

# Isolated Feedback Generator

## FEATURES

- An Amplitude-Modulation System for Transformer Coupling an Isolated Feedback Error Signal
- Low-Cost Alternative to Optical Couplers
- Internal 1% Reference and Error Amplifier
- Internal Carrier Oscillator Usable to 5MHz
- Modulator Synchronizable to an External Clock
- Loop Status Monitor

## DESCRIPTION

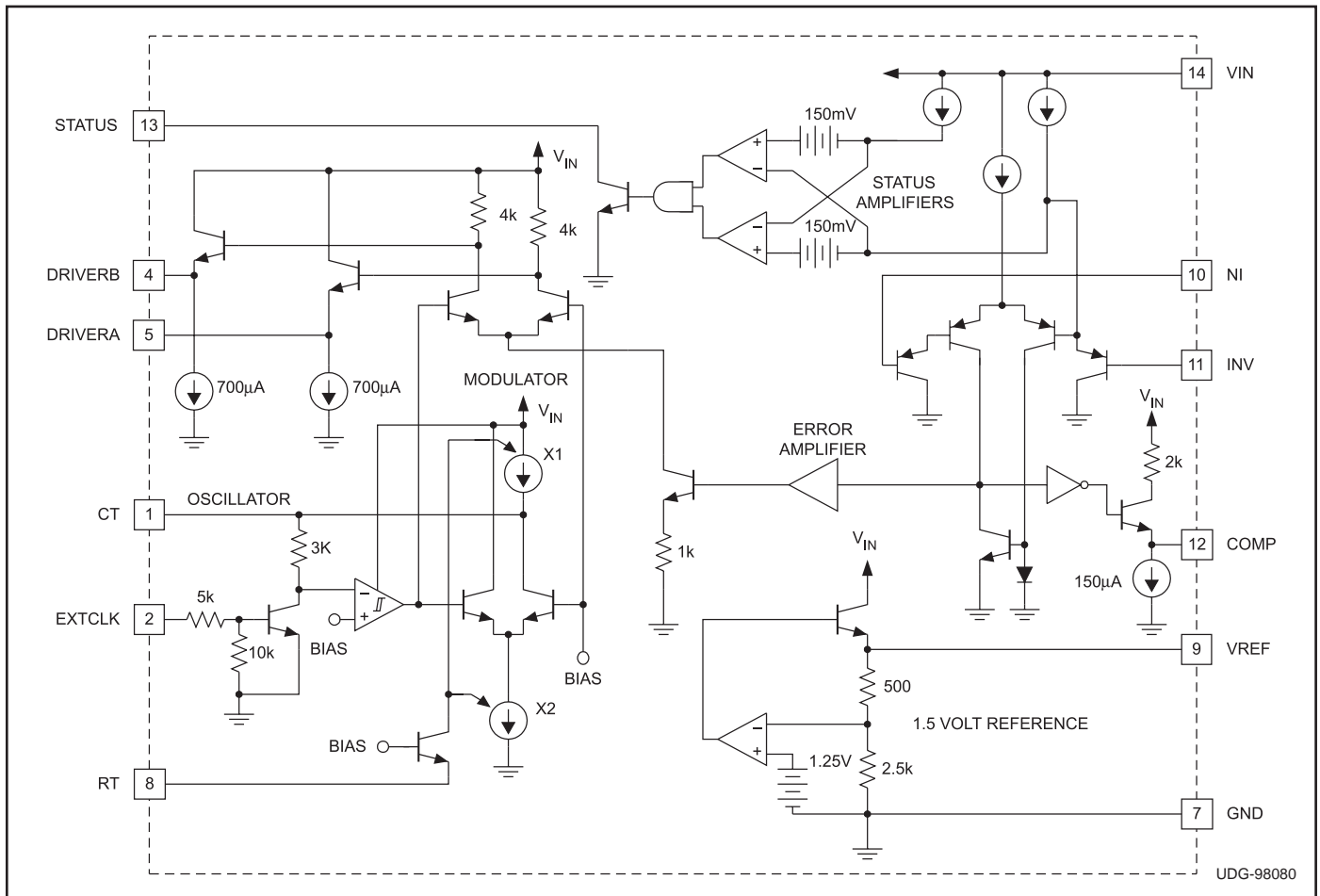
The UC1901 family is designed to solve many of the problems associated with closing a feedback control loop across a voltage isolation boundary. As a stable and reliable alternative to an optical coupler, these devices feature an amplitude modulation system which allows a loop error signal to be coupled with a small RF transformer or capacitor.

The programmable, high-frequency oscillator within the UC1901 series permits the use of smaller, less expensive transformers which can readily be built to meet the isolation requirements of today's line-operated power systems. As an alternative to RF operation, the external clock input to these devices allows synchronization to a system clock or to the switching frequency of a SMPS.

An additional feature is a status monitoring circuit which provides an active-low output when the sensed error voltage is within  $\pm 10\%$  of the reference. The DRIVERB output, DRIVERA output, and STATUS output are disabled until the input supply has reached a sufficient level to allow proper operation of the device.

Since these devices can also be used as a DC driver for optical couplers, the benefits of 4.5 to 40V supply operation, a 1% accurate reference, and a high gain general purpose amplifier offer advantages even though an AC system may not be desired.

## UC1901 SIMPLIFIED SCHEMATIC



### ABSOLUTE MAXIMUM RATINGS (Note 1)

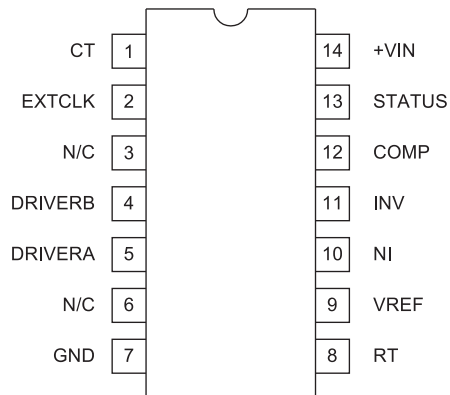
|   |                 |
|---|-----------------|
| Input Supply Voltage, $V_{IN}$ .....                | 40V             |
| Reference Output Current .....                      | -10mA           |
| Driver Output Currents .....                        | -35mA           |
| Status Indicator Voltage .....                      | 40V             |
| Status Indicator Current .....                      | 20mA            |
| Ext. Clock Input .....                              | 40V             |
| Error Amplifier Inputs .....                        | -0.5V to +35V   |
| Power Dissipation at $T_A = 25^\circ\text{C}$ ..... | 1000mW          |
| Power Dissipation at $T_c = 25^\circ\text{C}$ ..... | 2000mW          |
| Operating Junction Temperature .....                | -55°C to +150°C |
| Storage Temperature .....                           | -65°C to +150°C |
| Lead Temperature (Soldering, 10 seconds) .....      | 300°C           |

**Note 1:** Voltages are referenced to ground, Pin 7. Currents are positive into, negative out of the specified terminal.

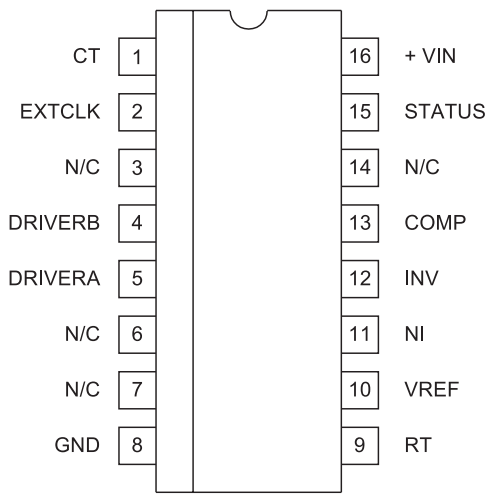
**Note 2:** Consult Packaging section of Databook for thermal limitations and considerations of package.

### CONNECTION DIAGRAMS

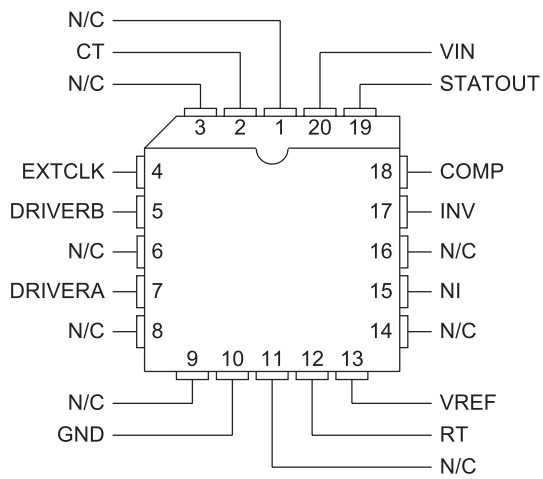
#### DIL-14, SOIC-14 (TOP VIEW) J or N Package, D Package



#### SOIC-16 Wide (TOP VIEW) DW Package



#### PLCC-20, LCC-20 (TOP VIEW) Q, L Packages



### TEMPERATURE AND PACKAGE SELECTION GUIDE

|        | TEMPERATURE RANGE | AVAILABLE PACKAGES |
|--------|-------------------|--------------------|
| UC1901 | -55°C to +125°C   | J, L               |
| UC2901 | -40°C to +85°C    | D, DW, J, N, Q     |
| UC3901 | 0°C to +70°C      | D, DW, J, N, Q     |

**ELECTRICAL CHARACTERISTICS** Unless otherwise stated, these specifications apply for  $V_{IN} = 10V$ ,  $R_T = 10k\Omega$ ,  $C_T = 820pF$ ,  $T_A = T_J$ .

| PARAMETER  | TEST CONDITIONS                                | UC1901/UC2901 |           |           | UC3901    |           |           | UNITS      |
|--|--|---------------|-----------|-----------|-----------|-----------|-----------|------------|
|  |  | MIN           | TYP       | MAX       | MIN       | TYP       | MAX       |            |
| <b>Reference Section</b>                                       |  |               |           |           |           |           |           |            |
| Output Voltage   | $T_J = 25^\circ C$                             | 1.485         | 1.5       | 1.515     | 1.47      | 1.5       | 1.53      | V          |
|  | $T_{MIN} \leq T_J \leq T_{MAX}$                | 1.470         | 1.5       | 1.530     | 1.455     | 1.5       | 1.545     |            |
| Line Regulation  | $V_{IN} = 4.5$ to $35V$                        |               | 2         | 10        |           | 2         | 15        | mV         |
| Load Regulation  | $I_{OUT} = 0$ to $5mA$                         |               | 4         | 10        |           | 4         | 15        | mV         |
| Short Circuit Current  | $T_J = 25^\circ C$                             |               | -35       | -55       |           | -35       | -55       | mV         |
| <b>Error Amplifier Section (To Compensation Terminal)</b>      |  |               |           |           |           |           |           |            |
| Input Offset Voltage   | $V_{CM} = 1.5V$                                |               | 1         | 4         |           | 1         | 8         | mV         |
| Input Bias Current   | $V_{CM} = 1.5V$                                |               | -1        | -3        |           | -1        | -6        | $\mu A$    |
| Input Offset Current   | $V_{CM} = 1.5V$                                |               | 0.1       | 1         |           | 0.1       | 2         | $\mu A$    |
| Small Signal Open Loop Gain                                    |  | 40            | 60        |           | 40        | 60        |           | dB         |
| CMRR   | $V_{CM} = 0.5$ to $7.5V$                       | 60            | 80        |           | 60        | 80        |           | dB         |
| PSRR   | $V_{IN} = 5$ to $25V$                          | 80            | 100       |           | 80        | 100       |           | dB         |
| Output Swing, $\Delta V_o$                                     |  | 0.4           | 0.7       |           | 0.4       | 0.7       |           | V          |
| Maximum Sink Current   |  | 90            | 150       |           | 90        | 150       |           | $\mu A$    |
| Maximum Source Current   |  | -2            | -3        |           | -2        | -3        |           | mA         |
| Gain Band Width Product  |  |               | 1         |           |           | 1         |           | MHz        |
| Slew Rate  |  |               | 0.3       |           |           | 0.3       |           | V/ $\mu S$ |
| <b>Modulators/Drivers Section (From Compensation Terminal)</b> |  |               |           |           |           |           |           |            |
| Voltage Gain   |  | 11            | 12        | 13        | 10        | 12        | 14        | dB         |
| Output Swing   |  | $\pm 1.6$     | $\pm 2.8$ |           | $\pm 1.6$ | $\pm 2.8$ |           | V          |
| Driver Sink Current  |  | 500           | 700       |           | 500       | 700       |           | $\mu A$    |
| Driver Source Current  |  | -15           | -35       |           | -15       | -35       |           | mA         |
| Gain Band Width Product  |  |               | 25        |           |           | 25        |           | MHz        |
| <b>Oscillator Section</b>                                      |  |               |           |           |           |           |           |            |
| Initial Accuracy   | $T_J = 25^\circ C$                             | 140           | 150       | 160       | 130       | 150       | 170       | kHz        |
|  | $T_{MIN} \leq T_J \leq T_{MAX}$                | 130           |           | 170       | 120       |           | 180       | kHz        |
| Line Sensitivity   | $V_{IN} = 5$ to $35V$                          |               | .15       | .35       |           | .15       | .60       | %/V        |
| Maximum Frequency  | $R_T = 10k$ , $C_T = 10pF$                     |               | 5         |           |           | 5         |           | MHz        |
| Ext. Clock Low Threshold                                       | Pin 1 ( $C_T$ ) = $V_{IN}$                     | 0.5           |           |           | 0.5       |           |           | V          |
| Ext. Clock High Threshold                                      | Pin 1 ( $C_T$ ) = $V_{IN}$                     |               |           | 1.6       |           |           | 1.6       | V          |
| <b>Status Indicator Section</b>                                |  |               |           |           |           |           |           |            |
| Input Voltage Window   | @ E/A Inputs, $V_{CM} = 1.5V$                  | $\pm 135$     | $\pm 150$ | $\pm 165$ | $\pm 130$ | $\pm 150$ | $\pm 170$ | mV         |
| Saturation Voltage   | E/A $\Delta$ Input = $0V$ , $I_{SINK} = 1.6mA$ |               |           | 0.45      |           |           | 0.45      | V          |
| Max. Output Current  | Pin 13 = $3V$ , E/A $\Delta$ Input = $0.0V$    | 8             | 15        |           | 8         | 15        |           | mA         |
| Leakage Current  | Pin 13 = $40V$ , E/A $\Delta$ Input = $0.2V$   |               | .05       | 1         |           | .05       | 5         | $\mu A$    |
| Supply Current   | $V_{IN} = 35V$                                 |               | 5         | 8         |           | 5         | 10        | mA         |
| <b>UVLO Section</b>  |  |               |           |           |           |           |           |            |
| Drivers Enabled Threshold                                      | At Input Supply $V_{IN}$                       |               | 3.9       | 4.5       |           | 3.9       | 4.5       | V          |
| Status Output Enabled Threshold                                | At Input Supply $V_{IN}$                       |               | 3.9       | 4.5       |           | 3.9       | 4.5       | V          |
| Change in Reference Output                                     | When $V_{IN}$ Reaches UVLO Threshold           |               | -2        | -30       |           | -2        | -30       | mV         |

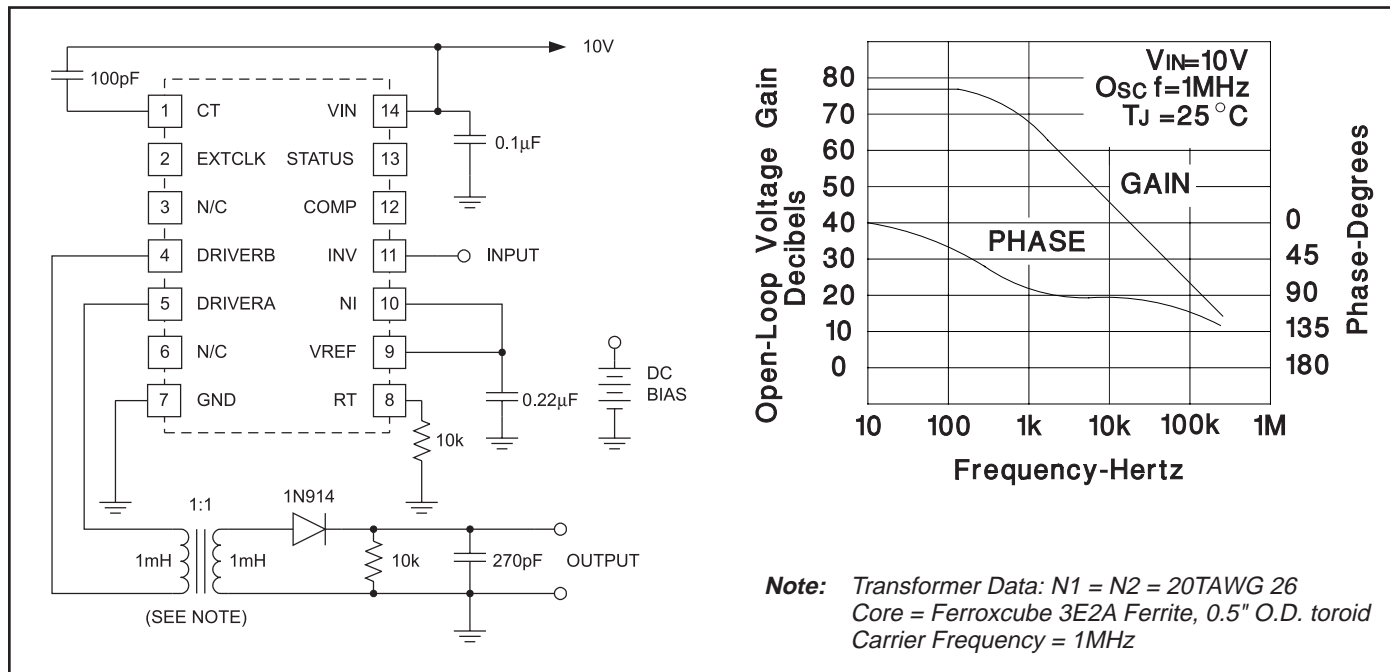


Figure 1. Transformer Coupled Open Loop Transfer Function

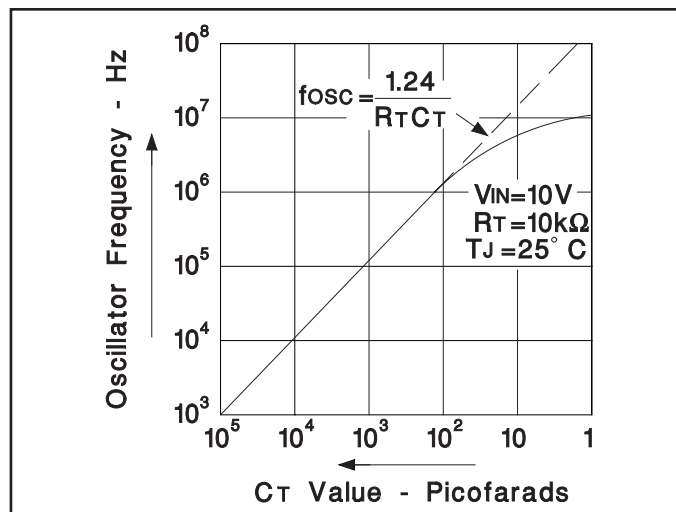


Figure 2. Oscillator Frequency

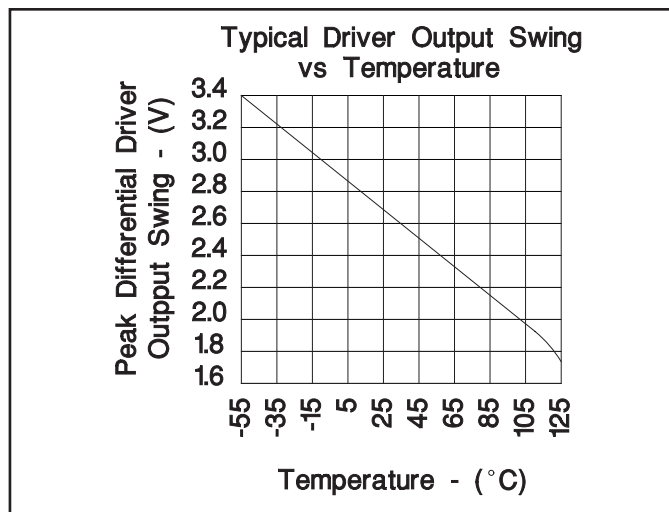


Figure 3. Typical Driver Output Swing vs Temperature

## APPLICATION INFORMATION

The error amplifier compensation terminal, Pin 12, is intended as a source of feedback to the amplifier's inverting input at Pin 11. For most applications, a series DC blocking capacitor should be part of the feedback network. The amplifier is internally compensated for unity feedback.

The waveform at the driver outputs is a squarewave with an amplitude that is proportional to the error amplifier input signal. There is a fixed 12dB of gain from the error amplifier compensation pin to the modulator driver outputs. The frequency of the output waveform is controlled by either the internal oscillator or an external clock signal.

With the internal oscillator the squarewave will have a fixed 50% duty cycle. If the internal oscillator is disabled by connecting Pin 1,  $C_R$ , to  $V_{IN}$  then the frequency and duty cycle of the output will be determined by the input clock waveform at Pin 2. If the oscillator remains disabled and there is not clock input at Pin 2, there will be a linear 12dB of signal gain to one or the other of the driver outputs depending on the DC state of Pin 2.

The driver outputs are emitter followers which will source a minimum of 15mA of current. The sink current, internally limited at 700 $\mu$ A, can be increased by adding resistors to ground at the driver outputs.

APPLICATION INFORMATION (continued)

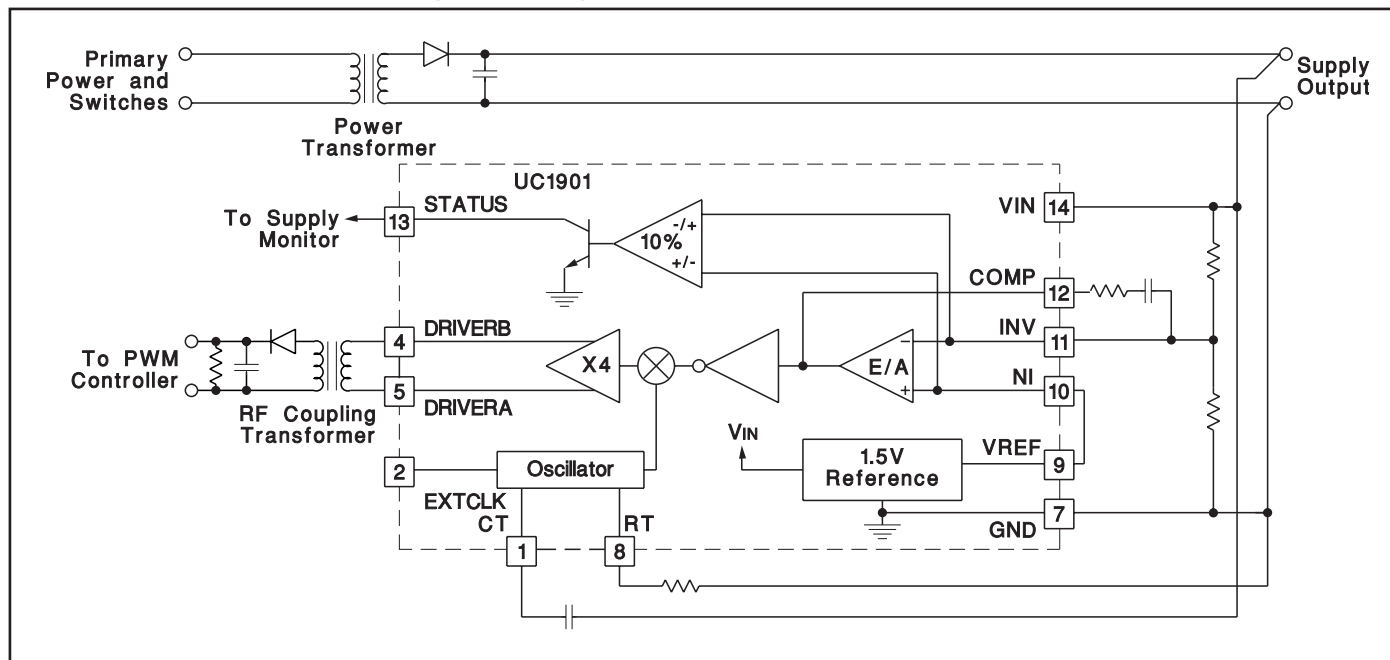


Figure 4. R.F. Transformer Coupled Feedback

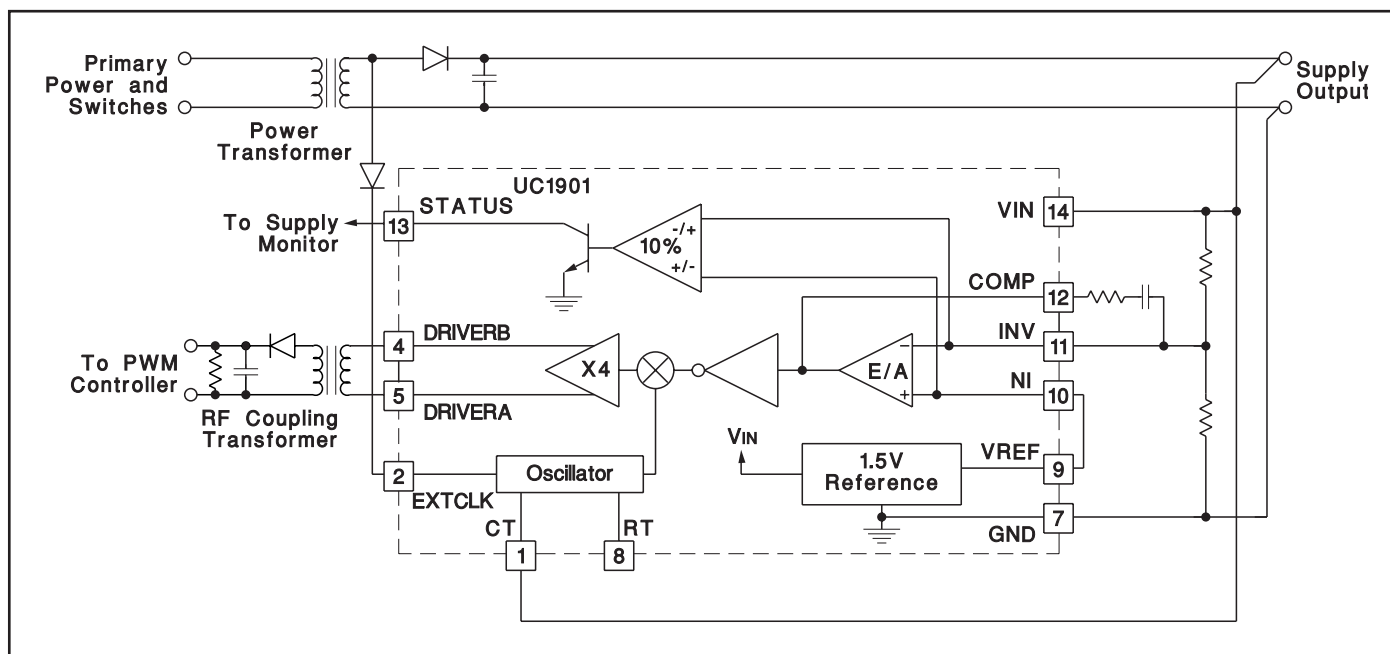
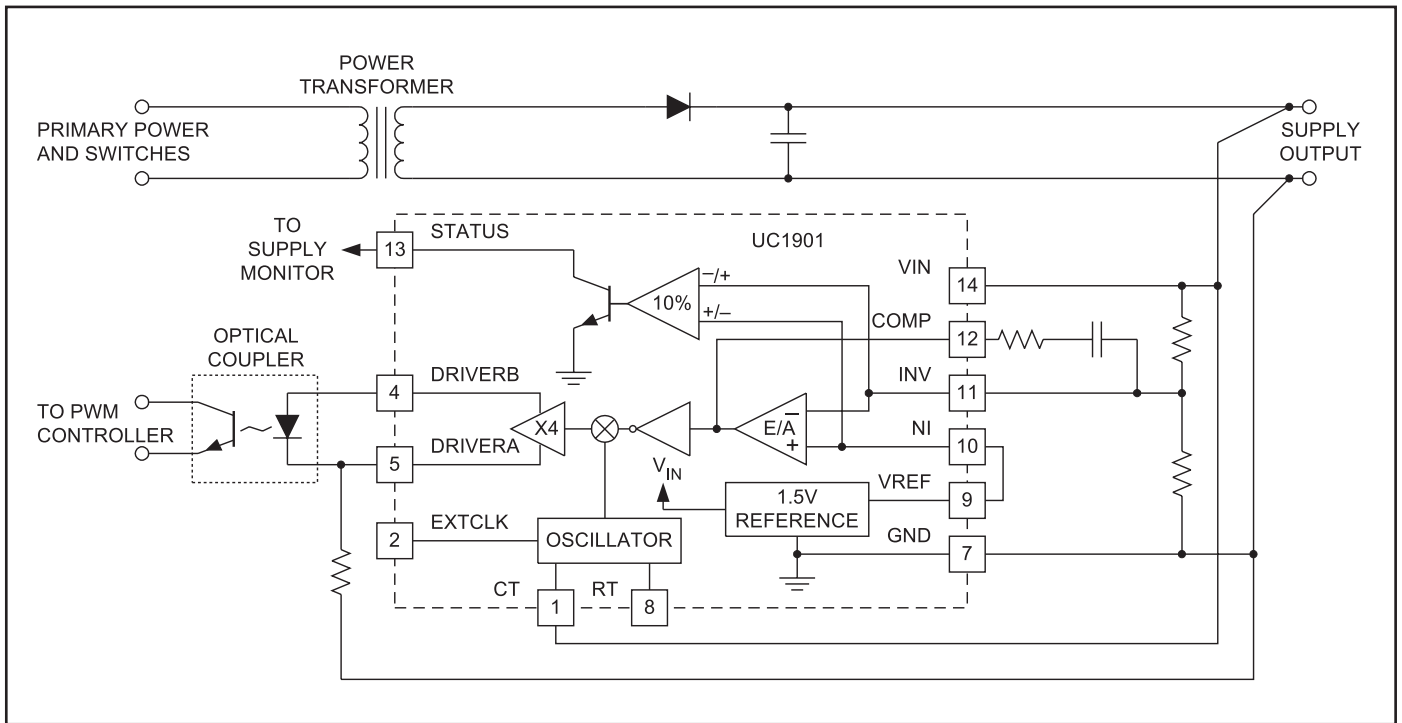


Figure 5. Feedback Coupled at Switching Frequency



## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)  | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)            | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|------------------|--------------------------------------|----------------------|--------------|------------------------------------|-------------------------|
| 5962-89441012A   | ACTIVE        | LCCC         | FK              | 20   | 55          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-89441012A<br>UC1901L/<br>883B | <a href="#">Samples</a> |
| 5962-8944101CA   | ACTIVE        | CDIP         | J               | 14   | 25          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-8944101CA<br>UC1901J/883B     | <a href="#">Samples</a> |
| 5962-8944101VCA  | ACTIVE        | CDIP         | J               | 14   | 25          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-8944101VCA<br>UC1901JQMLV     | <a href="#">Samples</a> |
| UC1901J          | ACTIVE        | CDIP         | J               | 14   | 25          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | UC1901J                            | <a href="#">Samples</a> |
| UC1901J883B      | ACTIVE        | CDIP         | J               | 14   | 25          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-8944101CA<br>UC1901J/883B     | <a href="#">Samples</a> |
| UC1901L          | ACTIVE        | LCCC         | FK              | 20   | 55          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | UC1901L                            | <a href="#">Samples</a> |
| UC1901L883B      | ACTIVE        | LCCC         | FK              | 20   | 55          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-89441012A<br>UC1901L/<br>883B | <a href="#">Samples</a> |
| UC2901D          | ACTIVE        | SOIC         | D               | 14   | 50          | RoHS & Green     | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | UC2901D                            | <a href="#">Samples</a> |
| UC2901DTR        | ACTIVE        | SOIC         | D               | 14   | 2500        | RoHS & Green     | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | UC2901D                            | <a href="#">Samples</a> |
| UC2901J          | ACTIVE        | CDIP         | J               | 14   | 25          | Non-RoHS & Green | SNPB                                 | N / A for Pkg Type   | -40 to 85    | UC2901J                            | <a href="#">Samples</a> |
| UC2901N          | ACTIVE        | PDIP         | N               | 14   | 25          | RoHS & Green     | NIPDAU                               | N / A for Pkg Type   | -40 to 85    | UC2901N                            | <a href="#">Samples</a> |
| UC3901D          | ACTIVE        | SOIC         | D               | 14   | 50          | RoHS & Green     | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | UC3901D                            | <a href="#">Samples</a> |
| UC3901DTR        | LIFEBUY       | SOIC         | D               | 14   | 2500        | RoHS & Green     | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | UC3901D                            |                         |
| UC3901DW         | LIFEBUY       | SOIC         | DW              | 16   | 40          | RoHS & Green     | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | UC3901DW                           |                         |
| UC3901N          | LIFEBUY       | PDIP         | N               | 14   | 25          | RoHS & Green     | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | UC3901N                            |                         |

(1) 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> **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> **Lead finish/Ball material** - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF UC1901, UC1901-SP, UC2901, UC2901-MIL, UC3901 :**

● Catalog : [UC3901](#), [UC1901](#)

● Enhanced Product : [UC2901-EP](#), [UC2901-EP](#)

● Military : [UC1901](#)

● Space : [UC1901-SP](#), [UC1901-SP](#)

NOTE: Qualified Version Definitions:



- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

| Device    | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-----------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| UC2901DTR | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| UC3901DTR | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device    | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------|--------------|-----------------|------|------|-------------|------------|-------------|
| UC2901DTR | SOIC         | D               | 14   | 2500 | 356.0       | 356.0      | 35.0        |
| UC3901DTR | SOIC         | D               | 14   | 2500 | 356.0       | 356.0      | 35.0        |

**TUBE**


\*All dimensions are nominal

| Device         | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| 5962-89441012A | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| UC1901L        | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| UC1901L883B    | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| UC2901D        | D            | SOIC         | 14   | 50  | 506.6  | 8      | 3940   | 4.32   |
| UC2901N        | N            | PDIP         | 14   | 25  | 506    | 13.97  | 11230  | 4.32   |
| UC3901D        | D            | SOIC         | 14   | 50  | 506.6  | 8      | 3940   | 4.32   |
| UC3901DW       | DW           | SOIC         | 16   | 40  | 507    | 12.83  | 5080   | 6.6    |
| UC3901N        | N            | PDIP         | 14   | 25  | 506    | 13.97  | 11230  | 4.32   |

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