 87.9114 | 87.6948 |
| HT7A3942 | 230Vac, 50Hz | ≧87 | 87.1703 | 87.0157 | 87.0805 | 87.5840 | 88.1111 |

**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.

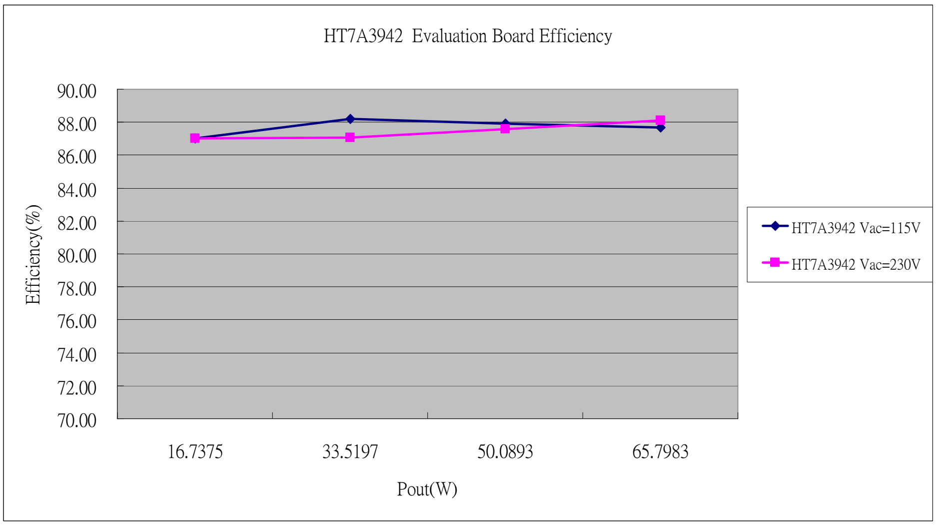



**Fig 7 HT7A3942 Efficiency**

## 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 for No-Load/Stand-by Conditions**

## Output Regulation

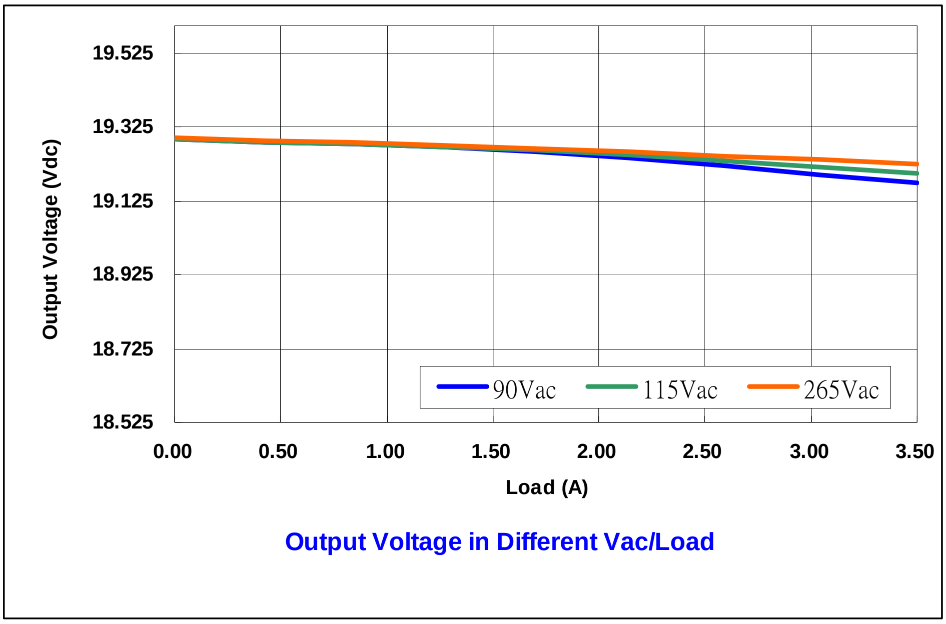



**Fig 8 Output Regulation**

## 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 HT7A3942 will send out a PWM signal to turn-on the output.

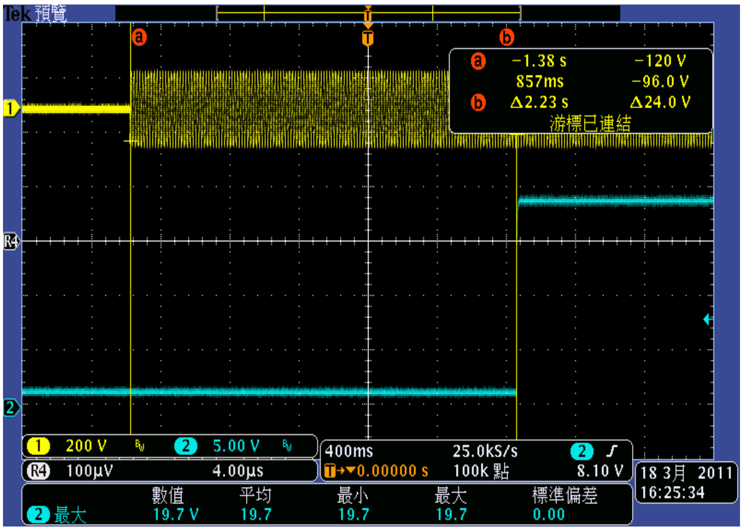



**Fig 9 Start-Up Time is 857ms at 90Vac, Full Load**

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

- The user can decrease the R7/R8 resistor values however the stand-by power consumption will be affected.
- A smaller C12 capacitor value also can improve the start-up time. If 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

The HT7A3942 has current limit function at the CS pin. When Vcs is greater than 1Vdc, the 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 $I_{peak} = \dfrac{V_{in}}{L_m} \times Duty \times \dfrac{1}{f_{sw}}$

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

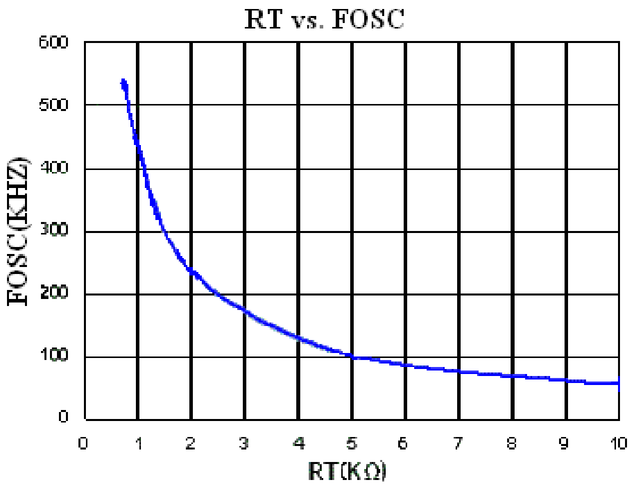



**Fig 10  RT and Operating Frequency Relationship**

## 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 scheme will be activated which will turn off the gate output to stop power circuit switching.

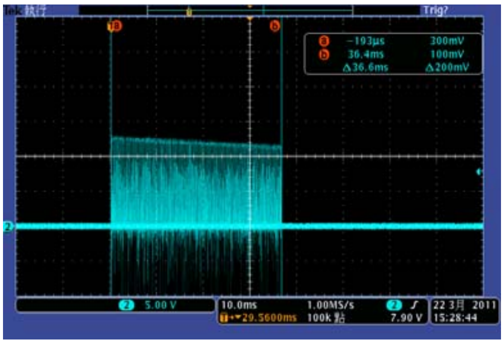


**Fig 11  (1). SCP test PWM at 85Vac**

**Fig 11  (2). SCP test PWM at 85Vac**

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