

## LM1391 Phase-Locked Loop

### General Description

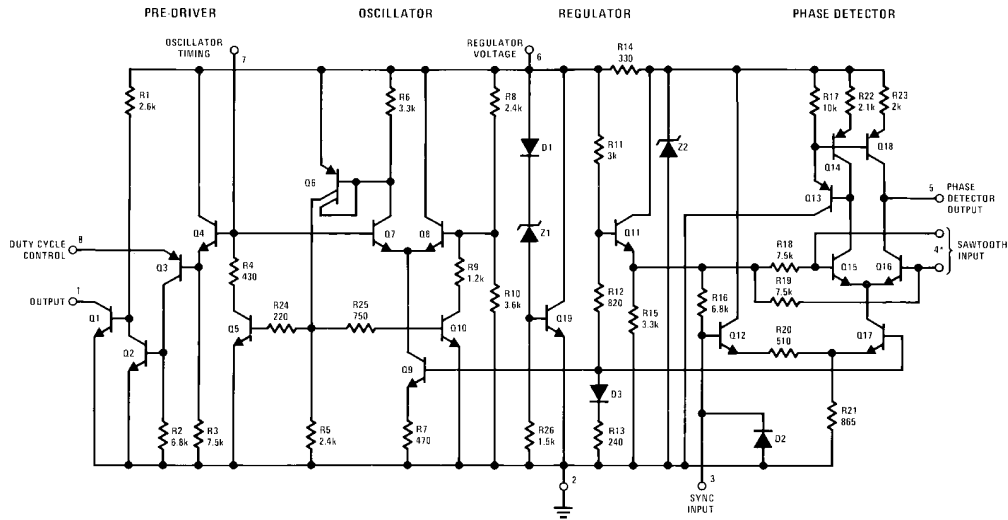
The LM1391 integrated circuit has been designed primarily for use in the horizontal section of TV receivers, but may find use in other low frequency signal processing applications. It includes a stable VCO, linear pulse phase detector, and variable duty cycle output driver.

### 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

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## Absolute Maximum Ratings

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

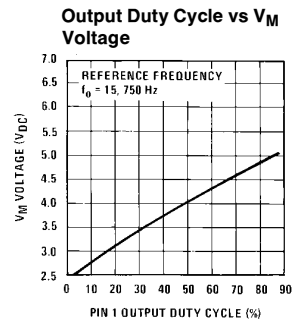
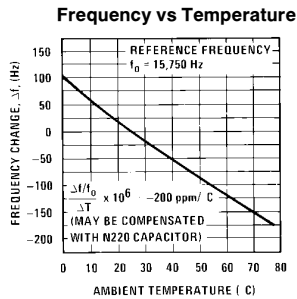
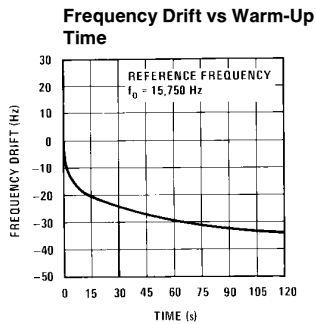
Supply Current	40 mA <sub>DC</sub>	Flyback Input Voltage (Pin 4)	5.0 Vp-p
Output Voltage	40 V <sub>DC</sub>	Power Dissipation (Package Limitation) Plastic Package (Note 1)	1000 mW
Output Current	30 mA <sub>DC</sub>	Operating Temperature Range (Ambient)	0°C to +70°C
Sync Input Voltage (Pin 3)	5.0 Vp-p	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	Vp-p
Sawtooth Input Voltage (Pin 4)		1.0		3.0	Vp-p
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



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## Application Information

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

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

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

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

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

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

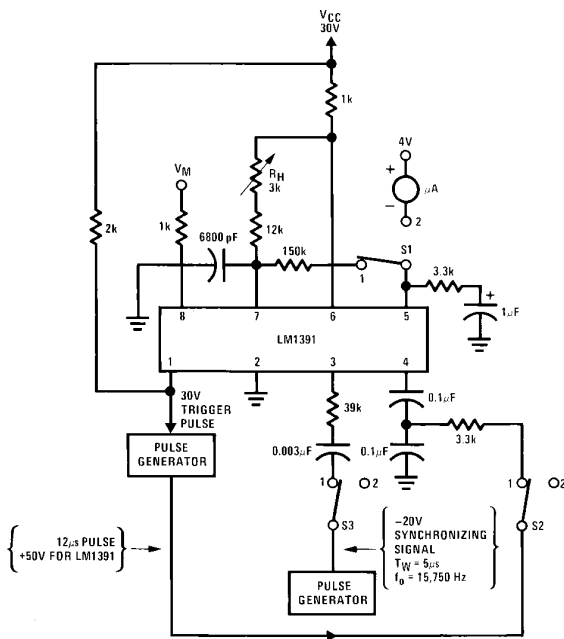
Noise Bandwidth

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

Damping Factor

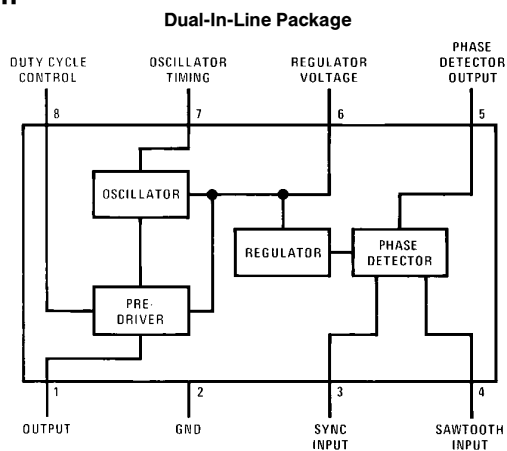
$$K \approx \frac{\pi R_X^2}{2 R_Y} C_C \mu\beta$$

## Test Circuit



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## Connection Diagram



TL/H/7889-2

Top View  
Order Number LM1391N  
See NS Package Number N08E

## Typical Applications

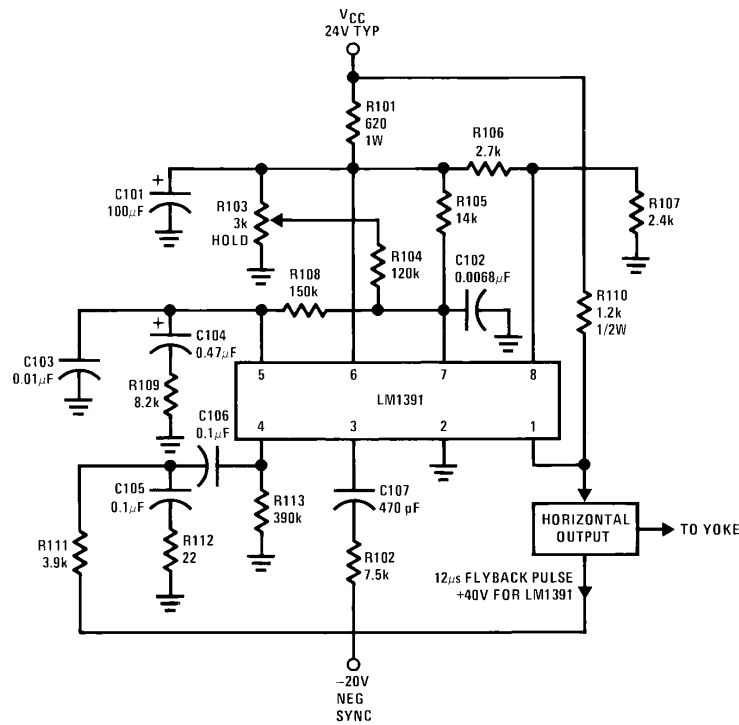


FIGURE 1. TV Horizontal Processor

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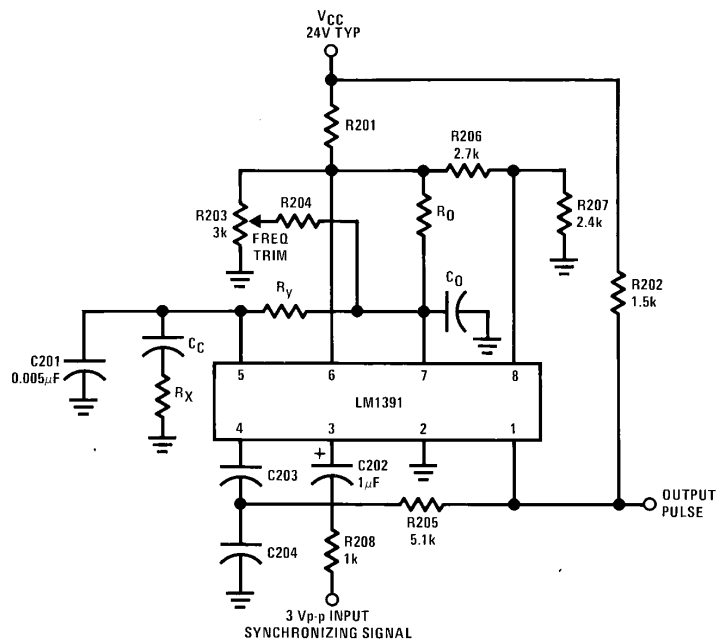
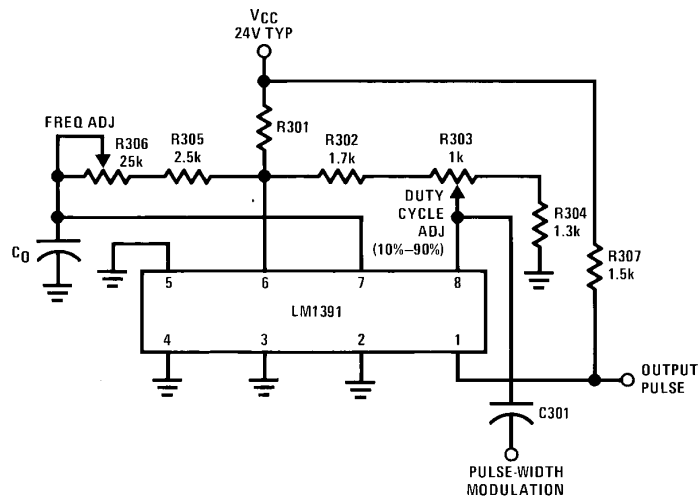


FIGURE 2. General Purpose Phase-Lock Loop  
(See Applications Information)

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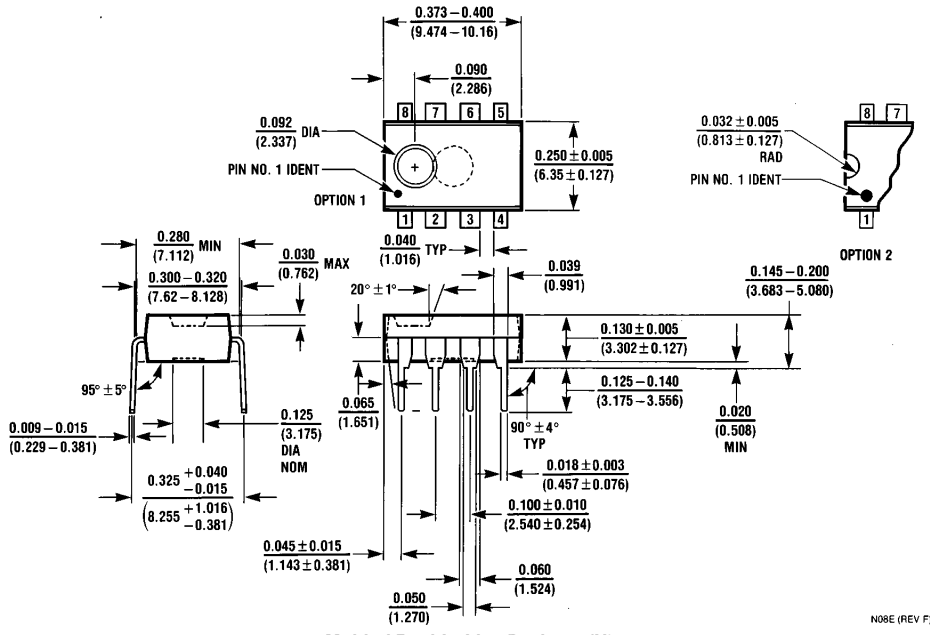
## Typical Applications (Continued)



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

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**Physical Dimensions** inches (millimeters)




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

N08E (REV F)

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