

## LM1391 Phase-Locked Loop

### General Description

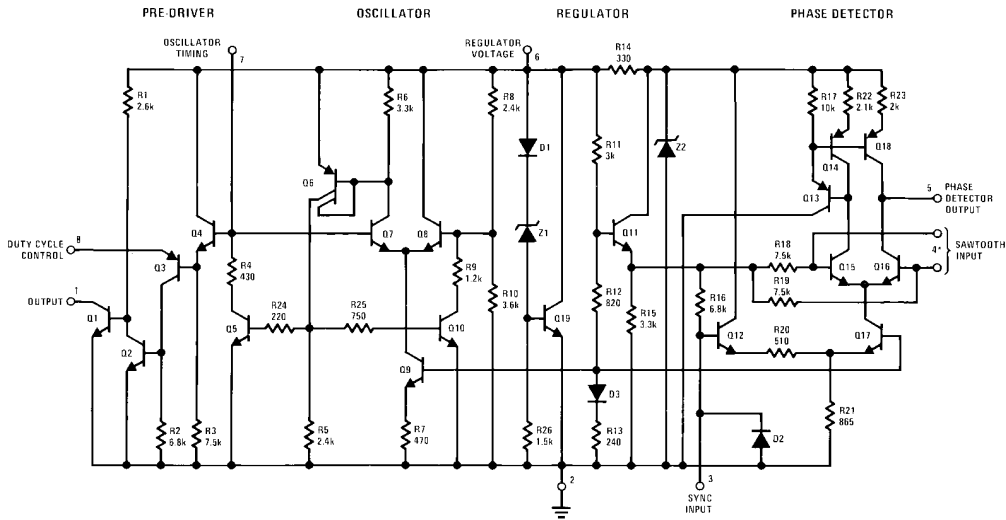
The LM1391 integrated circuit has been designed primarily for use in the horizontal section of TV receivers, but may find use in other low frequency signal processing applications. It includes a stable VCO, linear pulse phase detector, and variable duty cycle output driver.

### Features

- Internal active regulator for improved supply rejection
- Uncommitted collector of output transistor

- Output transistor with low saturation and high voltage swing
- APC of the oscillator with a synchronizing signal
- DC controlled output duty cycle
- $\pm 300$  Hz typical pull-in
- Linear balanced phase detector
- Low thermal frequency drift
- Small static phase error
- Adjustable DC loop gain

### Schematic Diagram



(\*) Pin 4 Base of Q16 (LM1391) for use with (+) flyback pulse

TL/H/7889-1

## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

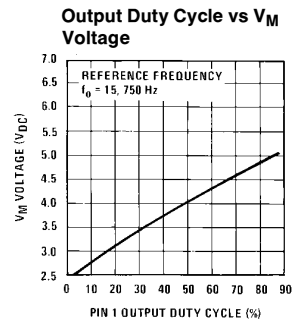
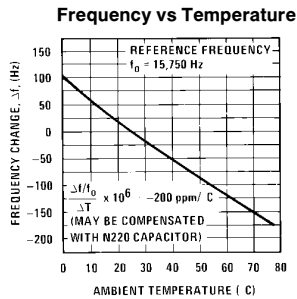
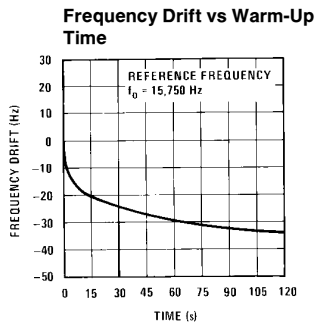
Supply Current	40 mA <sub>DC</sub>	Flyback Input Voltage (Pin 4)	5.0 V <sub>p-p</sub>
Output Voltage	40 V <sub>DC</sub>	Power Dissipation (Package Limitation) Plastic Package (Note 1)	1000 mW
Output Current	30 mA <sub>DC</sub>	Operating Temperature Range (Ambient)	0°C to +70°C
Sync Input Voltage (Pin 3)	5.0 V <sub>p-p</sub>	Storage Temperature Range	-65°C to +150°C
		Lead Temperature (Soldering, 10 sec.)	260°C

## Electrical Characteristics $T_A = 25^\circ\text{C}$ (see test circuit, all switches in position 1)

Parameter	Conditions	Min	Typ	Max	Units
Regulated Voltage (Pin 6)	$I_6 = 22 \text{ mA}_{DC}$	8.0	8.6	9.2	V <sub>DC</sub>
Supply Current (Pin 6)			20		mA <sub>DC</sub>
Collector-Emitter Saturation Voltage of Output Transistor (Pin 1)	$I_{C1} = 20 \text{ mA}$		0.30	0.40	V <sub>DC</sub>
Pin 4 Voltage			2.0		V <sub>DC</sub>
Oscillator Pull-in Range	Adjust R <sub>H</sub>		±300		Hz
Oscillator Hold-in Range	Adjust R <sub>H</sub>		±900		Hz
Static Phase Error	$\Delta f = 300 \text{ Hz}$		0.5		μs
Free-running Frequency Supply Dependence	S1 in position 2		±3.0		Hz/V <sub>DC</sub>
Phase Detector Leakage (Pin 5)	All switches in position 2			±1.0	μA
Sync Input Voltage (Pin 3)		2.0		5.0	V <sub>p-p</sub>
Sawtooth Input Voltage (Pin 4)		1.0		3.0	V <sub>p-p</sub>
Maximum Oscillator Frequency			500		kHz

**Note 1:** For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 120°C/W junction to ambient.

## Typical Performance Characteristics



TL/H/7889-3

## Application Information

The following equations may be considered when using the LM1391 in a particular application.

$$R_{201} = R_{301} = \frac{V_{CC} - 8.6}{0.02} \Omega$$

$$f_O \approx \frac{1}{0.6 R_O C_O} \text{ Hz } 1.5\text{k} \leq R_O < 51\text{k}$$

$$R_{204} \approx 10 R_O$$

$$C_{203} = C_{204} \approx \frac{1}{600 f_O(\text{Hz})} \text{ F}$$

$$\text{DC Loop Gain } \mu\beta \approx 3.2 \times 10^{-5} R_O f_O \text{ Hz/rad}$$

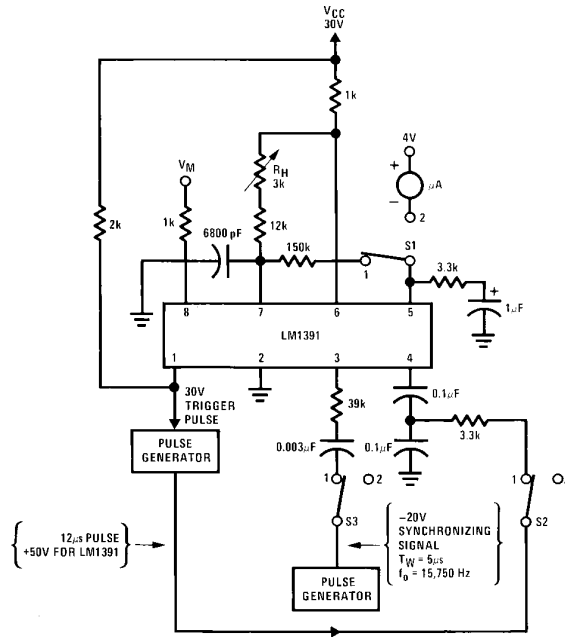
Noise Bandwidth

$$f_{nn} \approx \frac{1 + 2\pi \frac{R_X^2}{R_Y} C_C \mu\beta}{4R_X C_C} \text{ Hz}$$

Damping Factor

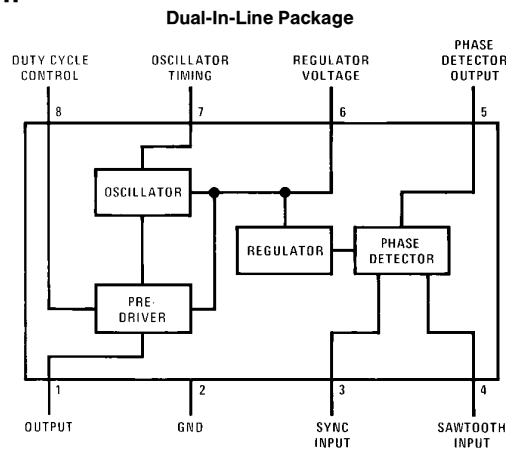
$$K \approx \frac{\pi R_X^2}{2 R_Y} C_C \mu\beta$$

## Test Circuit



TL/H/7889-4

## Connection Diagram

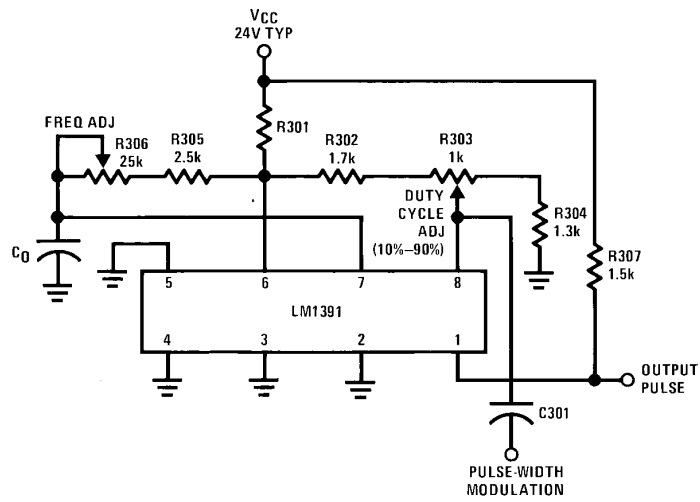


TL/H/7889-2

Top View  
Order Number LM1391N  
See NS Package Number N08E



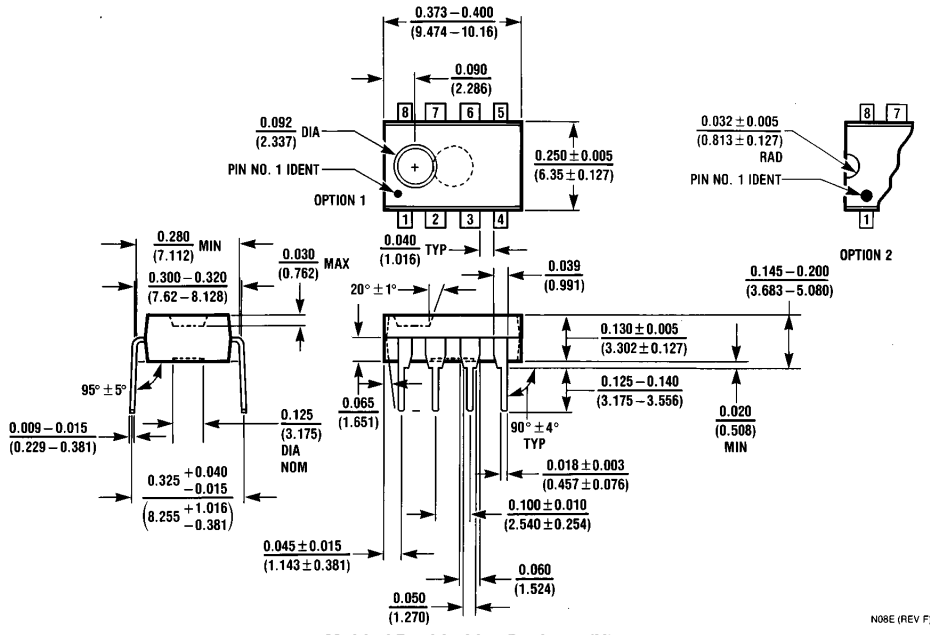
## Typical Applications (Continued)



**FIGURE 3. Variable Duty Cycle Oscillator**  
(See Applications Information)

TL/H/7889-7

**Physical Dimensions** inches (millimeters)




**Molded Dual-In-Line Package (N)**  
**Order Number LM1391N**  
**NS Package Number N08E**

**LIFE SUPPORT POLICY**

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

 <p><b>National Semiconductor Corporation</b>          1111 West Bardin Road          Arlington, TX 76017          Tel: 1(800) 272-9959          Fax: 1(800) 737-7018</p>	<p><b>National Semiconductor Europe</b></p> <p>Fax: (+49) 0-180-530 85 86          Email: cnjwge@tevm2.nsc.com          Deutsch Tel: (+49) 0-180-530 85 85          English Tel: (+49) 0-180-532 78 32          Français Tel: (+49) 0-180-532 93 58          Italiano Tel: (+49) 0-180-534 16 80</p>	<p><b>National Semiconductor Hong Kong Ltd.</b>          19th Floor, Straight Block,          Ocean Centre, 5 Canton Rd.          Tsimshatsui, Kowloon          Hong Kong          Tel: (852) 2737-1600          Fax: (852) 2736-9960</p>	<p><b>National Semiconductor Japan Ltd.</b>          Tel: 81-043-299-2309          Fax: 81-043-299-2408</p>
--	--	---	---

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.