

# 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

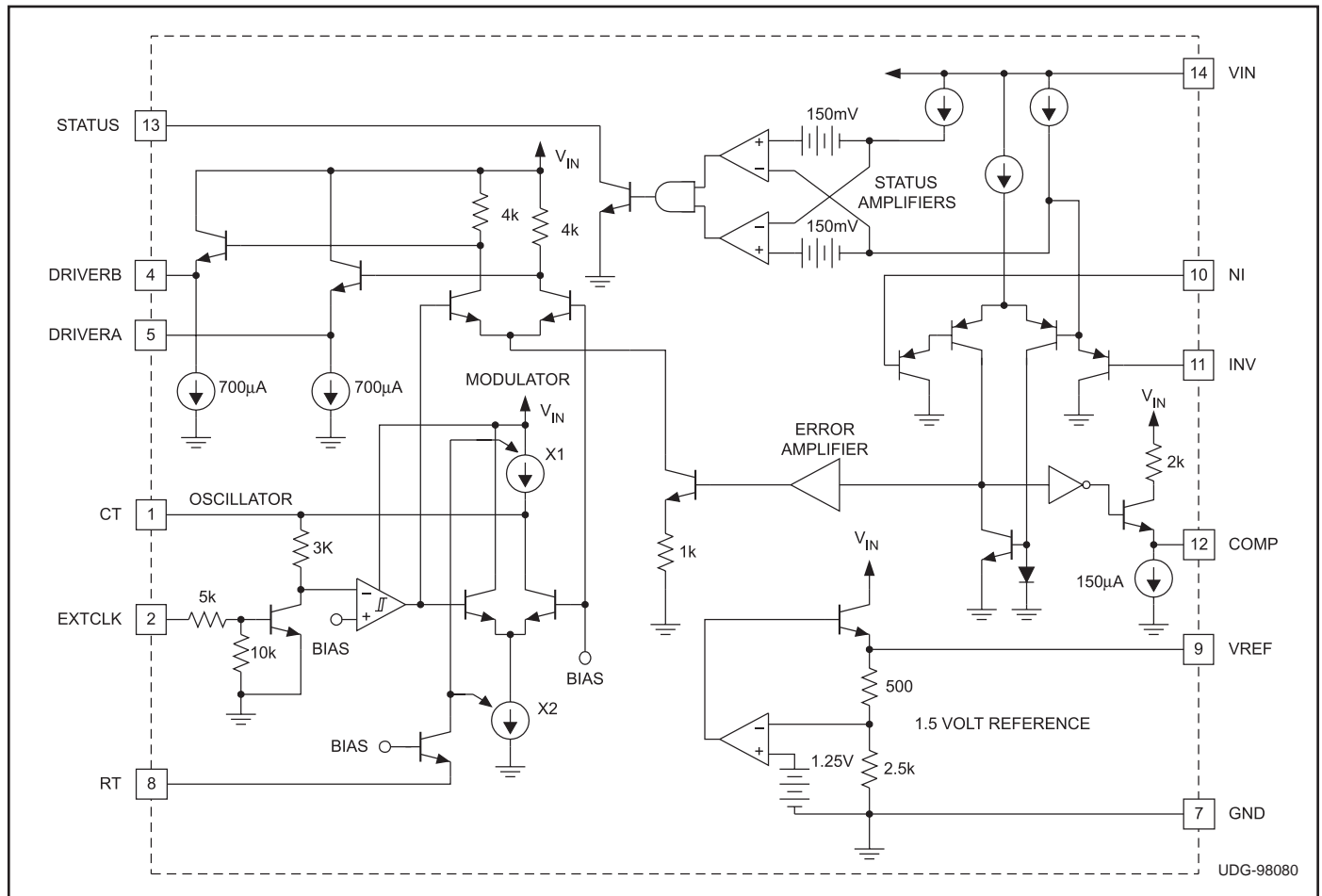
The UC1901 family is designed to solve many of the problems associated with closing a feedback control loop across a voltage isolation boundary. As a stable and reliable alternative to an optical coupler, these devices feature an amplitude modulation system which allows a loop error signal to be coupled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

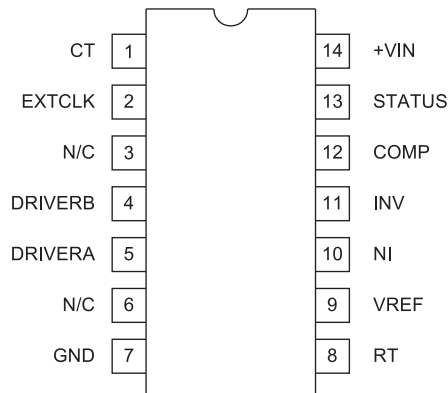
Input Supply Voltage, $V_{IN}$	40V
Reference Output Current	–10mA
Driver Output Currents	–35mA
Status Indicator Voltage	40V
Status Indicator Current	20mA
Ext. Clock Input	40V
Error Amplifier Inputs	–0.5V to +35V
Power Dissipation at $T_A = 25^{\circ}\text{C}$	1000mW
Power Dissipation at $T_c = 25^{\circ}\text{C}$	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.

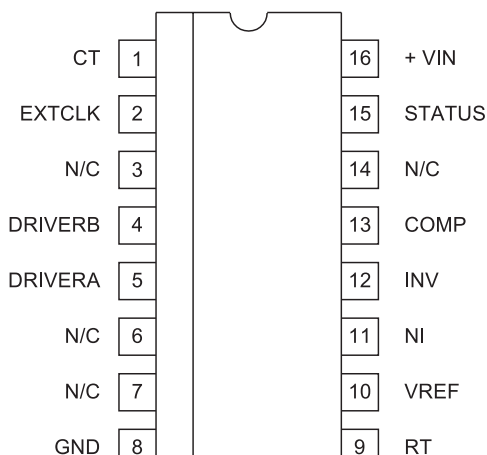
**Note 2:** Consult Packaging section of Databook for thermal limitations and considerations of package.

## CONNECTION DIAGRAMS

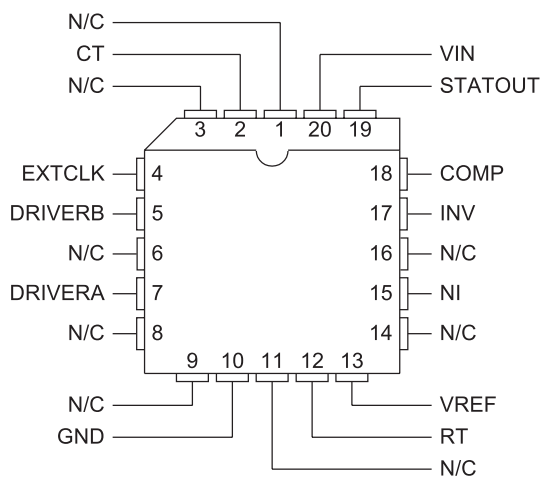
### DIL-14, SOIC-14 (TOP VIEW) J or N Package, D Package



### 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	
Reference Section										
Output Voltage	T <sub>J</sub> = 25°C	1.485	1.5	1.515	1.47	1.5	1.53	V		
	T <sub>MIN</sub> ≤ T <sub>J</sub> ≤ T <sub>MAX</sub>	1.470	1.5	1.530	1.455	1.5	1.545			
Line Regulation	V <sub>IN</sub> = 4.5 to 35V		2	10		2	15	mV		
Load Regulation	I <sub>OUT</sub> = 0 to 5mA		4	10		4	15	mV		
Short Circuit Current	T <sub>J</sub> = 25°C		−35	−55		−35	−55	mV		
Error Amplifier Section (To Compensation Terminal)										
Input Offset Voltage	V <sub>CM</sub> = 1.5V		1	4		1	8	mV		
Input Bias Current	V <sub>CM</sub> = 1.5V		−1	−3		−1	−6	μA		
Input Offset Current	V <sub>CM</sub> = 1.5V		0.1	1		0.1	2	μA		
Small Signal Open Loop Gain		40	60		40	60		dB		
CMRR	V <sub>CM</sub> = 0.5 to 7.5V	60	80		60	80		dB		
PSRR	V <sub>IN</sub> = 2 to 25V	80	100		80	100		dB		
Output Swing, Δ Vo		0.4	0.7		0.4	0.7		V		
Maximum Sink Current		90	150		90	150		μA		
Maximum Source Current		−2	−3		−2	−3		mA		
Gain Band Width Product			1			1		MHz		
Slew Rate			0.3			0.3		V/μS		
Modulators/Drivers Section (From Compensation Terminal)										
Voltage Gain		11	12	13	10	12	14	dB		
Output Swing		±1.6	±2.8		±1.6	±2.8		V		
Driver Sink Current		500	700		500	700		μA		
Driver Source Current		−15	−35		−15	−35		mA		
Gain Band Width Product			25			25		MHz		
Oscillator Section										
Initial Accuracy	T <sub>J</sub> = 25°C	140	150	160	130	150	170	kHz		
	T <sub>MIN</sub> ≤ T <sub>J</sub> ≤ T <sub>MAX</sub>	130		170	120		180	kHz		
Line Sensitivity	V <sub>IN</sub> = 5 to 35V		.15	.35		.15	.60	%/V		
Maximum Frequency	R <sub>T</sub> = 10k, C <sub>T</sub> = 10pF		5			5		MHz		
Ext. Clock Low Threshold	Pin 1 (C <sub>T</sub> ) = V <sub>IN</sub>	0.5			0.5			V		
Ext. Clock High Threshold	Pin 1 (C <sub>T</sub> ) = V <sub>IN</sub>			1.6			1.6	V		
Status Indicator Section										
Input Voltage Window	@ E/A Inputs, V <sub>CM</sub> = 1.5V	±135	±150	±165	±130	±150	±170	mV		
Saturation Voltage	E/A Δ Input = 0V, I <sub>SINK</sub> = 1.6mA			0.45			0.45	V		
Max. Output Current	Pin 13 = 3V, E/A Δ Input = 0.0V	8	15		8	15		mA		
Leakage Current	Pin 13 = 40V, E/A ΔInput = 0.2V		.05	1		.05	5	μA		
Supply Current	V <sub>IN</sub> = 35V		5	8		5	10	mA		
UVLO Section										
Drivers Enabled Threshold	At Input Supply V <sub>IN</sub>		3.9	4.5		3.9	4.5	V		
Status Output Enabled Threshold	At Input Supply V <sub>IN</sub>		3.9	4.5		3.9	4.5	V		
Change in Reference Output	When V <sub>IN</sub> Reaches UVLO Threshold		−2	−30		−2	−30	mV		

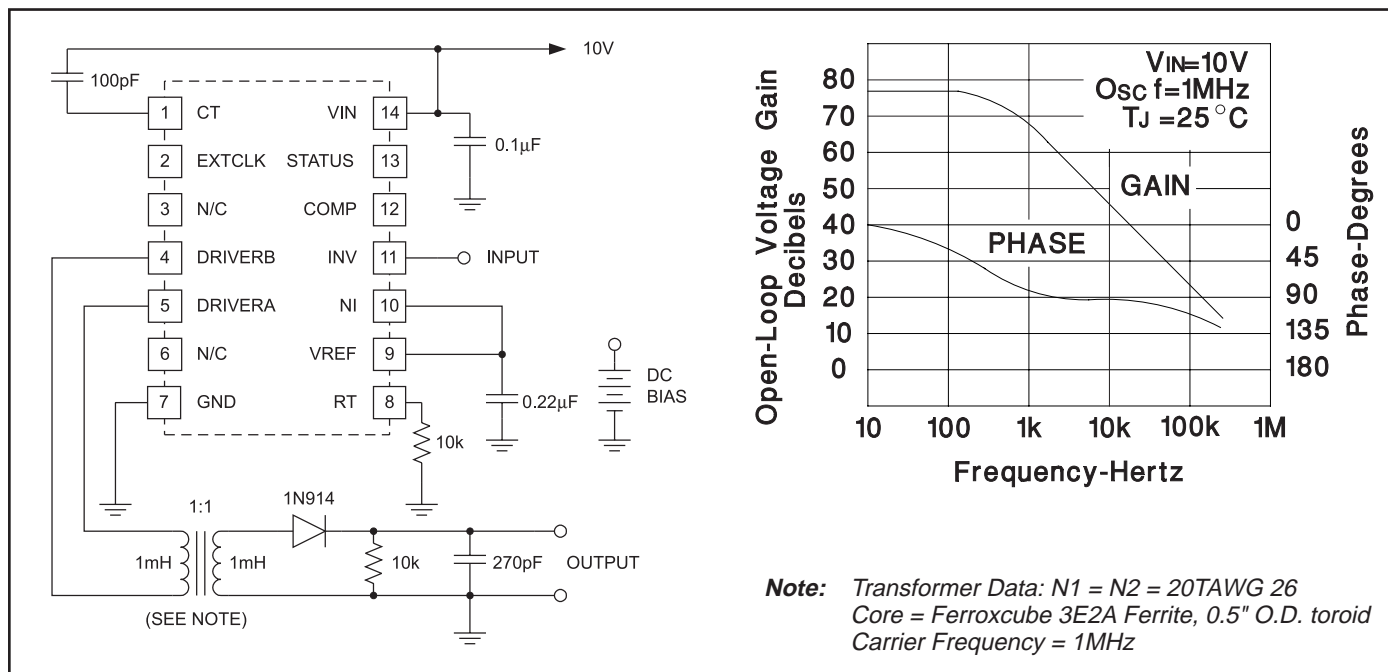


Figure 1. Transformer Coupled Open Loop Transfer Function

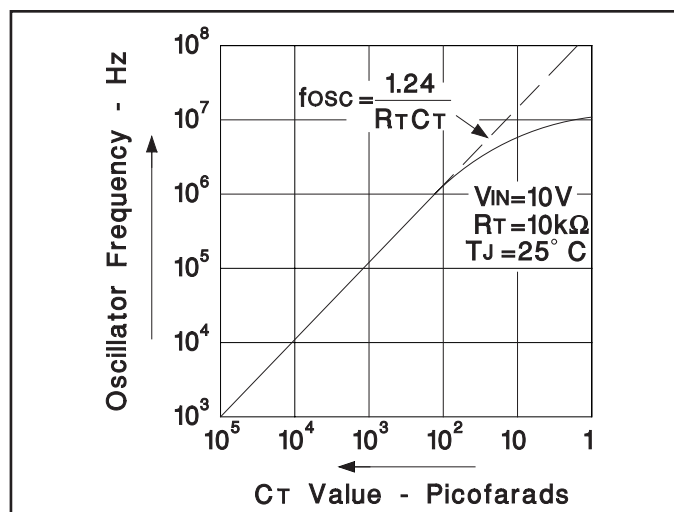


Figure 2. Oscillator Frequency

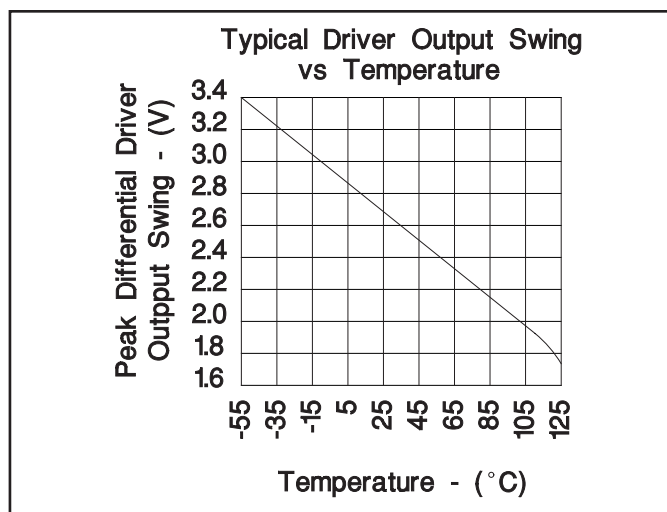


Figure 3. Typical Driver Output Swing vs Temperature

## 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 700μA, can be increased by adding resistors to ground at the driver outputs.

# APPLICATION INFORMATION (continued)

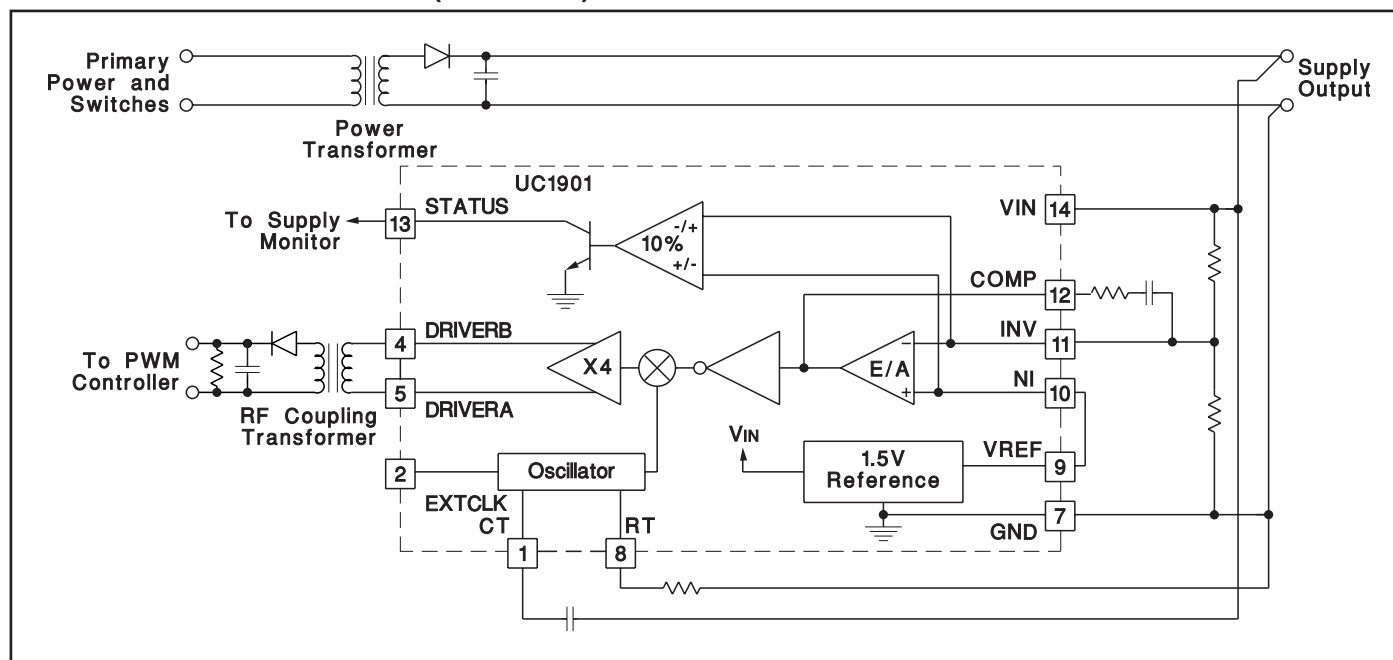


Figure 4. R.F. Transformer Coupled Feedback

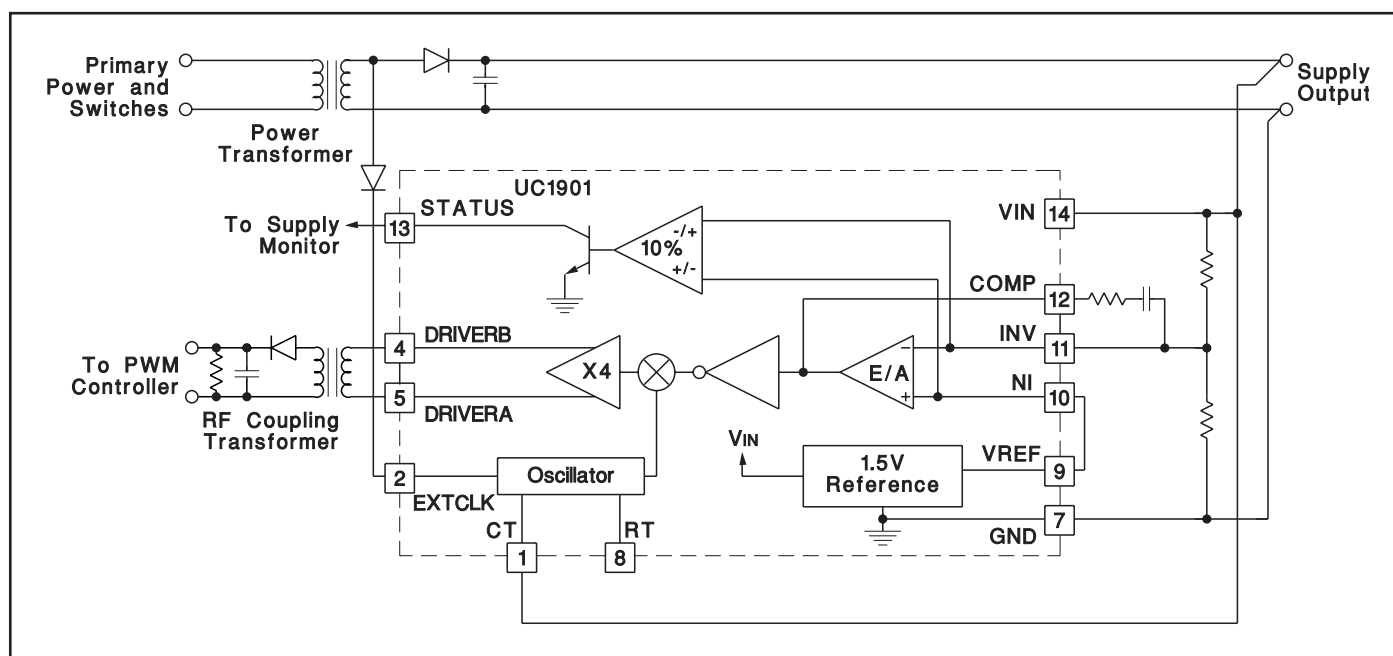
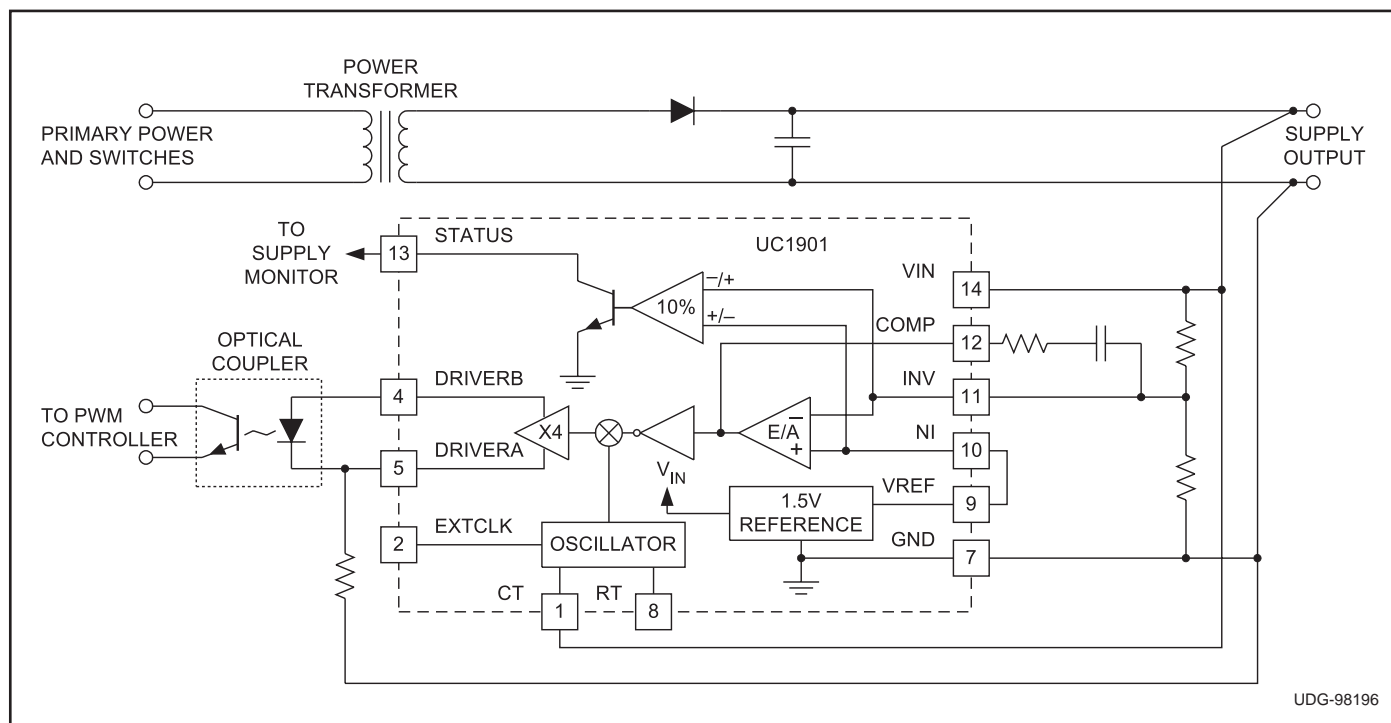


Figure 5. Feedback Coupled at Switching Frequency

## TYPICAL APPLICATION



**Figure 6. Optically Coupled DC Feedback**

**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>
5962-89441012A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
5962-8944101CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-8944101VCA	ACTIVE	CDIP	J	14	1	TBD	Call TI	Level-NC-NC-NC
UC1901J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
UC1901J883B	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
UC1901L	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
UC1901L883B	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
UC2901D	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM
UC2901DTR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
UC2901DW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC2901DWTR	ACTIVE	SOIC	DW	16	2000	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC2901J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
UC2901N	ACTIVE	PDIP	N	14	25	TBD	CU NIPDAU	Level-NA-NA-NA
UC2901Q	ACTIVE	PLCC	FN	20	46	TBD	CU SNPB	Level-2-220C-1 YEAR
UC2901QTR	ACTIVE	PLCC	FN	20	1000	TBD	CU SNPB	Level-2-220C-1 YEAR
UC3901D	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM
UC3901DTR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
UC3901DW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC3901DWTR	ACTIVE	SOIC	DW	16	2000	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC3901DWTRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
UC3901N	ACTIVE	PDIP	N	14	25	TBD	CU NIPDAU	Level-NA-NA-NA
UC3901Q	ACTIVE	PLCC	FN	20	46	TBD	CU SNPB	Level-2-220C-1 YEAR
UC3901QTR	ACTIVE	PLCC	FN	20	1000	TBD	CU SNPB	Level-2-220C-1 YEAR

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

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**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) 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.

**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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**PACKAGING INFORMATION**

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5962-89441012A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-8944101CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-8944101VCA	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type
UC1901J	ACTIVE	CDIP	J	14		TBD	A42 SNPB	N / A for Pkg Type
UC1901J883B	ACTIVE	CDIP	J	14		TBD	A42 SNPB	N / A for Pkg Type
UC1901L	ACTIVE	LCCC	FK	20		TBD	POST-PLATE	N / A for Pkg Type
UC1901L883B	ACTIVE	LCCC	FK	20		TBD	POST-PLATE	N / A for Pkg Type
UC2901D	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DG4	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DTR	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DTRG4	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DW	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DWG4	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DWTR	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901DWTRG4	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2901J	ACTIVE	CDIP	J	14		TBD	A42 SNPB	N / A for Pkg Type
UC2901N	ACTIVE	PDIP	N	14		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC2901NG4	ACTIVE	PDIP	N	14		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC2901Q	ACTIVE	PLCC	FN	20		Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR
UC3901D	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901DTR	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901DTRG4	ACTIVE	SOIC	D	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901DW	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901DWG4	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901DWTR	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901DWTRG4	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3901J	ACTIVE	CDIP	J	14		TBD	A42 SNPB	N / A for Pkg Type
UC3901N	ACTIVE	PDIP	N	14		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC3901Q	ACTIVE	PLCC	FN	20		Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR

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)								
UC3901QG3	ACTIVE	PLCC	FN	20		Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR
UC3901QTR	ACTIVE	PLCC	FN	20		Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR
UC3901QTRG3	ACTIVE	PLCC	FN	20		Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR

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**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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Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
		Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
		Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
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