

GENERAL DESCRIPTION

CM6901 is a SLS, SRC/LLC + SR resonant controller and it can operate at both SRC and LLC region with synchronous rectification to achieve high efficiency. Its unique features: FM + 2 PWMING modes. It is used for DC-DC conversion in offline application.

Light load regulation is accomplished by transitioning the controller from frequency modulation mode into PWM mode. To have the optimal balance performance between hold-up time and efficiency, its frequency range crosses fr1(resonant frequency).

CM6901 system has a constant voltage feedback loop with precision 2.5V VFB reference. The 1V ILIMIT can be latched when a standby converter is applied; otherwise, it is an auto-restart I limit.

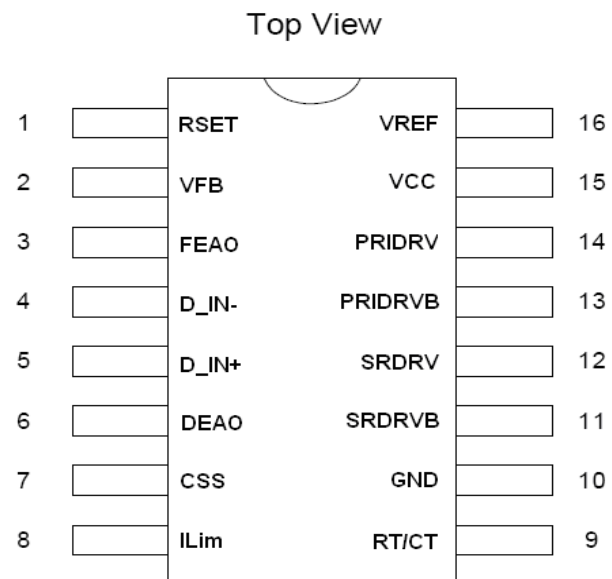
FEATURES

- ◆ 90+ Controller
- ◆ Smaller and Thinner Transformer
- ◆ 20ms with reasonable Bulk Cap(hold up time)
- ◆ SLS, SRC/LLC + SR resonant controller
- ◆ Supply Voltage Range : 10V to 20V.
- ◆ 2 Gate Drivers: Typical Peak Drive from 12V supply : (PMOS~200 ohm and NMOS~100 ohm).
- ◆ UVLO =11V with 1V Hysteresis.
- ◆ Reference OK Comparator.
- ◆ FM + 2 PWMING Mode Operation
- ◆ Light Load PWMING (light load regulation)
- ◆ SR Ideal Diode PWMING(cross resonant frequency application)
- ◆ GM FEAO, FM modulation Error Amplifier
- ◆ GM DEAO, PWM Error Amplifier
- ◆ Close Loop Soft start Capability with Shutdown Function.
- ◆ Auto-Restart during Current Limit .
- ◆ Precision 2.5V VFB threshold for constant voltage feedback loop.
- ◆ Precision 1V I limit threshold.

APPLICATIONS

- ◆ DC-DC power supply.
- ◆ Operates in FM/PWM mode.

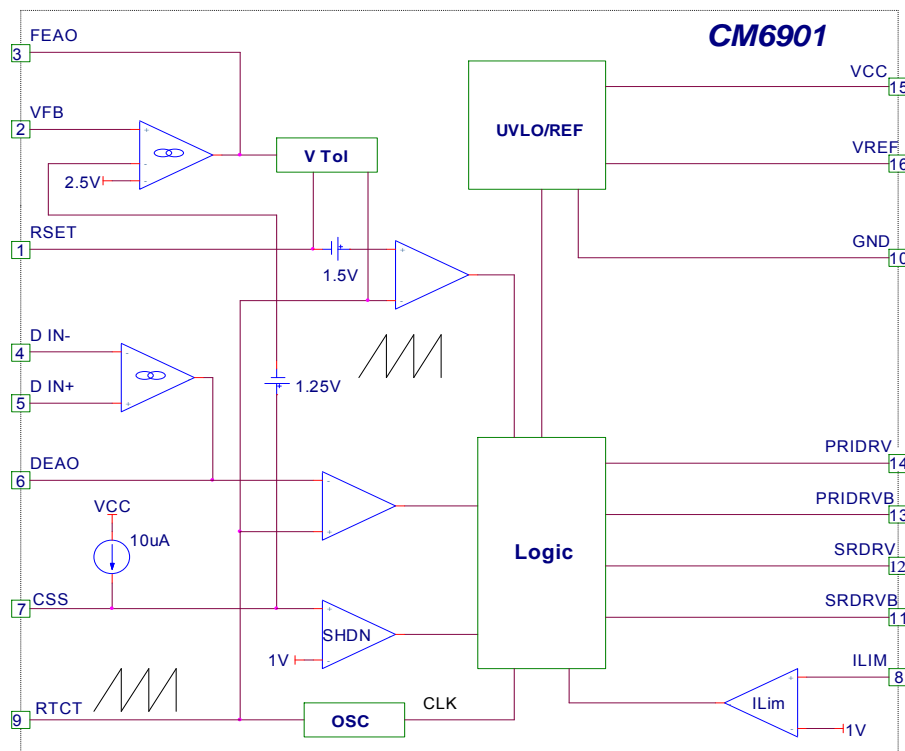
CM6901 Pin Configuration



ORDERING INFORMATION

| Part Number | Temperature Range | Package |
|--------------|-------------------|-------------------|
| CM6901GIS* | -40°C to 125°C | 16-Pin SOP (S16) |
| CM6901GISTR* | -40°C to 125°C | 16-Pin SOP (S16) |
| CM6901GIP* | -40°C to 125°C | 16-Pin PDIP (P16) |
| CM6901XIS* | -40°C to 125°C | 16-Pin SOP (S16) |
| CM6901XISTR* | -40°C to 125°C | 16-Pin SOP (S16) |
| CM6901XIP* | -40°C to 125°C | 16-Pin PDIP (P16) |

*Note : G : Suffix for Pb Free Product
 X : Suffix for Halogen Free and PB Free Product
 TR : Package is Typing Reel

BLOCK DIAGRAM


PIN DESCRIPTION

| Pin No. | Symbol | Description | Operating Voltage | | | |
|---------|---------|---|-------------------|------|------|------|
| | | | Min. | Typ. | Max. | Unit |
| 1 | RSET | External resistor which convert FEAO voltage signal into current signal for frequency modulation. SR is PWMing Control , when RSET lower than 1.5V. | 0 | | 5.5 | V |
| 2 | VFB | Non-inverting input into resonant error amplifier . | 0 | 2.5 | 3 | V |
| 3 | FEAO | Resonant error amplifier output and compensation node for frequency modulation control. | 0 | | 5.5 | V |
| 4 | D_IN- | Inverting input into PWM error amplifier. | 0 | | 6 | V |
| 5 | D_IN+ | Non-inverting input into PWM error amplifier. | 0 | | 6 | V |
| 6 | DEAO | PWM error amplifier output and compensation node for PWM control. | 0 | | 4.5 | V |
| 7 | CSS | Soft start for FM/PWM operation with 1V enable threshold. Also, use for auto-restart operation during current limit. | 0 | | 5.5 | V |
| 8 | ILIM | Input to current comparator with 1V threshold. | 0 | 1 | 1.25 | V |
| 9 | RTCT | Oscillator timing components which set the minimum frequency. | 1.2 | | 3 | V |
| 10 | GND | Ground | | | | |
| 11 | SDRVB | Synchronous MOSFET driver output. | -0.3 | | VCC | V |
| 12 | SDRV | Synchronous MOSFET driver output. | -0.3 | | VCC | V |
| 13 | PRIDRVB | Primary side MOSFET driver output. | -0.3 | | VCC | V |
| 14 | PRIDRV | Primary side MOSFET driver output. | -0.3 | | VCC | V |
| 15 | VCC | Positive supply for the IC | 10 | 15 | 20 | V |
| 16 | VREF | Buffered output for the 7.5V voltage reference | | 7.5 | | V |

ABSOLUTE MAXIMUM RATINGS (TA=25°C, unless otherwise specified.)

The following ratings designate persistent limits beyond which damage to the device may occur.

| Symbol | Parameter | Value | Unit |
|---------|---|------------------|------|
| VCC | DC Supply Voltage | -0.3 to 20 | V |
| SRDRV | SRDRV Voltage | -0.3 to VCC+0.3 | V |
| SRDRVB | SRDRVB Voltage | -0.3 to VCC+0.3 | V |
| PRIDRV | PRIDRV Voltage | -0.3 to VCC+0.3 | V |
| PRIDRVB | PRIDRVB Voltage | -0.3 to VCC+0.3 | V |
| VREF | VREF Voltage | -0.3 to 7.5 | V |
| RTCT | RTCT Voltage | -0.3 to VREF+0.3 | V |
| VILIM | VILIM Voltage | -0.3 to VREF+0.3 | V |
| CSS | CSS Voltage | -0.3 to VREF+0.3 | V |
| DEAO | PWM Error Amplifier Output Voltage | -0.3 to VREF+0.3 | V |
| D_IN+ | Non-Inverting Input Into PWM Error Amplifier Voltage | -0.3 to VREF+0.3 | V |
| FEAO | Resonant Error Amplifier Output Voltage | -0.3 to VREF+0.3 | V |
| VFB | Non-Inverting Input Into Resonant Error Amplifier Voltage | -0.3 to VREF+0.3 | V |
| RSET | V to I Voltage | -0.3 to VREF+0.3 | V |

ELECTRICAL CHARACTERISTICS

(VCC=12V, RT=40.2K±1%, CT=1470PF±1%, Freq. = 50 KHZ, Duty Cycle=48% , Temp= -40 ~ 125 °C, unless otherwise specified.)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--|--------|---------------------|------|-------|------|------|
| VREF (pin 16) | | | | | | |
| Reference Voltage (note1) | VREF | TA=25°C; Iref=1mA | 7.41 | 7.5 | 7.59 | V |
| | VREF | TA=-40°C; Iref=0mA | 7.44 | 7.53 | 7.62 | V |
| | VREF | TA=125°C; Iref=0mA | 7.53 | 7.67 | 7.7 | V |
| Line Regulation | | 11.5V < Vcc < 16.5V | | 10 | 25 | mV |
| Load Regulation | | 0mA < Iref < 5mA | 0 | 10 | 25 | mV |
| VCC (pin 15) | | | | | | |
| VCC Start up voltage | Vstart | | 10.5 | 10.8 | 11.1 | V |
| VCC Turn off voltage | | | 9.5 | 10 | 10.5 | V |
| VCC Start up current | | | 63.5 | 78.25 | 93 | uA |
| UVLO Hysteresics | Hys | | 0.95 | 1 | 1.05 | V |
| Operating Current | ICC | | | 1 | | mA |
| SRDRVB , SRDRV , PRIDRVB , PRIDRV (pin 11,12,13,14) | | | | | | |
| Output Low Voltage | Vol | Isrcrv=-6mA | | 0.6 | 1.2 | V |
| Output High Voltage | Voh | Isrcrv=+6mA | 9.6 | 10.8 | | V |
| Iout peak source current | Iout | | | 0.12 | | A |
| Iout peak sink current | Iout | | | 0.12 | | A |
| PMOS Rdson | Rout | TA=25°C | | 200 | 250 | Ohm |
| NMOS Rdson | Rout | TA=25°C | | 100 | 150 | Ohm |
| Dead Time between PRIDRV and PRIDRVB | TDead | TA=25°C | | 1 | | us |
| Rising Edge Delay Between PRIDRV and SRDRV | TDelay | TA=25°C | 164 | 205 | 246 | ns |
| Falling Edge Delay Between SRDRV and PRIDRV | TDelay | TA=25°C | 168 | 210 | 252 | ns |
| Duty Cycle Range | | | 0 | | 50 | % |
| ILIM (pin 8) | | | | | | |
| Threshold Voltage | Vth | TA=25°C | 1.45 | 1.65 | 1.75 | V |
| SS Voltage Hi | | TA=25°C | 0.95 | 1 | 1.05 | V |
| SS Voltage Low | | TA=25°C | 1.31 | 1.64 | 1.97 | V |

ELECTRICAL CHARACTERISTICS

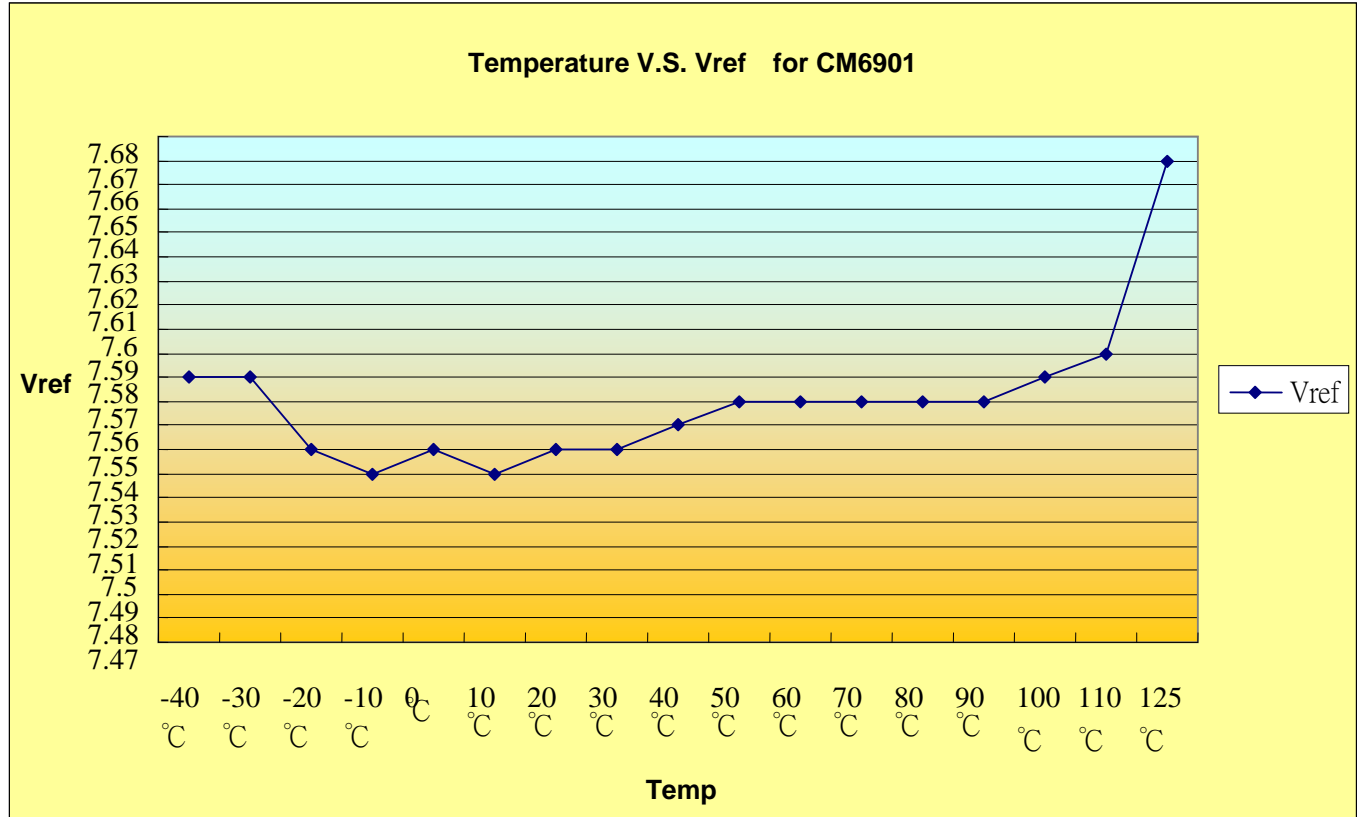
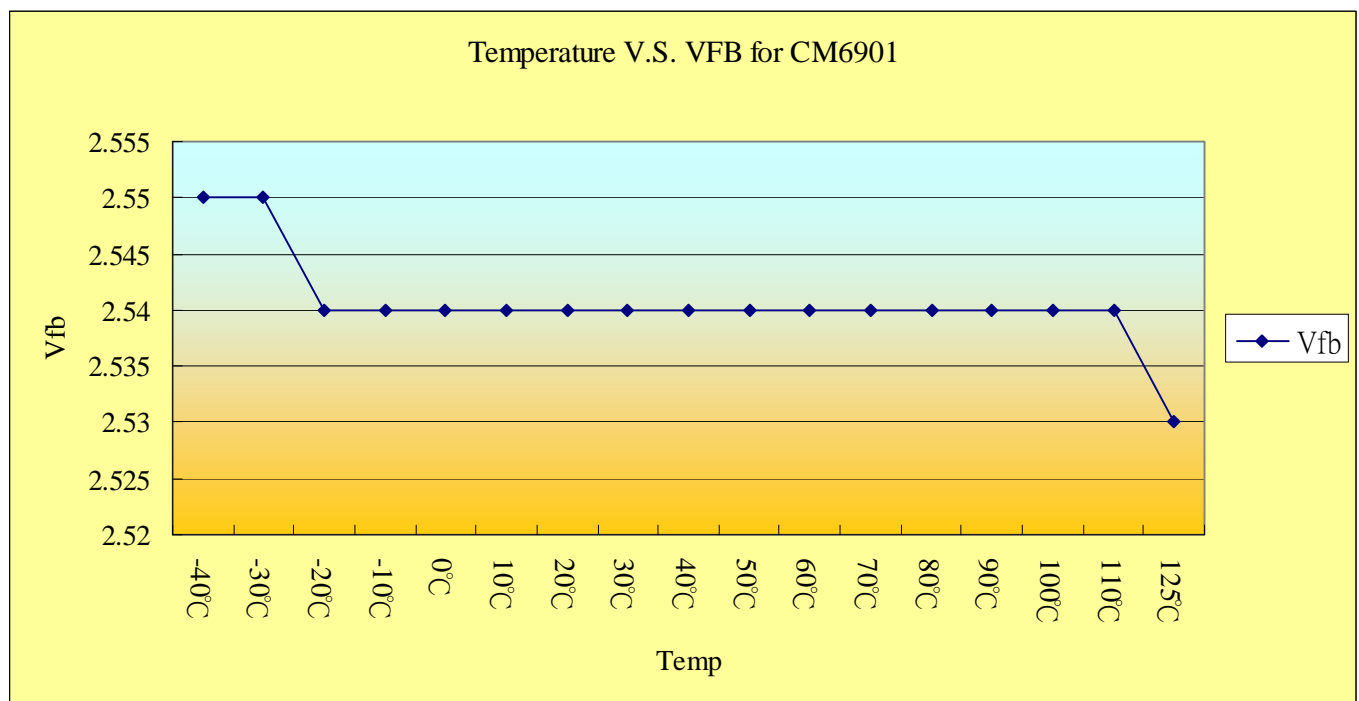
(VCC=12V, RT=40.2K±1%, CT=1470PF±1%, Freq. = 50 KHz, Duty Cycle=48% , Temp=-40 ~ 125°C, unless otherwise specified.)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--|------------------|---------------------------|-------|---------------------|-------|------|
| CSS (pin 7) | | | | | | |
| Soft Start Current | I _{ss} | TA=25°C | -8.8 | -7.5 | -6.3 | uA |
| Enable Voltage | V _{en} | TA=25°C | 0.9 | 1.0 | 1.1 | V |
| Enable Hysteresis | V _{hys} | TA=25°C | | 100 | | mV |
| Auto-restart Upper Threshold | V _{up} | | 4.85 | 5.0 | 5.15 | V |
| Auto-restart Lower Threshold | V _{lw} | | | 1-V _{hyst} | | V |
| FEAO Resonant Error Amplifier (pin 3) | | | | | | |
| Input Voltage Range | | | | | 6 | V |
| Transconductance | G _m | VFB±50mV, TA=25°C | 37 | 49.5 | 62 | umho |
| VFB (Pin2) | | | | | | |
| Feedback Reference Voltage (note 2) | | TA=25°C | 2.475 | 2.5 | 2.525 | V |
| | | TA=125°C | 2.485 | 2.51 | 2.535 | V |
| | | TA=-40°C | 2.465 | 2.49 | 2.515 | V |
| Input Bias Current | | | -1 | -0.5 | | uA |
| Output High Voltage | | | | 5.5+V _{BE} | | V |
| Output Low Voltage | | | | 0.1 | 0.4 | V |
| Sink Current | | VFB =250mV , TA=25°C | -21.5 | -17.55 | -13.6 | uA |
| Source Current | | VFB = -250mV , TA=25°C | 12.4 | 16.7 | 21 | uA |
| Open Loop Gain | | | | 60 | | dB |
| DEAO PWM Error Amplifier (pin 6) | | | | | | |
| Input Voltage Range | | | | | 6 | V |
| Reference Voltage | | | 0.96 | 1.01 | 1.06 | V |
| Transconductance | G _m | TA=25°C | 95 | 125 | 155 | umho |
| Input Bias Current | | | -1.0 | -0.5 | | uA |
| Output Voltage High | | | | 3+V _{BE} | | V |
| Output Voltage Low | | | | 0.1 | 0.4 | V |
| Sink Current | | | | -5 | | uA |
| Source Current | | | | 7 | | uA |
| Open Loop Gain | | | | 60 | | dB |

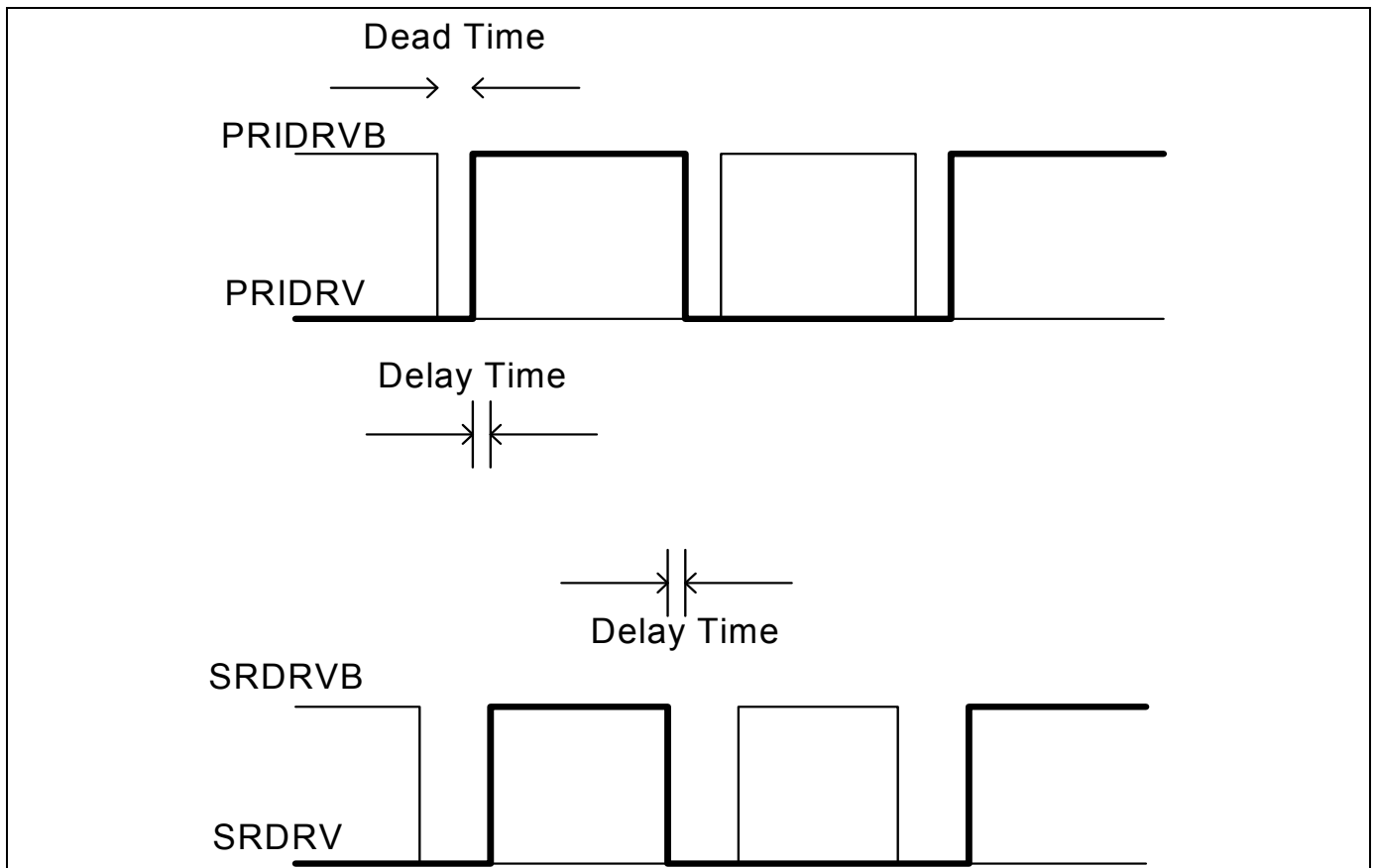
ELECTRICAL CHARACTERISTICS

(VCC=12V, RT=40.2K±1%, CT=1470PF±1%, Freq. = 50 KHz, Duty Cycle=48% , Temp=-40 ~ 125 °C, unless otherwise specified.)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|--------|----------------------|-------|------|-------|------|
| RTCT Oscillator ; RT=40.2K±1%;CT=1470pF±1%, (pin 9) | | | | | | |
| Initial Accuracy | | TA=25°C | 45 | 50 | 55 | Khz |
| Voltage Stability | | 11.5V < Vcc < 16.5V | | 1 | | % |
| Temperature Stability | | | | 2 | | % |
| Ramp Valley to Peak Voltage | | | | 2 | | V |
| CT Discharge Time | | | | 350 | | nS |
| Maximum Duty cycle | | DEAO > 3.0V | | 48 | | % |
| Minimum Duty Cycle | | DEAO < 1.2V | | 0 | | % |
| SR Ideal Diode ; Rset1=30.1K±1% ; Rset2=215K±1% (pin12) | | | | | | |
| Maximum Duty cycle | | TA=25°C , FEAO=2.2V | 37.4 | 44 | 50.6 | % |
| Middle Duty cycle | | TA=25°C , FEAO=1.57V | 28.4 | 30.2 | 32 | % |
| Minimum Duty cycle | | TA=25°C , FEAO=0V | 26.37 | 29.3 | 32.23 | % |
| Frequency at Minimum Duty cycle | | TA=25°C | 22.14 | 24.6 | 27.06 | KHz |

Note1

Note2


Timing Diagram



Oscillator

The oscillator frequency is determined by the values of RT and CT.

$$f_{osc} = 1 / (t_{RAMP} + t_{DEADTIME})$$

$$t_{RAMP} = RT * CT * \ln((V_{REF} + I_{CHG} * RT - 1.25) / (V_{REF} + I_{CHG} * RT - 3)) \text{ where } I_{CHG} = 4 * (FEAO - V_{BE}) / R_{SET}$$

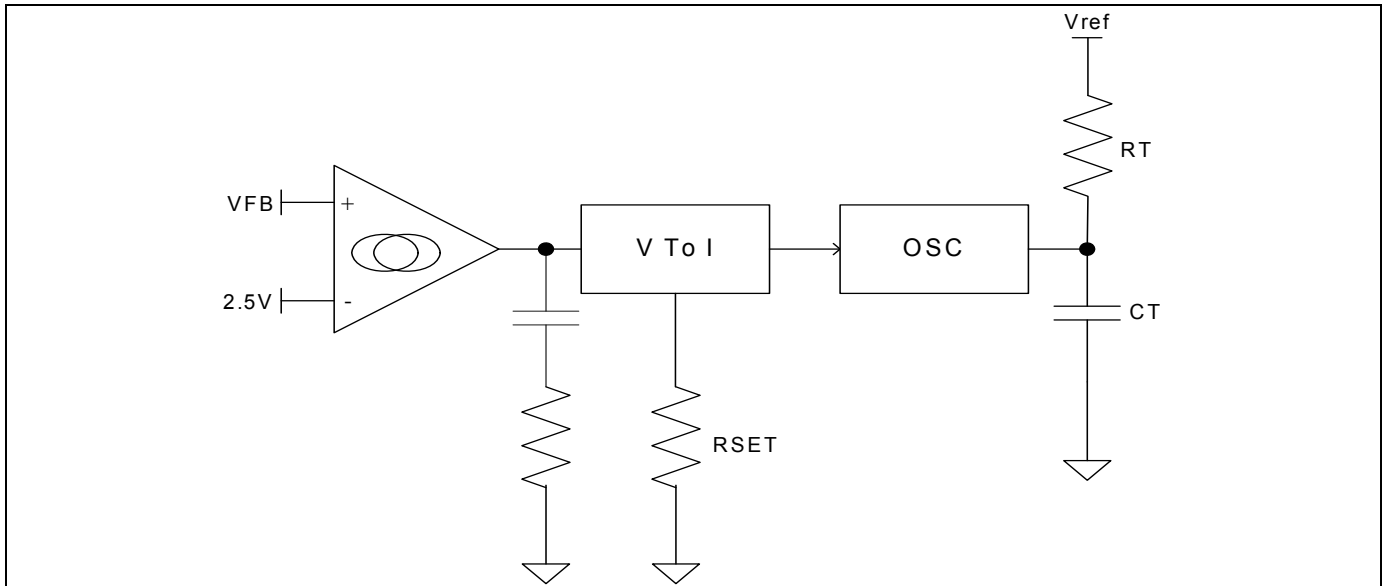
Resonant Section

FM Modulator

Frequency modulation of the resonant controller section is accomplished by controlling the charging current of the oscillator through resonant error amplifier. The frequency of the resonant section is $\frac{1}{2}$ of the oscillator frequency. Compensation is accomplished by connecting R and C in series to the FEAO pin.

$$I_{CHG} = 4 * (FEAO - V_{BE}) / R_{SET}$$

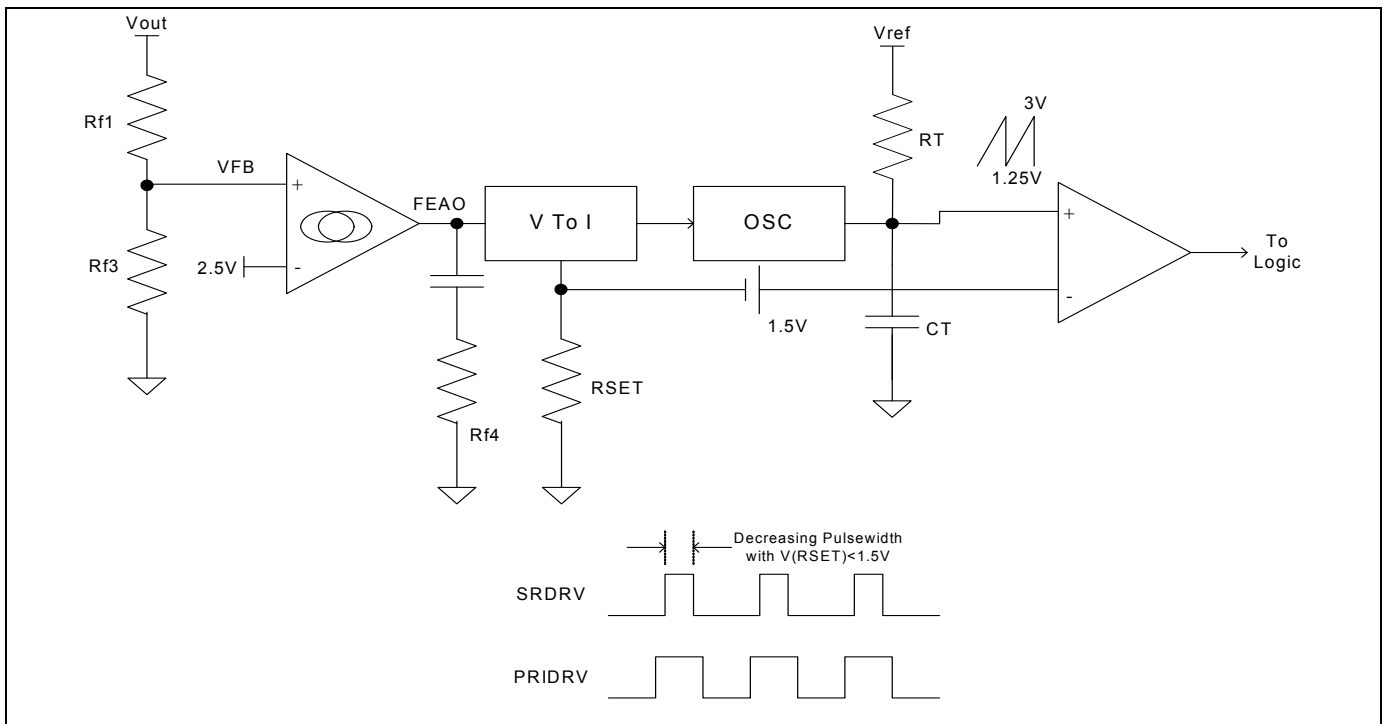
$$I_{CHG(max)} = 20V / R_{SET}$$



2 PWMings:

SR Ideal Diode PWMing (Synchronous Outputs)

SR Ideal Diode PWMing for synchronous drivers is accomplished by comparing the voltage signal at the RSET pin to RTCT ramp. The pulse-width reduction happens when the voltage at the RSET is lower than 1.5V. This allows safe operation of the power converter with synchronous rectification when the switching frequency is below the highest resonant point frequency f_{r1} .

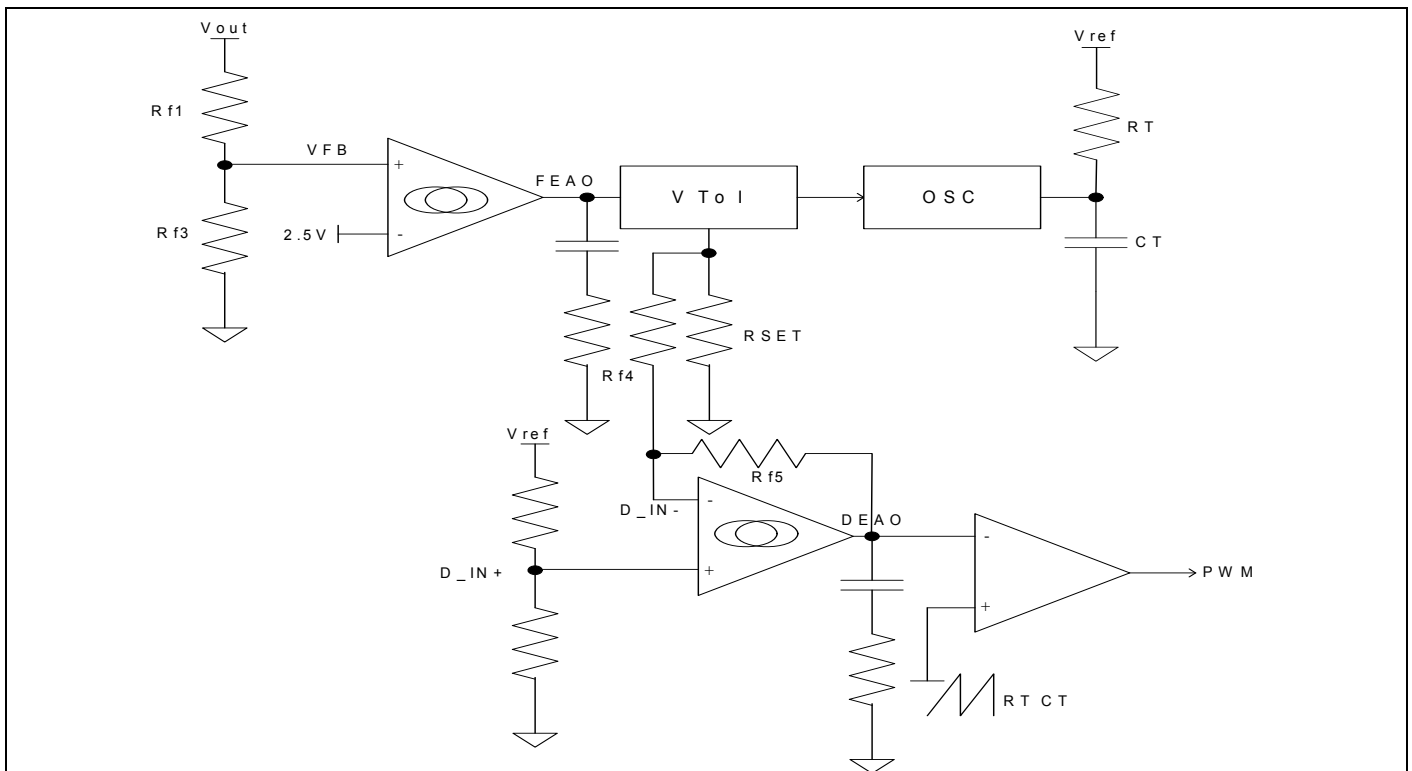


Light Load PWMING

In Application , low gain configuration accomplished by connecting R_{f4} and R_{f5} in the closed loop configuration . The gain for the PWM is determined by R_{f4} and R_{f5} where the gain is equal to $-R_{f5}/R_{f4}$. The voltage of V_{Rset} at which the controller goes into FM and PWM simultaneously is equal to :

$$V_{Rset} = D_{IN+} \times (1+R_{f4}/R_{f5}) - (R_{f4}/R_{f5}) \times 3 \text{ where } 3 \text{ is the peak voltage of } RTCT$$

Varyin R_{set} from V_{Rset} to $V_{Rset} + 1.75 \times R_{f4}/R_{f5}$ will cause the duty cycle to vary from 50% to 0% while the frequency will vary propotionally according to $1.75 \times R_{f4}/R_{f5}$ where 1.75 is the peak-to-peak voltage of the RTCT ramp. For proper operation, select R_{f5} value so that the current through R_{f5} $\{((D_{IN+}) - 1.2)/R_{f5}\}$ should be less than 5uA.



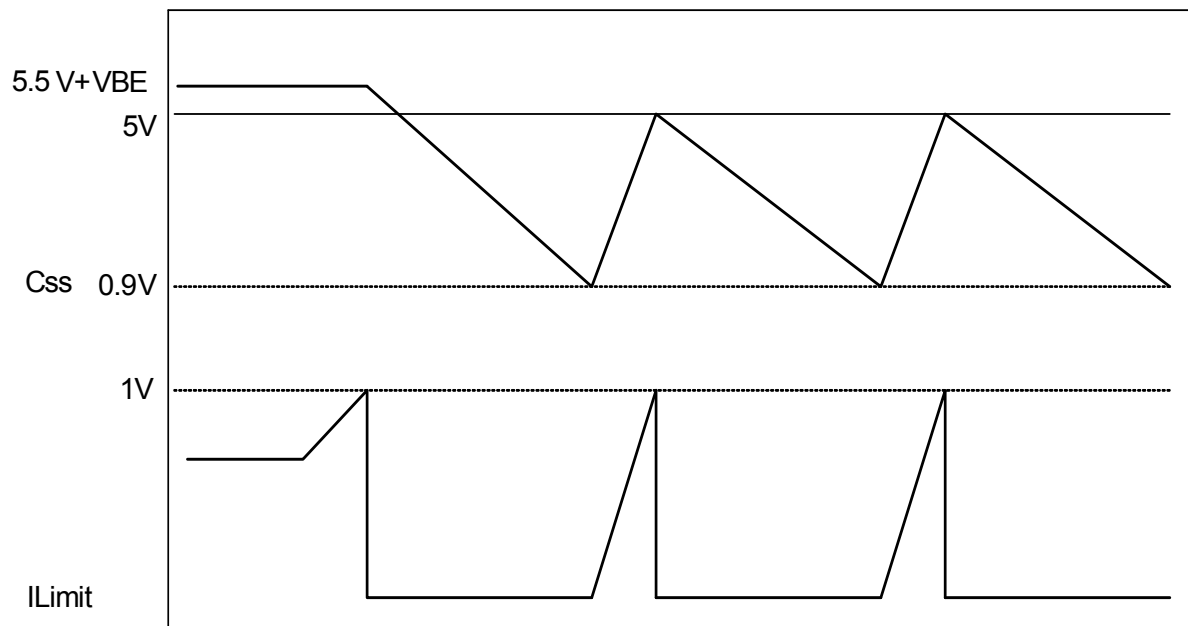
Soft Start and Enable

Soft start of the FM and PWM is controlled by the selection of the external capacitor at CSS pin. A current source of 7.5uA supplies the charging current for the capacitor. Soft start of the FM and PWM begins at 1.25V. The soft start pin CSS also serves as an enable function. The output drivers are enabled when CSS pin reached 1V.

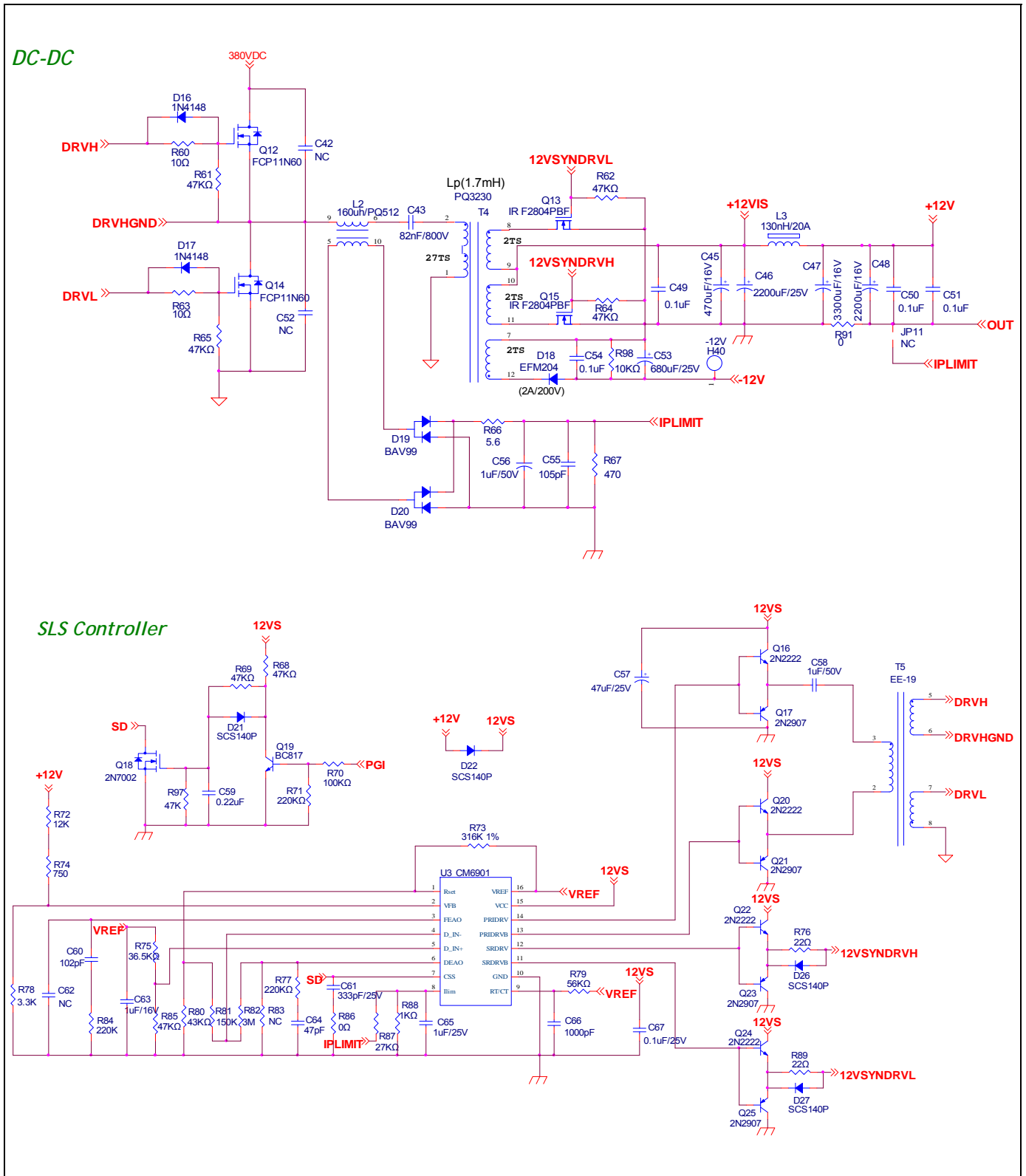
Auto-retry Mode

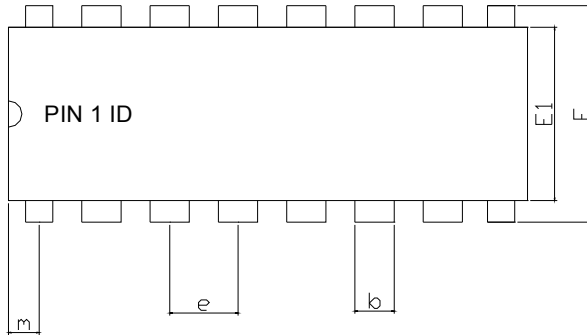
During normal operation, CSS pin will be charged to $5.5V + V_{BE}$. When VFB exceeds 2.93V due to ILIM exceeds 1V due to over current condition, output drivers are immediate set to low, and CSS begins to discharge with 0.75uA current source. When CSS pin is below 0.9V, 7.5uA current source start charging the CSS pin. When CSS pin reaches 1V, the output drivers are re-enable and the controller goes into soft start mode. If over current condition still exists then, the outputs are immediately disabled, but CSS continues to charge toward 5V. When CSS reaches 5V, 7.5uA charging current is disabled and 0.75uA current source begins to discharge the CSS, and the cycle repeat until over current condition is removed.

OCP Setting

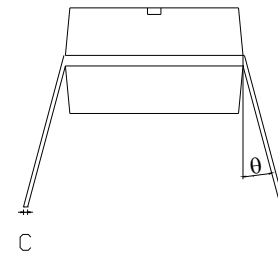
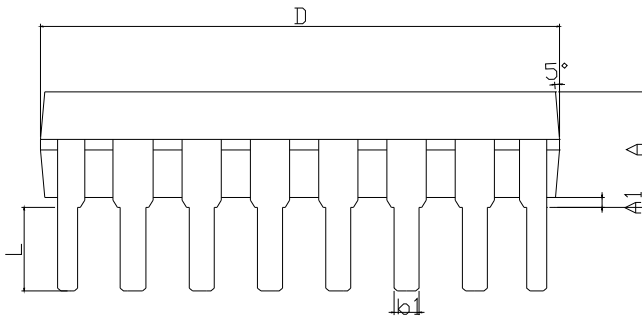
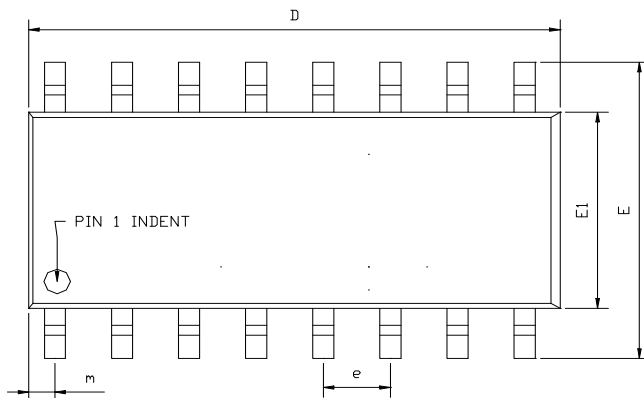


TYPICAL APPLICATION CIRCUIT



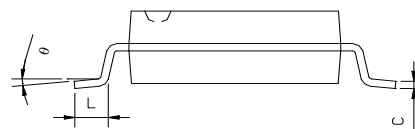
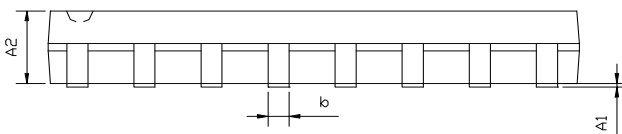
PACKAGE DIMENSION
16-PIN PDIP (P16)


| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHS | | |
|---------|---------------------------|------|-------|---------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | --- | --- | 4.32 | --- | --- | 0.170 |
| A1 | 0.38 | --- | --- | 0.015 | --- | --- |
| b | 1.40 | --- | 1.65 | 0.055 | --- | 0.065 |
| b1 | 0.40 | --- | 0.66 | 0.016 | --- | 0.022 |
| C | 0.20 | --- | 0.31 | 0.008 | --- | 0.012 |
| D | 18.79 | --- | 19.31 | 0.740 | --- | 0.760 |
| E | 7.49 | --- | 8.26 | 0.295 | --- | 0.325 |
| E1 | 6.09 | --- | 6.61 | 0.240 | --- | 0.260 |
| e | --- | 2.54 | --- | --- | 0.100 | --- |
| L | 3.18 | --- | --- | 0.125 | --- | --- |
| m | 0.50 | --- | --- | 0.02 | --- | --- |
| θ | 0° | --- | 15° | 0° | --- | 15° |


16-PIN SOP (S16)


| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHS | | |
|---------|---------------------------|------|-------|---------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A1 | 0.05 | --- | 0.15 | 0.002 | --- | 0.006 |
| A2 | 1.40 | --- | 1.55 | 0.055 | --- | 0.061 |
| b | 0.30 | --- | 0.51 | 0.012 | --- | 0.020 |
| C | 0.15 | --- | 0.26 | 0.006 | --- | 0.010 |
| D | 9.80 | --- | 10.06 | 0.386 | --- | 0.396 |
| E | 5.79 | --- | 6.20 | 0.228 | --- | 0.244 |
| E1 | 3.76 | --- | 4.01 | 0.148 | --- | 0.158 |
| e | --- | 1.27 | --- | --- | 0.050 | --- |
| L | 0.38 | --- | 0.69 | 0.015 | --- | 0.035 |
| m | 0.43 | --- | 0.69 | 0.017 | --- | 0.027 |
| θ | 0° | --- | 8° | 0° | --- | 8° |

EXPOSED PAD DIMENSION : (mm)
PAD SIZE: X=2.3 ; Y=2.8



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