Designing a Flyback Power Supply Using The N3856x Series

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INTRODUCTION

The main advantages of the flyback power supply are cost-effective , simplicity and ease of reach green mode power consumption requirment without any extra stand-by power circuit.
The N3856x series of synchronous rectification controller are designed for secondary side to control a low Rds(on) power MOSFET, instead of the turn-on duty of the output rectifier diode. Base on the power MOSFET technology , a few mΩ Rds(on) of power MOSFETs are very prevalent ,we can use the feature of low Rds(on) ,easily replace the output rectifier diode of conventional flyback power supply and obtain lower power loss .
The N3856x builded a adjustable slope current dectecter for detecting the current vis MOSFET in the discontinuous mode operating. It also builded a comparator for comparing the saw-tooth waveform of RT/CT pin with internal 1/3 VCC voltage to generate a constant pulse width in the continuous mode operating.

BLOCK DIAGRAM

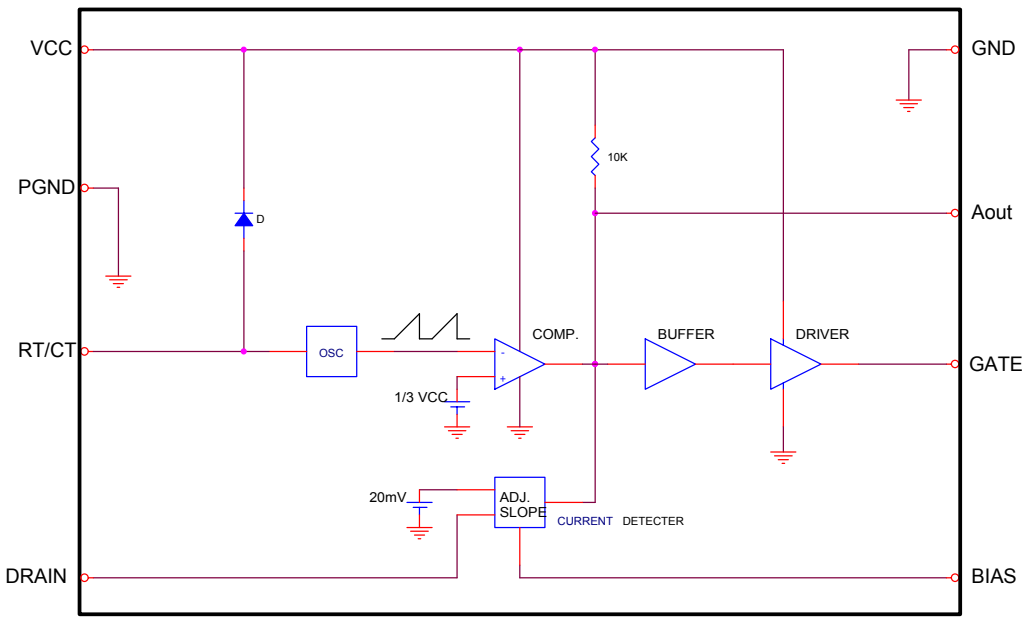

Fig 1 N3856x Function Block Diagram

PIN FUNCTIONS

GATE (Pin 1) : This pin is driver output of N3856x, It's capable of source and sink 1A current ,directly connected to the Gate of synchronous rectification MOSFET or series with a small resistance of resistor .

PGND (Pin 2) : This is the Power GND for the output totem pole driver of the ship .

GND (Pin 3) : This is the signal GND for the control logic signals of the ship.

BIAS (Pin 4) : The pin connected a resistor to VCC ,In the discontinuous mode operating , if adjust the resistance will cause a different slope voltage between the Gate and Source of MOSFET , the down slope Vgs waveform is determined turn-off time when the voltage reach the threshold voltage level of the MOSFET.

DRAIN (Pin 5) : The pin is directly connected to the Drain pin of the synchronous rectification MOSFET for detecting the drop voltage between Source and Drain .

Aout (Pin 6) : This pin is internal comparator output to control "pin1" output duty , it also provided the primary control function by a pulse transformer in the continuous mode operating .It could connect a resistor to VCC pin to modify the rise time of turn-on , keep this pin is floating if doesn't use .

RT/CT (Pin 7) : This pin connected a resistor and capacitor to generate a saw-tooth waveform Comparing with internal reference voltage(1/3 VCC) .When the saw-tooth waveform reach the voltage level will cause output driver turning low voltage and MOSFET is off. The charging current will discharge via internal circuit.

VCC (Pin 8) : This pin is for supply voltage for the ship, it is also a synchronization pin for the control logic ,so it can't connect any filtering capacitor for normal operating .

TRANSFORMER DESIGN

One of the most important factors in design of a flyback power supply is the design of the transformer .Usualy ,we recommended the Maximum duty is 0.5 in conventional flyback power supply for obtaining a best efficiency , but in the synchronous rectification application ,we recommended the Maximum duty is 0.3 , and let the synchronous rectfication MOSFET have more turn-on period ,resulting a lower power loss during energy tranfer to output stage.
For the N3856x controller application ,we need to provide a AUX winding for the supply voltage and synchronization purpose . The AUX winding is approximately supply a 12V via a fast recovery diode(1N4148) to VCC pin of the N3856x derectly without any filtering capacitor , the AUX winding should be placed near by the main output winding for obtaining a best connection and less leakage inductance, a higher leakage inductance may cause more spike voltage on VCC pin that could increase turn-on delay time for the N3856x.

OPERATION

DISCONTINUE MODE OPERATING

In the discontinue mode operating , when the primary power MOSFET is turn-off ,then the transformer begin to release the storing energy to secondary output , the down slope current flows through source and drain of the MOSFET , formed a drop voltage comparing with internal reference voltage 20mV by the adjustable slope current detecter ,when the drop voltage is over 20mV, the driver output high level to turn on the MOSFET , if the drop voltage down to 20mV ,will generate a down slope voltage waveform for the driver output ,if the voltage reach to the threshold level of power MOSFET, therefore power MOSFET is turn-off, then wait next operating period ,the MOSFET is turn-on again . There are two detecting pins on the adjustable slope current detecter ,one is pin 5 ,another is pin 3, the pin 5 is directly connected to the drain of MOSFET , the pin 3 is connected to the source of MOSFET . For the diffent Rds(on) MOSFET ,we designed a adjustable slope function for tunning a best turn-off point in the discontinuous mode operating ,see the Fig 2 , adjust the resistance of the bias resistor ,let Vgs voltage down to the min. voltage level (near to 0V) before the resonant waveform beginning (T2) resulting by Land C ,If the resistance of bias resistor is smaller ,the slope will be faster .

HOW TO ADJUST THE BIAS RESISTOR (R1)

In the discontinue mode operating ,set the output load heavier ,then adjust the bias resirtor

until the Vgs slope down to 0V before he resonant waveform beginning (T2) resulting by Land C , and checking no load codition waveform ,if switching action is not normal , reducing the resistance until waveform is normal .

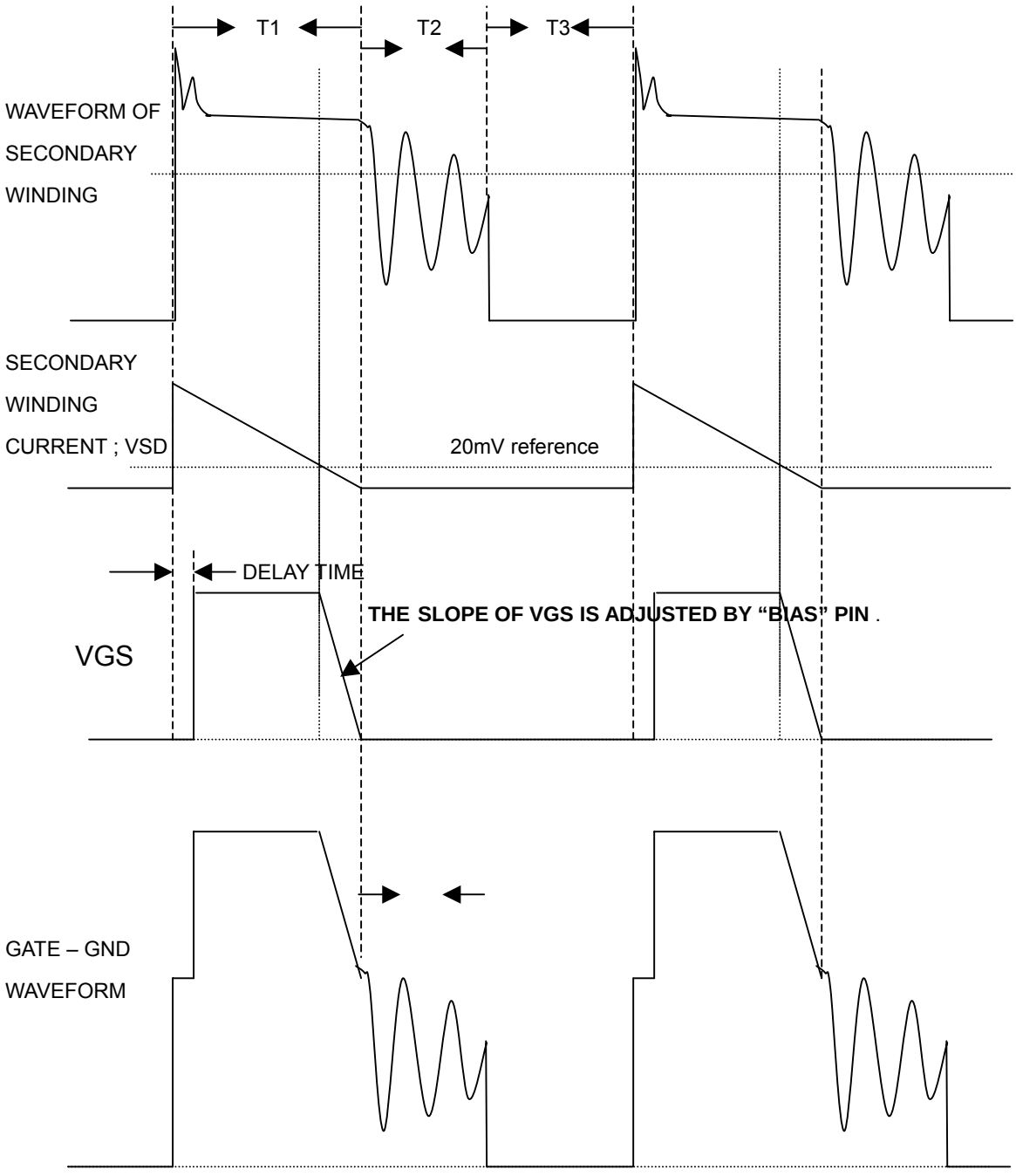

Fig 2 Control waveform for the discontinue mode

CONTINUE MODE OPERATING

In the continue mode operating , the output control dead time is used by a comparator , RT/CT(pin 7) connected a resistor (RT) to VCC ,and connect a capacitor (CT) to GND , the pin 7 is charging current via RT to CT and forming a saw-tooth waveform voltage, the voltage is reaching 1/3VCC , then the comparator will become low level ,therefore the driver output changed to low and turn off the MOSFET . See the Fig 3 , the dead time appears on the end of T1 period .

HOW TO ADJUST DEAD TIME

First, adjust output load from light load to high load slowly ,check the waveform of GATE –GND When the output load into the boundary of the discontinue mode and continue mode ,checking the dead time of the waveform of GATE –GND, it appears or not , if dead time not appear , then reducing resistance of RT or the capacitance of CT , if dead time appear , check dead time is OK or not ,adjust it to the best point .

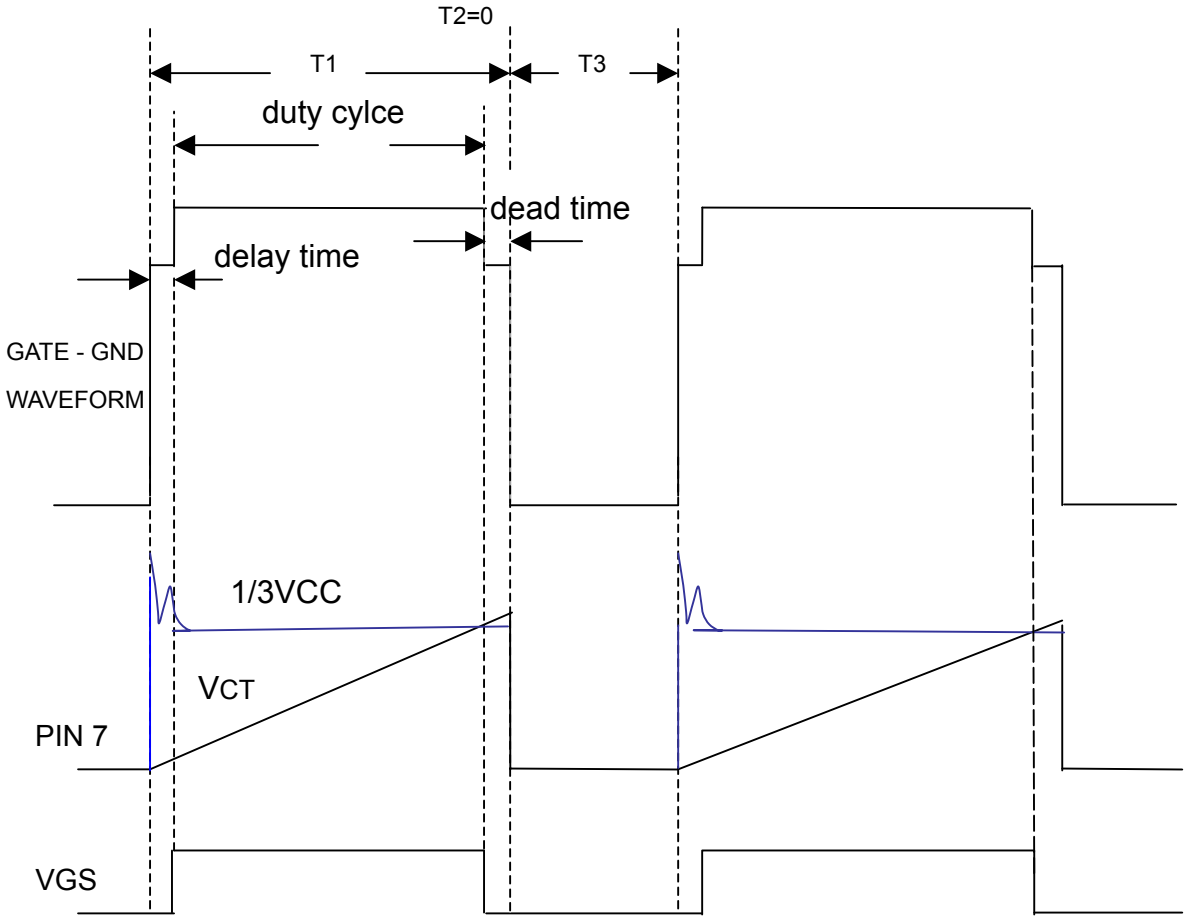

Fig 3 Control waveform for the continue mode

See the Fig 4 , showing Delay Time and Dead Time on 120W power supply application ,

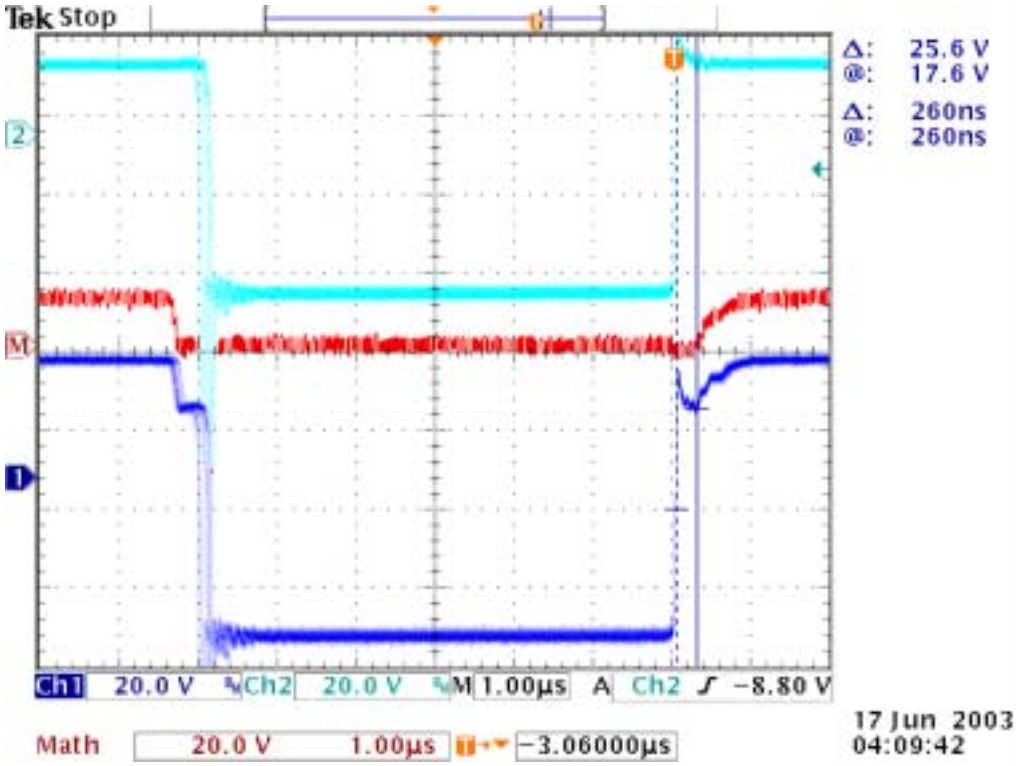

Fig 4 Delay Time and Dead Time measurement on 120W,19V/6.3A power application

POWER SUPPLY DESIGN CRITERIA REQUIRED

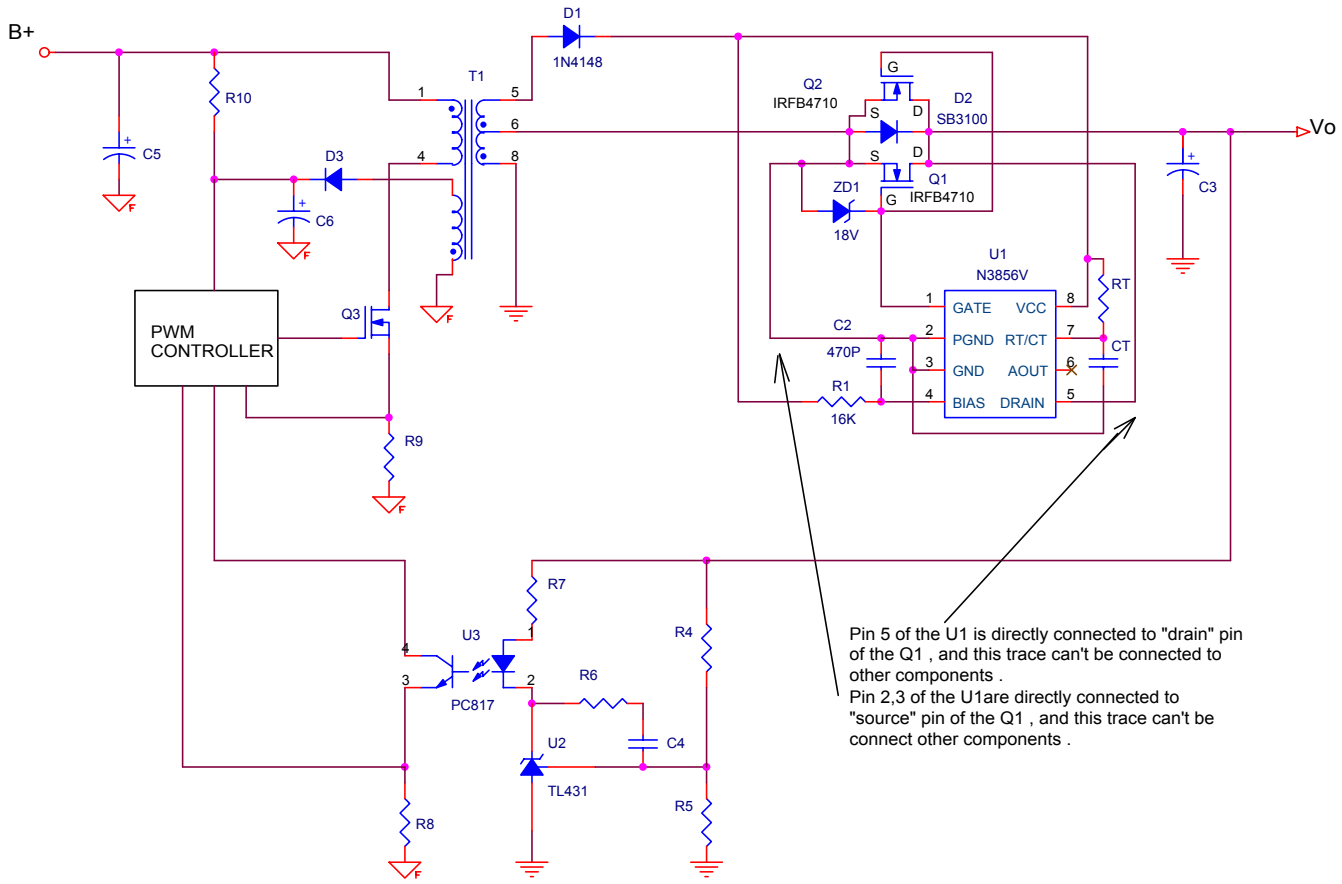

Fig 5 Typical Flyback power supply using the N3856x Series

1) Recommended operating frequency for the best efficiency --- fs = 50K~60KHz
2) Maximum duty cycle --- Dmax ≈ 0.3
3) Recommended low Rds(on) power MOSFET for the synchronous rectification --- less than 16mΩ .
4) Recommended AUX winding voltage is approximately 12V.
5) Adjusted bias resistor R1 for tuning a turn-off point in the discontinue mode operating.
6) Adjusted RT or CT for tuning a dead time in the continue mode operating ,RT is required for 1% precision resistor and CT is reuired for 1~2%NPO or other low temperature drift characteristic capacitor .
7) Schottky diode D2 is required(about1/3 output current rating) for reducing conduction loss during delay time and dead time because the body diode Vf of the MOSFET> schottky diode Vf , if in the 2 pcs of MOSFETs parallel application , the body diode Vf of the parralel MOSFETs will be decreased, we may remove the schottky diode D2 .

Synchronous signal from primary side application

See the Fig 5 , showing synchronous signal from primary side application in the continue mode operating ,the RT/CT pin (pin 7) is shorted to PGND (pin 2) . the synchronous signal from primary side must be ahead of the gate waveform of Q2 , let Q1 is turn-off before Q2 turn-on .

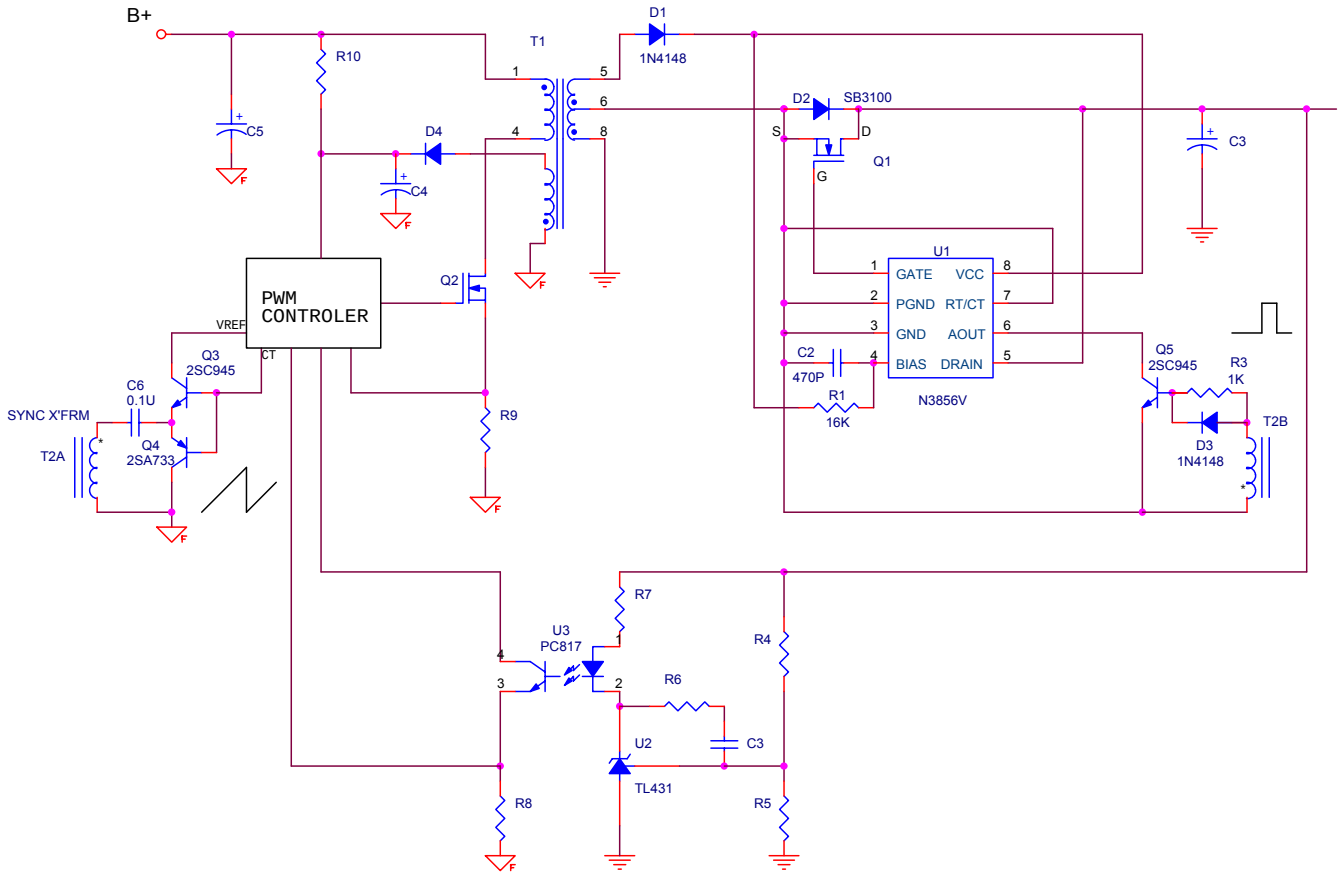

Fig 5 Synchronous signal from primary side , using the N3856x Series

See the Fig 6 , showing the another synchronous signal from primary side application .

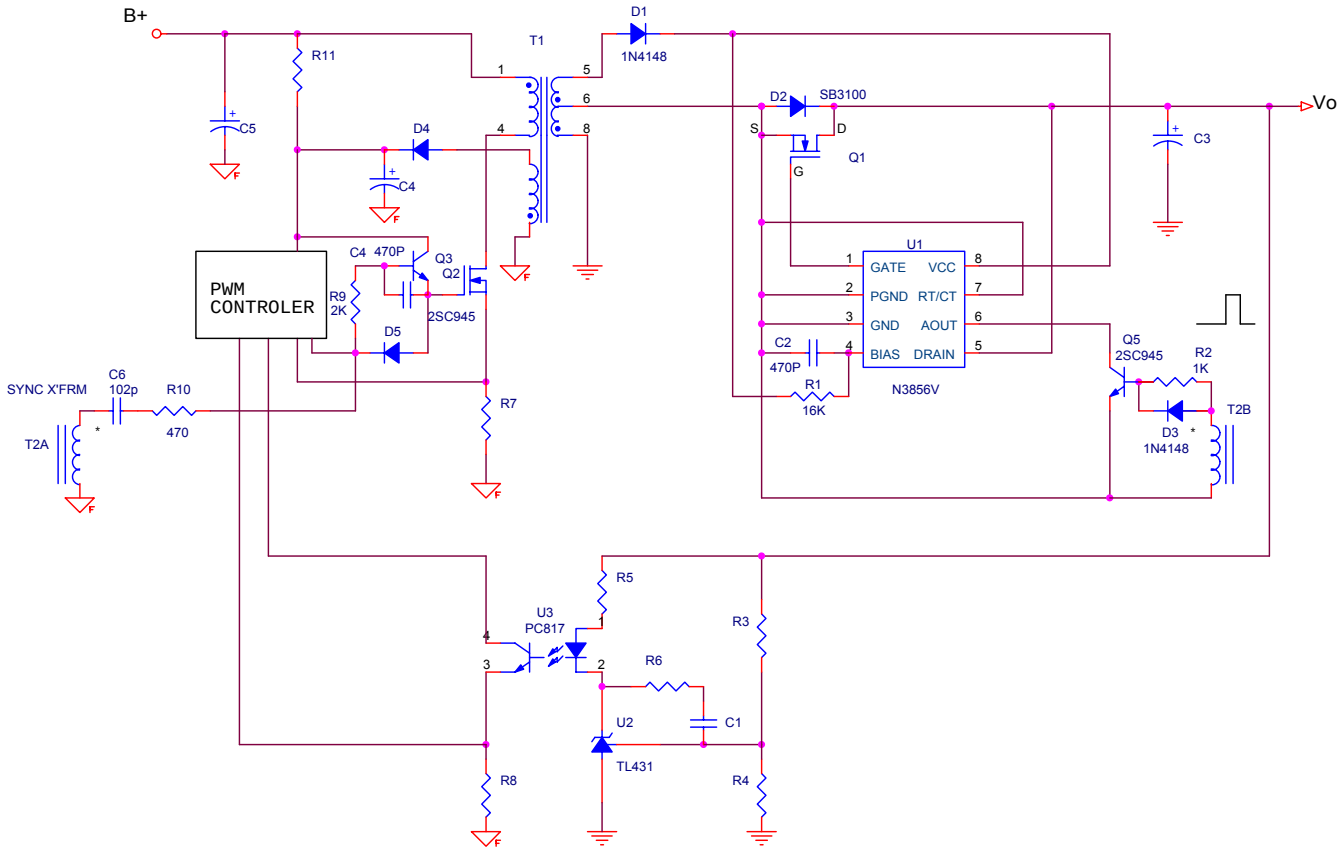

Fig 6 Synchronous signal from primary side , using the N3856x Series

See the Fig 7 , we can connect synchronous rectification MOSFET to the GND , and it is implemented for multiple output application .

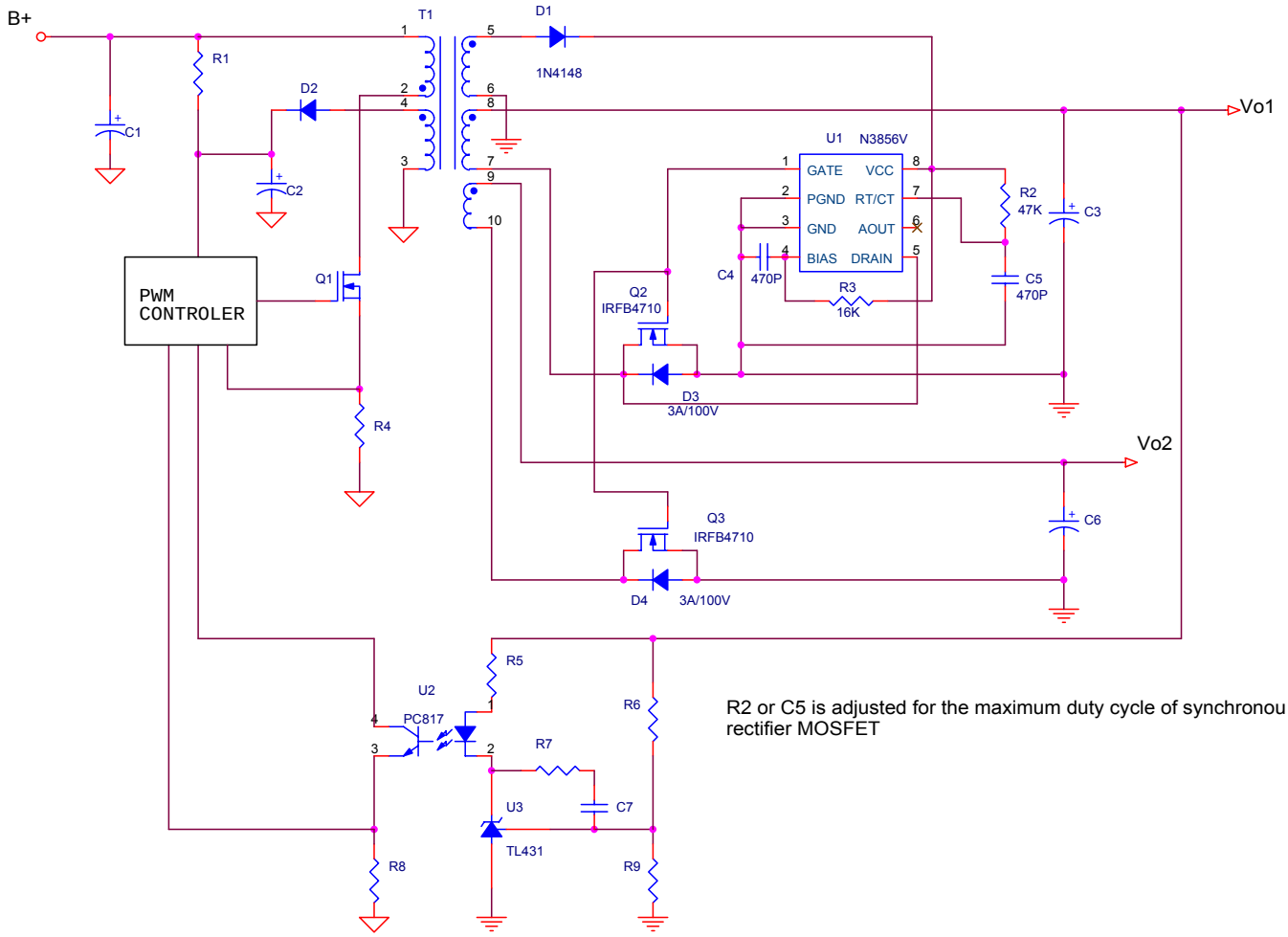

Fig 7 Multiple output and the MOSFET on the low side application

DEMO BOARD DESCRIPTION

The Fig .8 presents a demo board for the N3856x , This board replaces the output rectifier diode with synchronous rectification MOSFET in flyback power supply and includes all the components needs by the N3856x to operate, R3 and C1 can be adjusted for diffferent switching frequency and turn-on duty demand

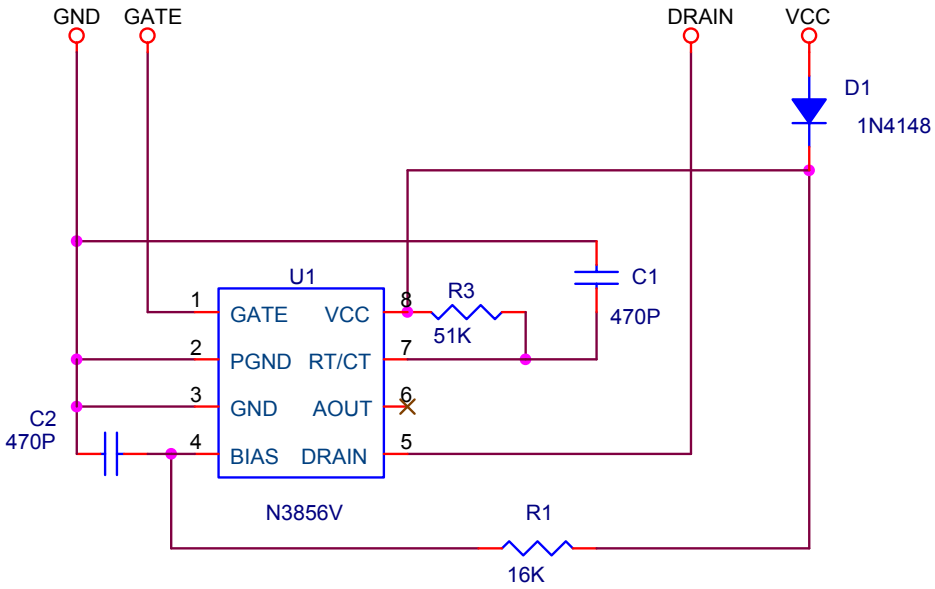

Fig 8 Demo board layout----componects

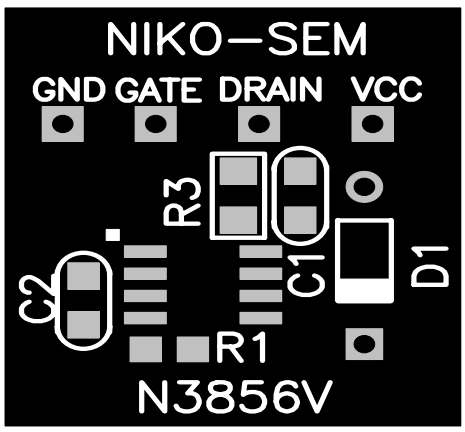

Fig 9 Demo board layout----component side

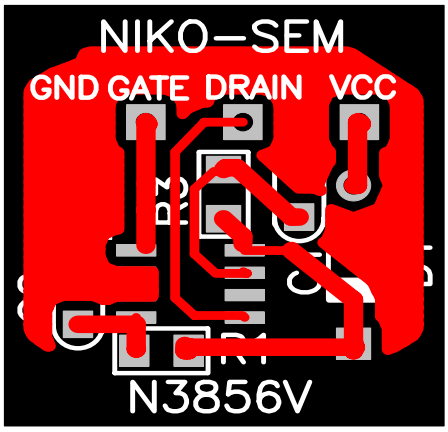

Fig 10 Demo board layout--- soldering side