

# Current Mode PWM Controller

## FEATURES

- Automatic Feed Forward Compensation
- Programmable Pulse-by-Pulse Current Limiting
- Automatic Symmetry Correction in Push-pull Configuration
- Enhanced Load Response Characteristics
- Parallel Operation Capability for Modular Power Systems
- Differential Current Sense Amplifier with Wide Common Mode Range
- Double Pulse Suppression
- 500mA (Peak) Totem-pole Outputs
- $\pm 1\%$  Bandgap Reference
- Under-voltage Lockout
- Soft Start Capability
- Shutdown Terminal
- 500kHz Operation

## DESCRIPTION

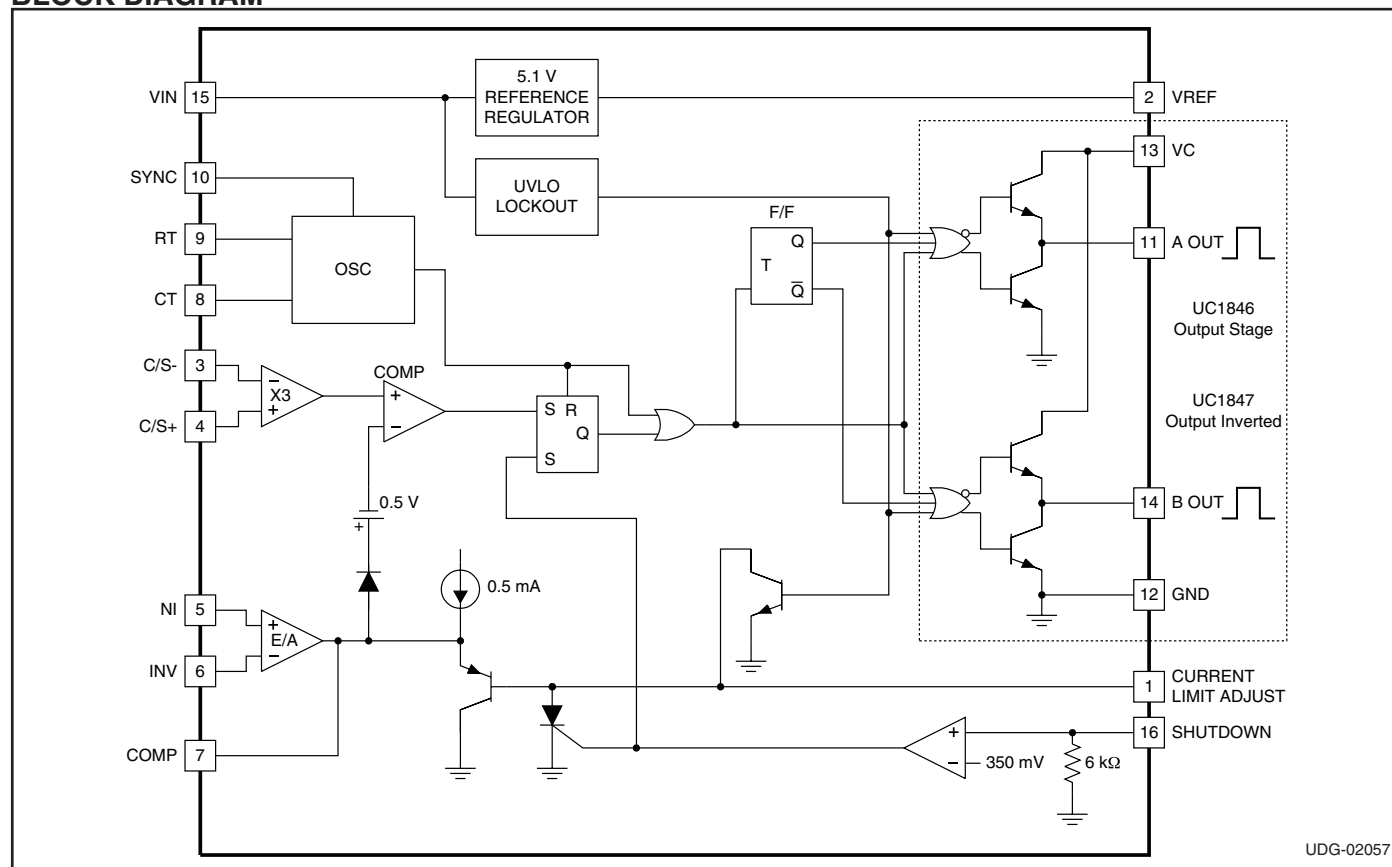
The UC1846/7 family of control ICs provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier-to-design control loop. Topological advantages include inherent pulse-by-pulse current limiting capability, automatic symmetry correction for push-pull converters, and the ability to parallel "power modules" while maintaining equal current sharing.

Protection circuitry includes built-in under-voltage lockout and programmable current limit in addition to soft start capability. A shutdown function is also available which can initiate either a complete shutdown with automatic restart or latch the supply off.

Other features include fully latched operation, double pulse suppression, deadline adjust capability, and a  $\pm 1\%$  trimmed bandgap reference.

The UC1846 features low outputs in the OFF state, while the UC1847 features high outputs in the OFF state.

## BLOCK DIAGRAM



UDG-02057

## ABSOLUTE MAXIMUM RATINGS (Note 1)

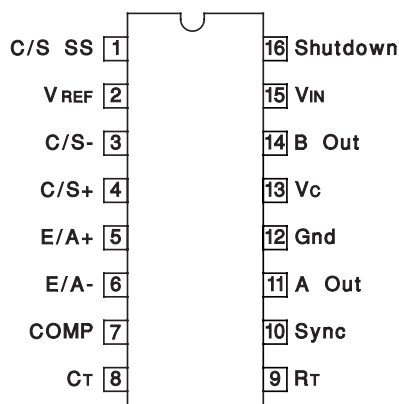
|                                              |                           |
|----------------------------------------------|---------------------------|
| Supply Voltage (Pin 15)                      | +40V                      |
| Collector Supply Voltage (Pin 13)            | +40V                      |
| Output Current, Source or Sink (Pins 11, 14) | 500mA                     |
| Analog Inputs (Pins 3, 4, 5, 6, 16)          | -0.3V to +V <sub>IN</sub> |
| Reference Output Current (Pin 2)             | -30mA                     |
| Sync Output Current (Pin 10)                 | -5mA                      |
| Error Amplifier Output Current (Pin 7)       | -5mA                      |
| Soft Start Sink Current (Pin 1)              | 50mA                      |
| Oscillator Charging Current (Pin 9)          | 5mA                       |
| Power Dissipation at T <sub>A</sub> =25°C    | 1000mW                    |
| Power Dissipation at T <sub>C</sub> =25°C    | 2000mW                    |
| Storage Temperature Range                    | -65°C to +150°C           |
| Lead Temperature (soldering, 10 seconds)     | +300°C                    |

Note 1. All voltages are with respect to Ground, Pin 13. Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages. Pin numbers refer to DIL and SOIC packages only.

## CONNECTION DIAGRAMS

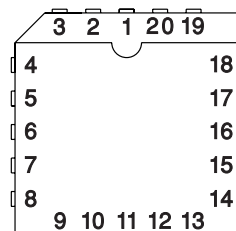
### DIL-16, SOIC-16 (TOP VIEW)

J or N Package, DW Package



### PLCC-20, LCC-20 (TOP VIEW)

Q, L Packages



| PACKAGE PIN FUNCTION |     |
|----------------------|-----|
| FUNCTION             | PIN |
| N/C                  | 1   |
| C/L SS               | 2   |
| V <sub>REF</sub>     | 3   |
| C/S-                 | 4   |
| C/S+                 | 5   |
| N/C                  | 6   |
| E/A+                 | 7   |
| E/A-                 | 8   |
| Comp                 | 9   |
| C <sub>T</sub>       | 10  |
| N/C                  | 11  |
| R <sub>T</sub>       | 12  |
| Sync                 | 13  |
| A Out                | 14  |
| Gnd                  | 15  |
| N/C                  | 16  |
| V <sub>C</sub>       | 17  |
| B Out                | 18  |
| V <sub>IN</sub>      | 19  |
| Shutdown             | 20  |

**ELECTRICAL CHARACTERISTICS** (Unless otherwise stated, these specifications apply for T<sub>A</sub>=-55°C to +125°C for UC1846/7; -40°C to +85°C for the UC2846/7; and 0°C to +70°C for the UC3846/7; V<sub>IN</sub>=15V, R<sub>T</sub>=10k, C<sub>T</sub>=4.7nF, T<sub>A</sub>=T<sub>J</sub>.)

| PARAMETER                    | TEST CONDITIONS                                 | UC1846/UC1847<br>UC2846/UC2847 |      |      | UC3846/UC3847 |      |      | UNITS |
|------------------------------|-------------------------------------------------|--------------------------------|------|------|---------------|------|------|-------|
|                              |                                                 | MIN.                           | TYP. | MAX. | MIN.          | TYP. | MAX. |       |
| Reference Section            |                                                 |                                |      |      |               |      |      |       |
| Output Voltage               | T <sub>J</sub> =25°C, I <sub>o</sub> =1mA       | 5.05                           | 5.10 | 5.15 | 5.00          | 5.10 | 5.20 | V     |
| Line Regulation              | V <sub>IN</sub> =8V to 40V                      |                                | 5    | 20   |               | 5    | 20   | mV    |
| Load Regulation              | I <sub>L</sub> =1mA to 10mA                     |                                | 3    | 15   |               | 3    | 15   | mV    |
| Temperature Stability        | Over Operating Range, (Note 2)                  |                                | 0.4  |      |               | 0.4  |      | mV/°C |
| Total Output Variation       | Line, Load, and Temperature (Note 2)            | 5.00                           |      | 5.20 | 4.95          |      | 5.25 | V     |
| Output Noise Voltage         | 10Hz ≤ f ≤ 10kHz, T <sub>J</sub> =25°C (Note 2) |                                | 100  |      |               | 100  |      | μV    |
| Long Term Stability          | T <sub>J</sub> =125°C, 1000 Hrs. (Note 2)       |                                | 5    |      |               | 5    |      | mV    |
| Short Circuit Output Current | V <sub>REF</sub> =0V                            | -10                            | -45  |      | -10           | -45  |      | mA    |

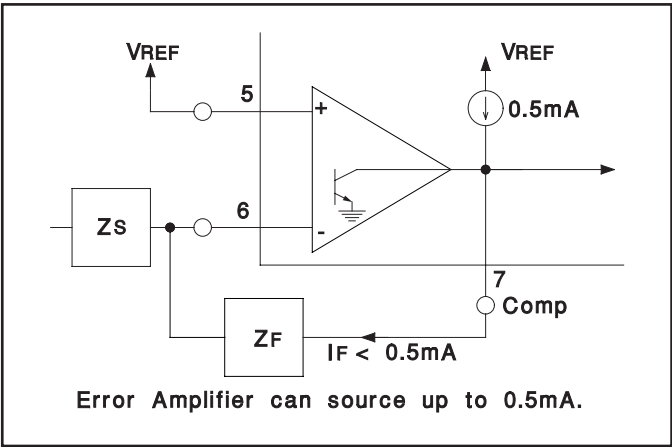
**ELECTRICAL CHARACTERISTICS (cont.)** (Unless otherwise stated, these specifications apply for  $T_A = -55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  for UC1846/7;  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  for the UC2846/7; and  $0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  for the UC3846/7;  $V_{IN} = 15\text{V}$ ,  $R_T = 10\text{k}$ ,  $C_T = 4.7\text{nF}$ ,  $T_A = T_J$ .)

| PARAMETER                                            | TEST CONDITIONS                              | UC1846/UC1847<br>UC2846/UC2847 |      |        | UC3846/UC3847 |      |        | UNITS |
|------------------------------------------------------|----------------------------------------------|--------------------------------|------|--------|---------------|------|--------|-------|
|                                                      |                                              | MIN.                           | TYP. | MAX.   | MIN.          | TYP. | MAX.   |       |
| Oscillator Section                                   |                                              |                                |      |        |               |      |        |       |
| Initial Accuracy                                     | TJ=25°C                                      | 39                             | 43   | 47     | 39            | 43   | 47     | kHz   |
| Voltage Stability                                    | VIN=8V to 40V                                |                                | -1   | 2      |               | -1   | 2      | %     |
| Temperature Stability                                | Over Operating Range (Note 2)                |                                | -1   |        |               | -1   |        | %     |
| Sync Output High Level                               |                                              | 3.9                            | 4.35 |        | 3.9           | 4.35 |        | V     |
| Sync Output Low Level                                |                                              |                                | 2.3  | 2.5    |               | 2.3  | 2.5    | V     |
| Sync Input High Level                                | Pin 8=0V                                     | 3.9                            |      |        | 3.9           |      |        | V     |
| Sync Input Low Level                                 | Pin 8=0V                                     |                                |      | 2.5    |               |      | 2.5    | V     |
| Sync Input Current                                   | Sync Voltage=3.9V, Pin 8=0V                  |                                | 1.3  | 1.5    |               | 1.3  | 1.5    | mA    |
| Error Amp Section                                    |                                              |                                |      |        |               |      |        |       |
| Input Offset Voltage                                 |                                              |                                | 0.5  | 5      |               | 0.5  | 10     | mV    |
| Input Bias Current                                   |                                              |                                | -0.6 | -1     |               | -0.6 | -2     | µA    |
| Input Offset Current                                 |                                              |                                | 40   | 250    |               | 40   | 250    | nA    |
| Common Mode Range                                    | VIN=8V to 40V                                | 0                              |      | VIN-2V | 0             |      | VIN-2V | V     |
| Open Loop Voltage Gain                               | ΔVo=1.2 to 3V, VCM=2V                        | 80                             | 105  |        | 80            | 105  |        | dB    |
| Unity Gain Bandwidth                                 | TJ=25°C (Note 2)                             | 0.7                            | 1.0  |        | 0.7           | 1.0  |        | MHz   |
| CMRR                                                 | VCM=0V to 38V, VIN=40V                       | 75                             | 100  |        | 75            | 100  |        | dB    |
| PSRR                                                 | VIN=8V to 40V                                | 80                             | 105  |        | 80            | 105  |        | dB    |
| Output Sink Current                                  | VID=-15mV to -5V, VPIN 7=1.2V                | 2                              | 6    |        | 2             | 6    |        | mA    |
| Output Source Current                                | VID=15mV to 5V, VPIN 7=2.5V                  | -0.4                           | -0.5 |        | -0.4          | -0.5 |        | mA    |
| High Level Output Voltage                            | RL=(Pin 7) 15kΩ                              | 4.3                            | 4.6  |        | 4.3           | 4.6  |        | V     |
| Low Level Output Voltage                             |                                              |                                | 0.7  | 1      |               | 0.7  | 1      | V     |
| Current Sense Amplifier Section                      |                                              |                                |      |        |               |      |        |       |
| Amplifier Gain                                       | VPIN 3=0V, Pin 1 Open (Notes 3 & 4)          | 2.5                            | 2.75 | 3.0    | 2.5           | 2.75 | 3.0    | V     |
| Maximum Differential Input<br>Signal (VPIN 4-VPIN 3) | Pin 1 Open (Note 3)<br>RL (Pin 7)=15kW       | 1.1                            | 1.2  |        | 1.1           | 1.2  |        | V     |
| Input Offset Voltage                                 | VPIN 1=0.5V, Pin 7 Open (Note 3)             |                                | 5    | 25     |               | 5    | 25     | mV    |
| CMRR                                                 | VCM=1V to 12V                                | 60                             | 83   |        | 60            | 83   |        | dB    |
| PSRR                                                 | VIN=8V to 40V                                | 60                             | 84   |        | 60            | 84   |        | dB    |
| Input Bias Current                                   | VPIN 1=0.5V, Pin 7 Open (Note 3)             |                                | -2.5 | -10    |               | -2.5 | -10    | µA    |
| Input Offset Current                                 | VPIN 1=0.5V, Pin 7 Open (Note 3)             |                                | 0.08 | 1      |               | 0.08 | 1      | µA    |
| Input Common Mode Range                              |                                              | 0                              |      | VIN-3  | 0             |      | VIN-3  | V     |
| Delay to Outputs                                     | TJ=25°C, (Note 2)                            |                                | 200  | 500    |               | 200  | 500    | ns    |
| Current Limit Adjust Section                         |                                              |                                |      |        |               |      |        |       |
| Current Limit Offset                                 | VPIN 3=0V, VPIN 4=0V, Pin 7 Open<br>(Note 3) | 0.45                           | 0.5  | 0.55   | 0.45          | 0.5  | 0.55   | V     |
| Input Bias Current                                   | VPIN 5=VREF, VPIN 6=0V                       |                                | -10  | -30    |               | -10  | -30    | µA    |
| Shutdown Terminal Section                            |                                              |                                |      |        |               |      |        |       |
| Threshold Voltage                                    |                                              | 250                            | 350  | 400    | 250           | 350  | 400    | mV    |
| Input Voltage Range                                  |                                              | 0                              |      | VIN    | 0             |      | VIN    | V     |
| Minimum Latching Current<br>(IPIN 1)                 | (Note 6)                                     | 3.0                            | 1.5  |        | 3.0           | 1.5  |        | mA    |

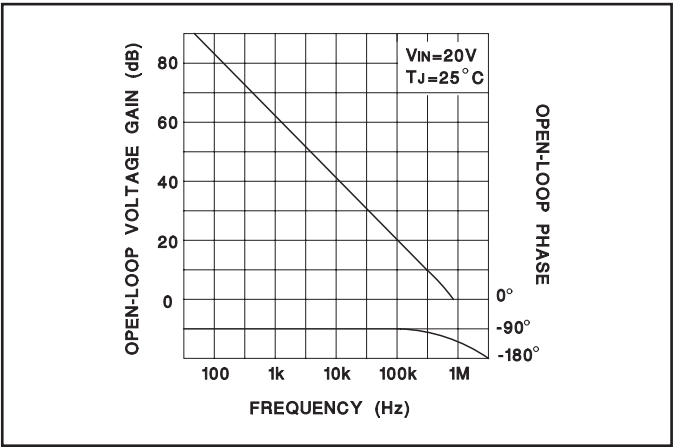


# APPLICATIONS DATA (cont.)

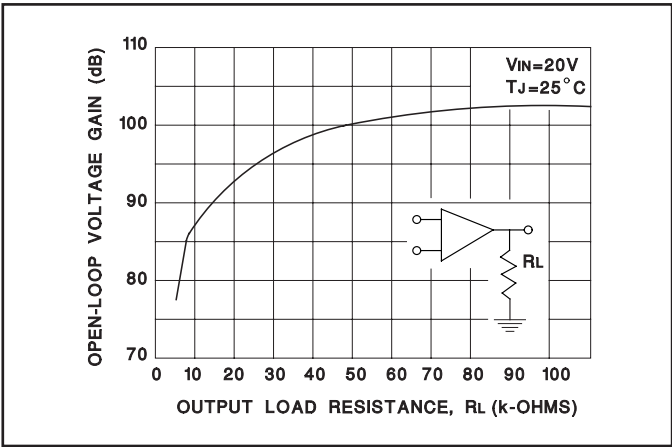
Error Amp Output Configuration



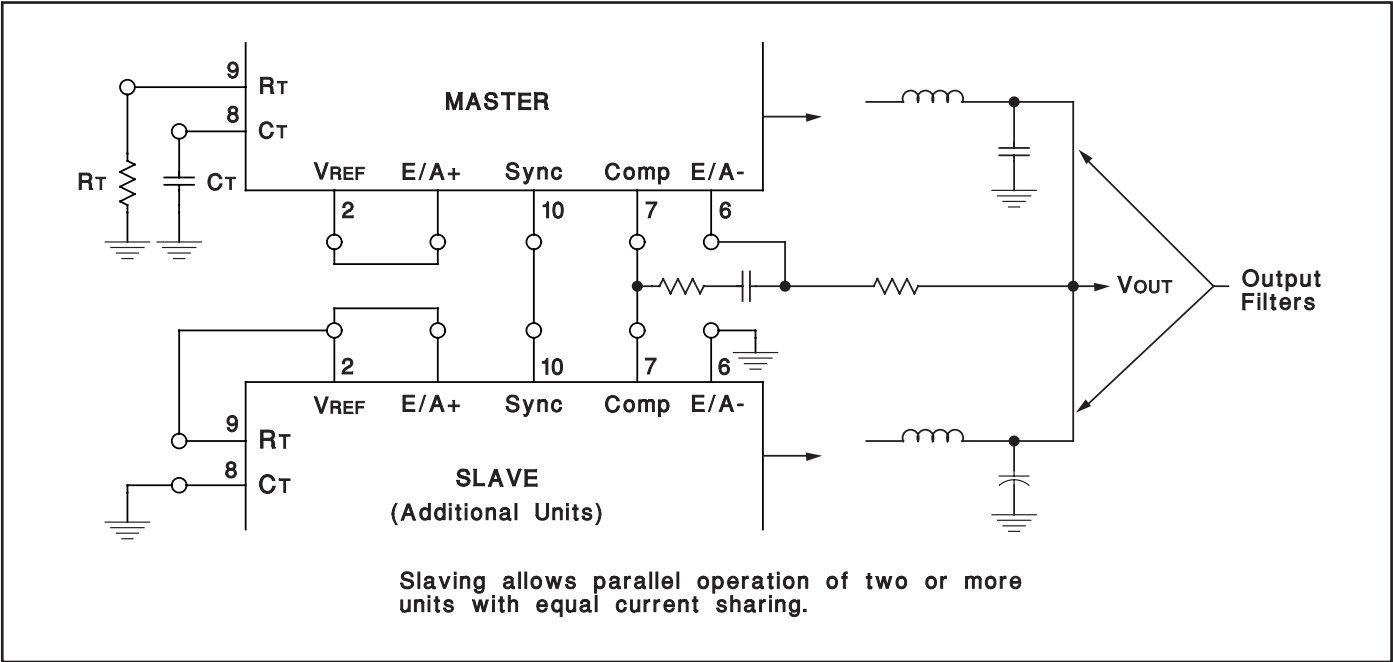
Error Amp Gain and Phase vs Frequency



Error Amp Open-Logic D.C. Gain vs Load Resistance

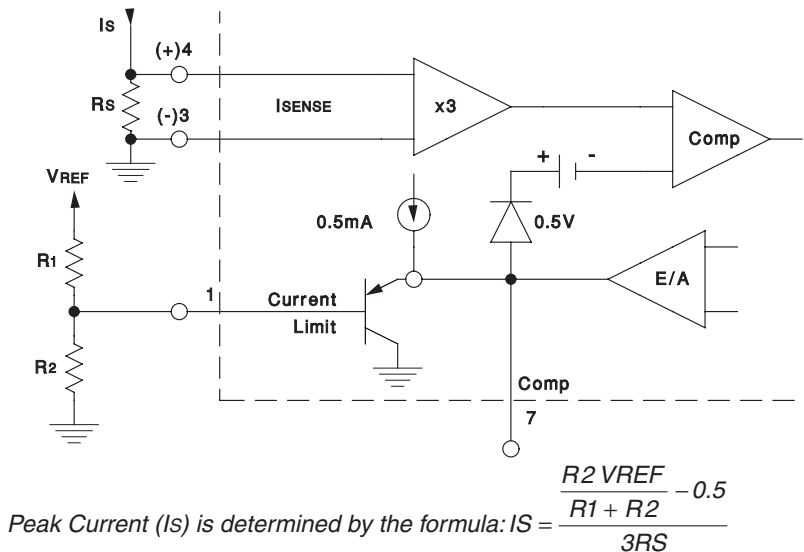


Parallel Operation

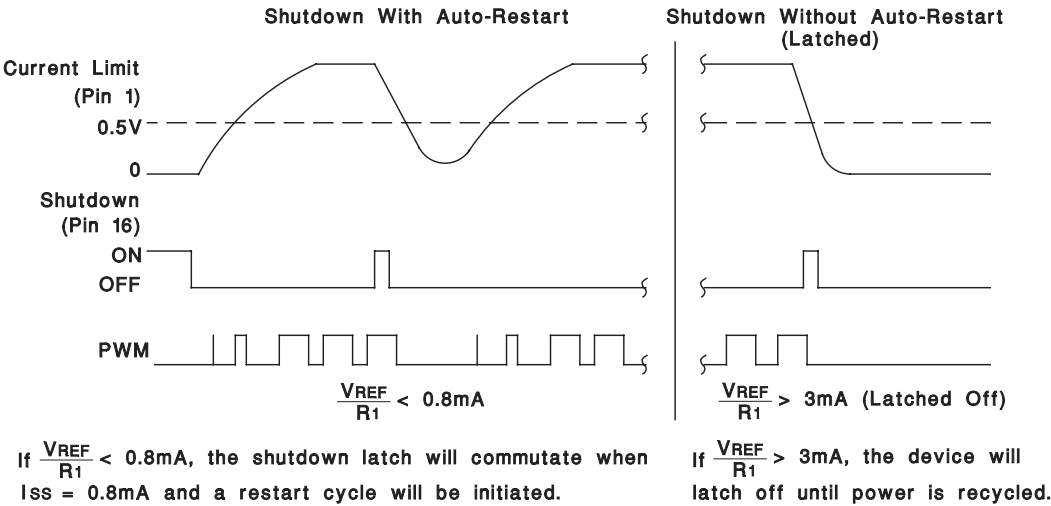
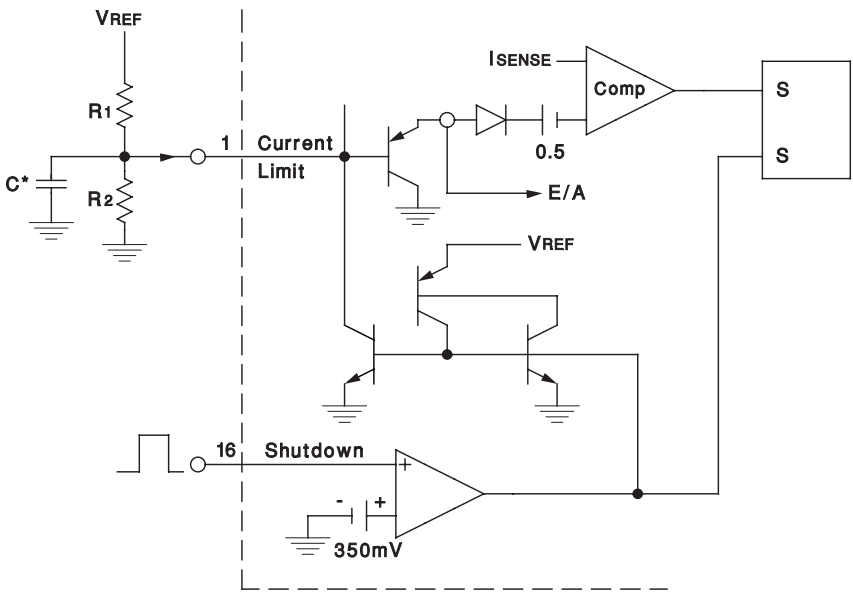


# APPLICATIONS DATA (cont.)

## Pulse by Pulse Current Limiting



## Soft Start and Shutdown /Restart Functions



*A small RC filter may be required in some applications to reduce switch transients. Differential input allows remote, noise free sensing.*

The diagram shows a UC1846 motor driver circuit with the following components and connections:

- Timing Resistor (Pin 9):** Connected to a potentiometer for "Freq. Set & Max Duty Cycle Rt" with values 150k, 10k, and 1.8k.
- Timing Cap (Pin 8):** Connected to a potentiometer for "Timing Cap Ct" with values 0.1μF, 1nF, and 4.7nF.
- Is+ (Pin 4):** Connected to a 1k resistor and a potentiometer for "ISENSE Adjust (≈1V PK)".
- Comp (Pin 7):** Connected to a potentiometer for "Duty Cycle Adjust".
- Inv (Pin 6):** Connected to a 1k resistor and a potentiometer for "Current Limit Adjust".
- Non (Pin 5):** Connected to a 1k resistor and a potentiometer for "Current Limit Adjust".
- Is+ (Pin 3):** Connected to a 0.1μF capacitor for "IL Adj".
- VREF (+5V Output) (Pin 2):** Connected to a 0.1μF capacitor.
- VIN (+12V) (Pin 15):** Connected to a 0.1μF capacitor.
- Shutdown (Pin 16):** Connected to a 0.1μF capacitor and a 2k resistor.
- Out A (Pin 14):** Connected to a 150Ω resistor.
- Out B (Pin 11):** Connected to a 150Ω resistor.
- Gnd (Pin 12):** Connected to ground.
- Ground for Normal Operation (Pin 3):** Connected to ground.

- Bypass Caps Should Be Low ESR & ESL Type
- Short Pins 6 & 7 for Unity Gain Testing

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-86806012A   | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type           |
| 5962-8680601EA   | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| 5962-8680601V2A  | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| 5962-8680601VEA  | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| UC1846J          | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| UC1846J/80257    | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC1846J/80364    | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC1846J/80619    | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC1846J883B      | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| UC1846JQMLV      | ACTIVE                | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC1846L883B      | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type           |
| UC1846LQMLV      | ACTIVE                | LCCC         | FK              | 20   |             | TBD                     | Call TI          | Call TI                      |
| UC1847J          | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC1847J883B      | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC1847L          | OBSOLETE              | LCCC         | FK              | 20   |             | TBD                     | Call TI          | Call TI                      |
| UC1847L883B      | OBSOLETE              | LCCC         | FK              | 20   |             | TBD                     | Call TI          | Call TI                      |
| UC2846DW         | ACTIVE                | SOIC         | DW              | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2846DWG4       | ACTIVE                | SOIC         | DW              | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2846DWTR       | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2846DWTRG4     | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2846J          | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| UC2846N          | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |
| UC2846NG4        | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |
| UC2846Q          | ACTIVE                | PLCC         | FN              | 20   | 46          | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1 YEAR          |
| UC2846QTR        | ACTIVE                | PLCC         | FN              | 20   | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1 YEAR          |
| UC2846QTRG3      | ACTIVE                | PLCC         | FN              | 20   | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1 YEAR          |
| UC2847DW         | ACTIVE                | SOIC         | DW              | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2847DWG4       | ACTIVE                | SOIC         | DW              | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2847DWTR       | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2847DWTRG4     | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC2847N          | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |
| UC2847NG4        | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| no Sb/Br)        |                       |              |                 |      |             |                         |                  |                              |
| UC3846DW         | ACTIVE                | SOIC         | DW              | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC3846DWTR       | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC3846DWTRG4     | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC3846J          | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| UC3846N          | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |
| UC3846NG4        | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |
| UC3846Q          | ACTIVE                | PLCC         | FN              | 20   | 46          | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1 YEAR          |
| UC3846QG3        | ACTIVE                | PLCC         | FN              | 20   | 46          | TBD                     | Call TI          | Call TI                      |
| UC3846QTR        | ACTIVE                | PLCC         | FN              | 20   | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1 YEAR          |
| UC3846QTRG3      | ACTIVE                | PLCC         | FN              | 20   | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1 YEAR          |
| UC3847DW         | ACTIVE                | SOIC         | DW              | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC3847DWG4       | ACTIVE                | SOIC         | DW              | 16   | 40          | TBD                     | Call TI          | Call TI                      |
| UC3847DWTR       | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC3847DWTRG4     | ACTIVE                | SOIC         | DW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| UC3847J          | OBSOLETE              | CDIP         | J               | 16   |             | TBD                     | Call TI          | Call TI                      |
| UC3847N          | ACTIVE                | PDIP         | N               | 16   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | N / A for Pkg Type           |
| UC3847NG4        | ACTIVE                | PDIP         | N               | 16   | 25          | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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