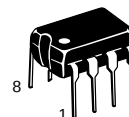


## TV Horizontal Processor

## TV HORIZONTAL PROCESSOR

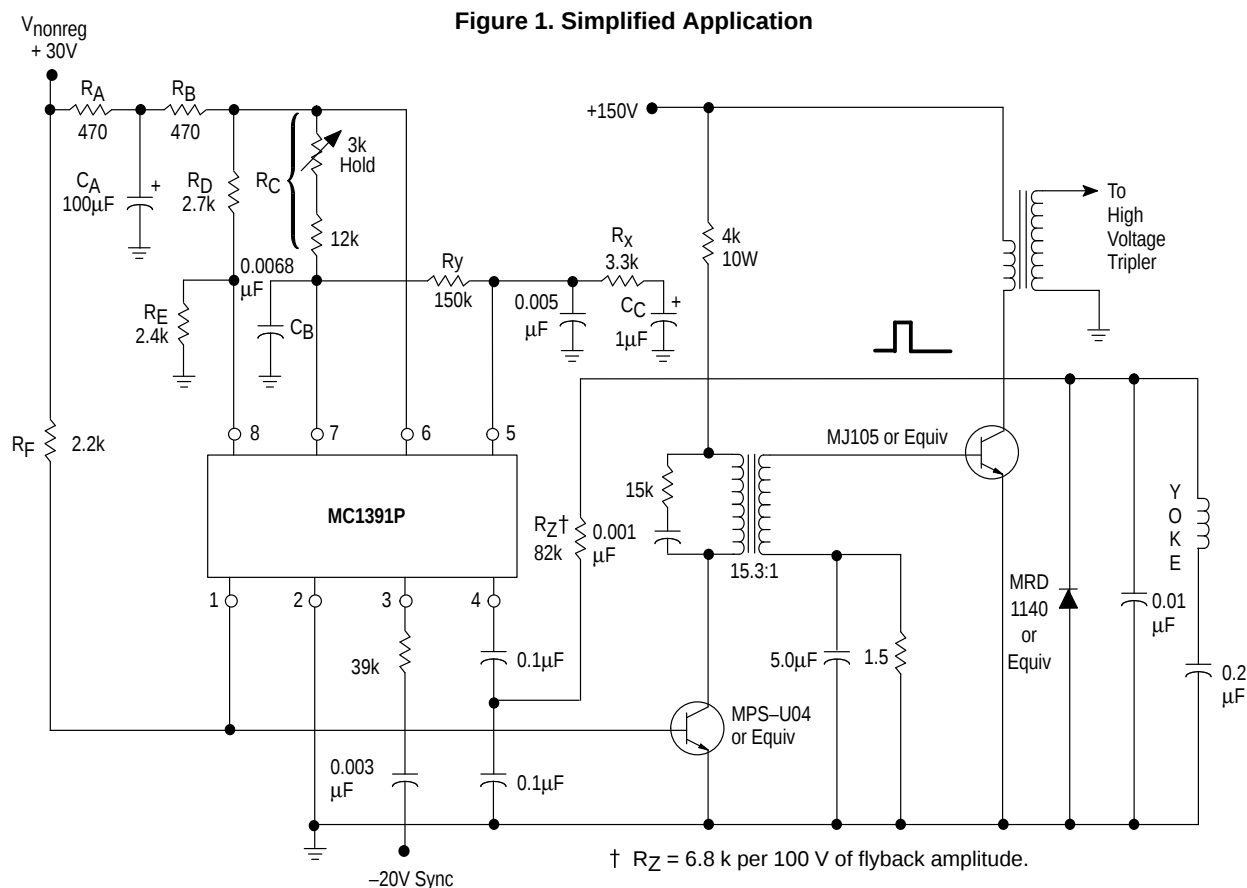
SEMICONDUCTOR  
TECHNICAL DATA

**P SUFFIX**  
PLASTIC PACKAGE  
CASE 626

## ORDERING INFORMATION

| Device  | Operating Temperature Range  | Package     |
|---------|------------------------------|-------------|
| MC1391P | T <sub>A</sub> = 0° to +70°C | Plastic DIP |

### Figure 1. Simplified Application



This circuit has an oscillator pull-in range of  $\pm 300$  Hz, a noise bandwidth of 320 Hz, and a damping factor of 0.8.

## MC1391

**MAXIMUM RATINGS** (T<sub>A</sub> = +25°C, unless otherwise noted.)

| Rating                                 | Value       | Unit            |
|----------------------------------------|-------------|-----------------|
| Supply Current                         | 40          | mAdc            |
| Output Voltage                         | 40          | Vdc             |
| Output Current                         | 30          | mAdc            |
| Sync Input Voltage (Pin 3)             | 5.0         | V <sub>pp</sub> |
| Flyback Input Voltage (Pin 4)          | 5.0         | V <sub>pp</sub> |
| Power Dissipation (Package Limitation) |             |                 |
| Plastic Package                        | 625         | mW              |
| Derate above T <sub>A</sub> = +25°C    | 5.0         | mW/°C           |
| Operating Temperature Range (Ambient)  | 0 to +70    | °C              |
| Storage Temperature Range              | −65 to +150 | °C              |

**ELECTRICAL CHARACTERISTICS** ( $T_A = +25^{\circ}\text{C}$ , unless otherwise noted. See Test Circuit of Figure 2, all switches in position 1.)

| Characteristics                                                                                                 | Min | Typ  | Max  | Unit            |
|-----------------------------------------------------------------------------------------------------------------|-----|------|------|-----------------|
| Regulated Voltage (Pin 6)                                                                                       | 8.0 | 8.6  | 9.4  | Vdc             |
| Supply Current (Pin 6)                                                                                          | –   | 20   | –    | mAdc            |
| Collector–Emitter Saturation Voltage (Output Transistor Q1 in Figure 6)<br>(I <sub>C</sub> = 20 mA, Pin 1 ) Vdc | –   | 0.15 | 0.25 | Vdc             |
| Voltage (Pin 4)                                                                                                 | –   | 2.0  | –    | Vdc             |
| Oscillator Pull–in Range (Adjust R <sub>H</sub> in Figure 2)                                                    | –   | ±300 | –    | Hz              |
| Oscillator Hold–in Range (Adjust R <sub>H</sub> in Figure 2)                                                    | –   | ±900 | –    | Hz              |
| Static Phase Error<br>(Δf = 300 Hz)                                                                             | –   | 0.5  | –    | μs              |
| Free–running Frequency Supply Dependence<br>(S1 in position 2)                                                  | –   | ±3.0 | –    | Hz/Vdc          |
| Phase Detector Leakage (Pin 5)<br>(All switches in position 2)                                                  | –   | –    | ±1.0 | μA              |
| Sync Input Voltage (Pin 3)                                                                                      | 2.0 | –    | 5.0  | V <sub>pp</sub> |
| Sawtooth Input Voltage (Pin 4)                                                                                  | 1.0 | –    | 3.0  | V <sub>pp</sub> |

### Figure 2. Test Circuit

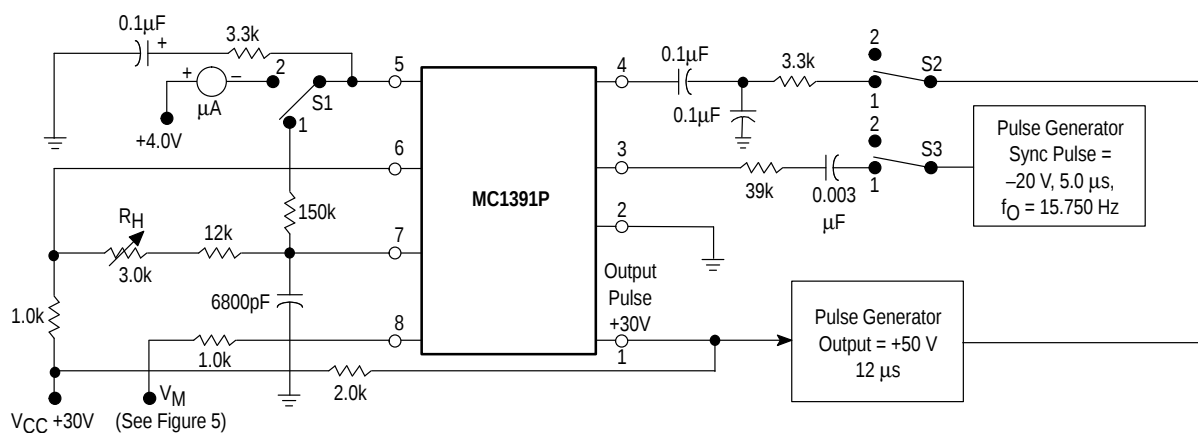


Figure 3. Frequency versus Temperature

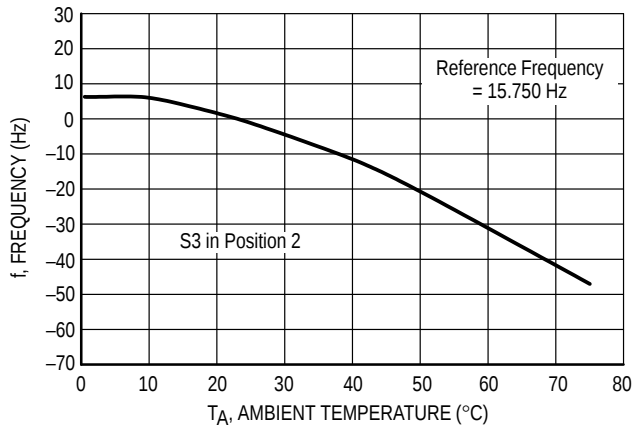


Figure 4. Frequency Drift versus Warm-Up Time

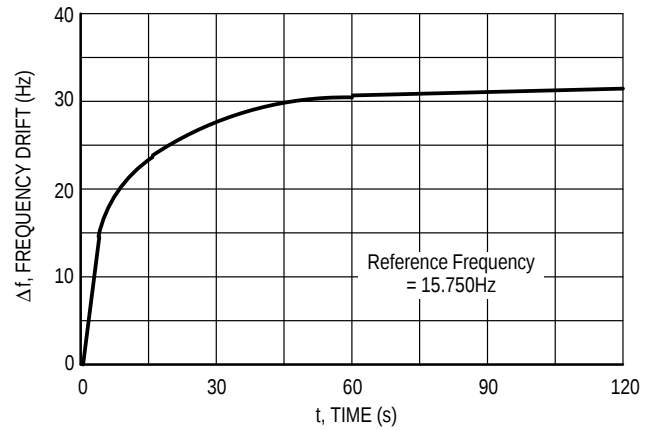


Figure 5. Mark Space Ratio

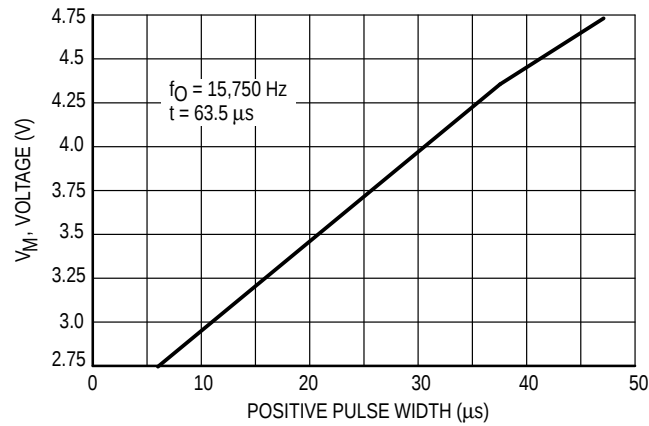
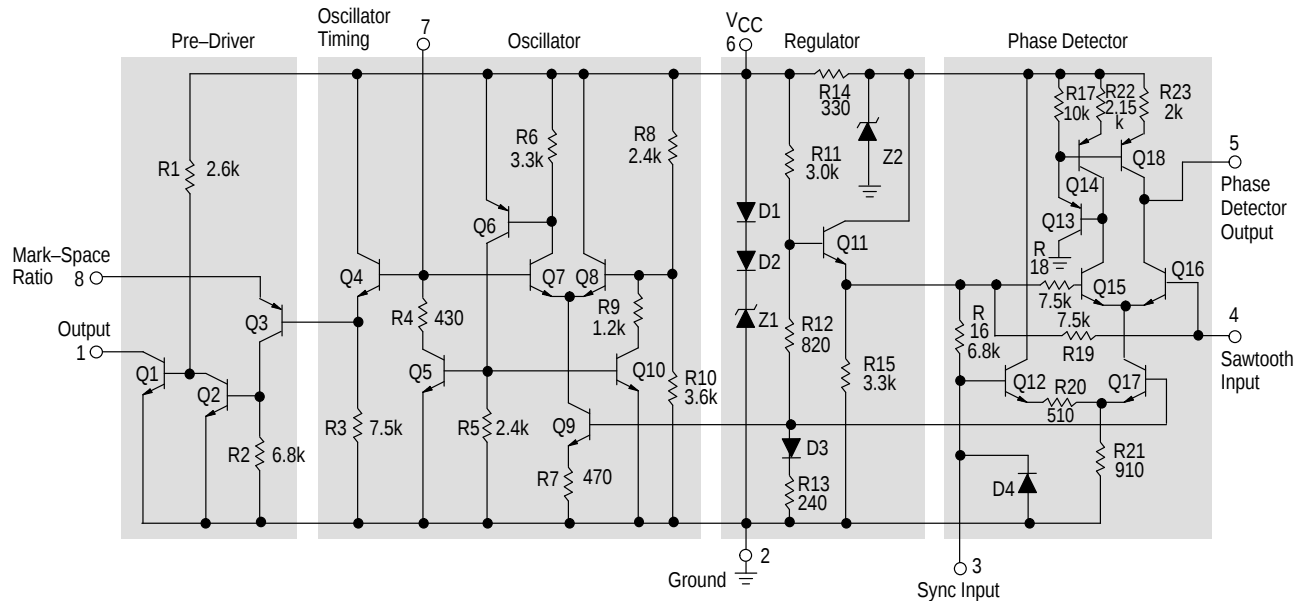


Figure 6. Representative Schematic Diagram



# MC1391

## CIRCUIT OPERATION

The MC1391P contains the oscillator, phase detector and predriver sections needed for a television horizontal APC loop.

The oscillator is an RC type with one pin (Pin 7) used to control the timing. The basic operation can be explained easily. If it is assumed that Q7 is initially off, then the capacitor connected from Pin 7 to ground will be charged by an external resistor ( $R_C$ ) connected to Pin 6. As soon as the voltage at Pin 7 exceeds the potential set at the base of Q8 by resistors R8 and R10, Q7 will turn on and Q6 will supply base current to Q5 and Q10. Transistor Q10 will set a new, lower potential at the base of Q8 determined by R8, R9 and R10. At the same time, transistor Q5 will discharge the capacitor through R4 until the base bias of Q7 falls below that of Q8, at which time Q7 will turn off and the cycle repeats.

The sawtooth generated at the base of Q4 will appear across R3 and turn off Q3 whenever it exceeds the bias set on Pin 8. By adjusting the potential at Pin 8, the duty cycle (MSR) at the predriver output pin (Pin 1) can be changed to accommodate either tube or transistor horizontal output stages.

The phase detector is isolated from the remainder of the circuit by R14 and Z2. The phase detector consists of the comparator Q15, Q16 and the gated current source Q17. Negative going sync pulses at Pin 3 turn off Q12 and the current division between Q15 and Q16 will be determined by the phase relationship of the sync and the sawtooth waveform at Pin 4, which is derived from the horizontal flyback pulse. If there is no phase difference between the sync and sawtooth, equal currents will flow in the collectors of Q15 and Q16 each of half the sync pulse period. The current in Q15 is turned around by Q18 so that there is no net output current at Pin 5 for balanced conditions. When a phase offset occurs, current will flow either in or out of Pin 5. This pin is connected via an external low-pass filter to Pin 7, thus controlling the oscillator.

Shunt regulation for the circuit is obtained with a zero temperature coefficient from the series combination of D1, D2 and Z1.

## APPLICATION INFORMATION

Although it is an integrated circuit, the MC1391P has all the flexibility of a conventional discrete component horizontal APC loop. The internal temperature compensated voltage regulator allows a wide supply voltage variation to be tolerated, enabling operation from nonregulated power supplies. A minimum value for supply current into Pin 6 to maintain zener regulation is about 18 mA. Allowing 2.0 mA for the external dividers

$$R_A + R_B = \frac{V_{\text{nonreg(min)}} - 8.8}{20 \times 10^{-3}}$$

Components  $R_A$ ,  $R_B$  and  $C_A$  are used for ripple rejection. If the supply voltage ripple is expected to be less than 100 mV (for a 30 V supply) then  $R_A$  and  $R_B$  can be combined and  $C_A$  omitted.

The output pulse width can be varied from 6.0  $\mu$ s to 48  $\mu$ s by changing the voltage at Pin 8 (see Figure 5). However, care should be taken to keep the lead lengths to Pin 8 as short as possible at Pin 1. The parallel impedance of  $R_D$  and  $R_E$  should be close to 1.0 k $\Omega$  to ensure stable pulse widths. For 15 mA drive at saturation

$$R_F = \frac{V_{\text{nonreg}} - 0.3}{15 \times 10^{-3}}$$

The oscillator free-running frequency is set by  $R_C$  and  $C_B$  connected to Pin 7. For values of  $R_C \geq R_{\text{discharge}}$  (R4 in Figure 6), a useful approximation for the free-running frequency is

$$f_O = \frac{1}{0.6 R_C C_B}$$

Proper choice of  $R_C$  and  $C_B$  will give a wide range of oscillator frequencies – operation at 31.5 kHz for countdown circuits is possible for example. As long as the product  $R_C C_B \approx 10^{-4}$  many combinations of values of  $R_C$  and  $C_B$  will satisfy the free-running frequency requirement of 15.734 kHz. However, the sensitivity of the oscillator ( $\beta$ ) to control-current from the phase detector is directly dependent on the magnitude of  $R_C$ , and this provides a convenient method of adjusting the dc loop gain ( $f_c$ ).

For a given phase detector sensitivity ( $\mu$ ) =  $1.60 \times 10^{-4}$  A/rad

$$f_c = \mu \beta \text{ and } \beta = 3.15 \times R_C \text{ Hz/mA}$$

Increasing  $R_C$  will raise the dc loop gain and reduce the static phase error (S.P.E.) for a given frequency offset. Secondary effects are to increase the natural resonant frequency of the loop ( $\omega_n$ ) and give a wider pull-in range from an out-of-lock condition. The loop will also tend to be underdamped with fast pull-in times, producing good airplane flutter performance. However, as the loop becomes more underdamped impulse noise can cause shock excitation of the loop. Unlimited increase in the dc loop gain will also raise the noise bandwidth excessively causing horizontal jitter with thermal noise. Once the dc loop gain has been selected for adequate SPE performance, the loop filter can be used to produce the balance between other desirable characteristics. Damping of the loop is achieved most directly by changing the resistor  $R_X$  with respect to  $R_Y$  which modifies the ac/dc gain ration ( $m$ ) of the loop. Lowering this ratio will reduce the pull-in range and noise bandwidth ( $f_{nn}$ ). (Note: very large values of  $R_Y$  will limit the control capability of the phase detector with a corresponding reduction in hold-in range.)

Static phasing can be adjusted simply by adding a small resistor between the flyback pulse integrating capacitor and ground. The sync coupling capacitor should not be too small or it can charge during the vertical pulse and this may result in picture bends at the top of the CRT.

Note: In adjusting the loop parameters, the following equations may prove useful:

$$f_{nn} = \frac{1 \times \chi^2 T \omega_C}{4 \chi T} \quad \chi = \frac{R_X}{R_Y}$$

$$\omega_n = \sqrt{\frac{\omega_C}{(1 + \chi)}} \quad \omega_C = 2 \pi f_c$$

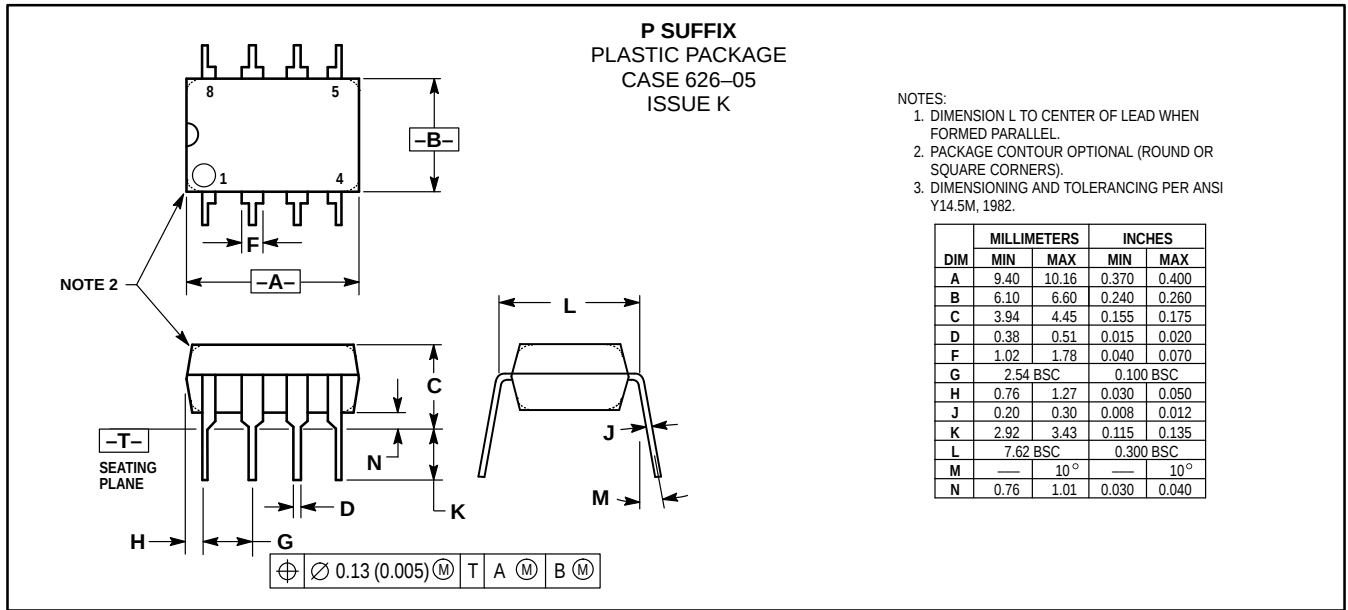
$$T = R_Y C_C$$

$$K = \frac{\chi^2 T \omega_C}{4}$$

where: K = loop damping coefficient

# MC1391

## OUTLINE DIMENSIONS



Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

**How to reach us:**

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609

**INTERNET:** <http://Design-NET.com>

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,  
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

**MOTOROLA****MC1391/D**