

## CLD Application Notes

### Connection Options

**Series**—Higher voltages may be obtained by connecting identical CLDs in series (Figure 4). Voltage balancing resistors are recommended. Since the resistors shunt the output resistance, their values should be high.

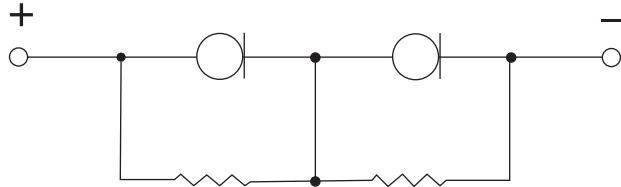


Figure 4. CLDs Connected in Series

**Parallel**—Increasing the current range may be accomplished by connecting CLDs in parallel (Figure 5). The resulting current is the sum of the individual currents. No special precautions are necessary.

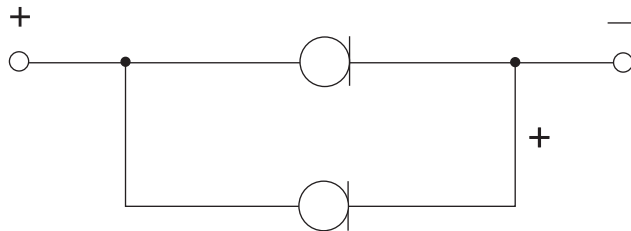


Figure 5. CLDs Connected in Parallel

**Bidirectional**—Two CLDs connected back-to-back make a useful AC clipper circuit which will regulate in either direction (Figure 6).



Figure 6. CLDs Connected Back-to-Back

## Typical Applications

### The CLD as a Biasing, Coupling and Load Resistor

**Emitter/Source Biasing**—The CLD can replace the usual emitter and source bias resistor (Figure 7), improving negative supply rejection.

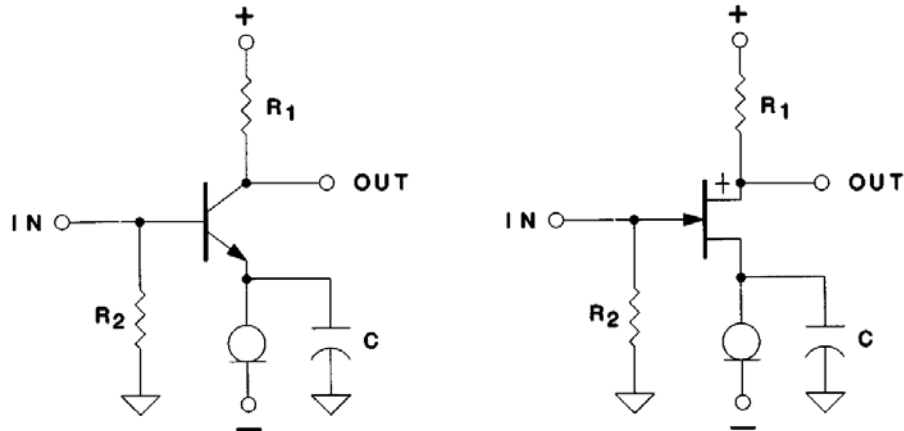


Figure 7. Emitter/Source Biasing

**Common-Mode Biasing of Differential Amplifiers**—The common-mode rejection ratio (CMR) of a differential amplifier is directly proportional to the value of the common-mode biasing resistor ( $R_{CM}$  in Figure 8a). Replacing  $R_{CM}$  with a CLD (Figure 8b) will improve the common-mode rejection ratio and, in addition, will improve the temperature stability.

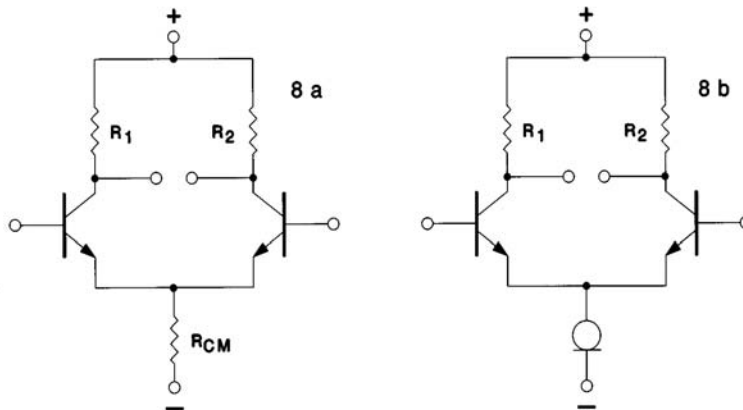


Figure 8. Common-Mode Biasing of Differential Amplifiers

## Typical Applications (Continued)

**Biasing of Darlington Input Differential Amplifiers**—The standard Darlington input differential amplifier can be improved two ways using CLDs. First, by improving the common-mode rejection ratio by replacing  $R_{CM}$  (Figure 9a) with CLD  $D_2$  (Figure 9b). Secondly, adding CLDs  $D_1$  and  $D_3$  (Figure 9b) fixes the current in  $Q_1$  and  $Q_4$ , thereby eliminating the need to match the beta in transistor pairs  $Q_1$ - $Q_2$  and  $Q_3$ - $Q_4$ . An additional benefit is the improved frequency response and reduces noise density.

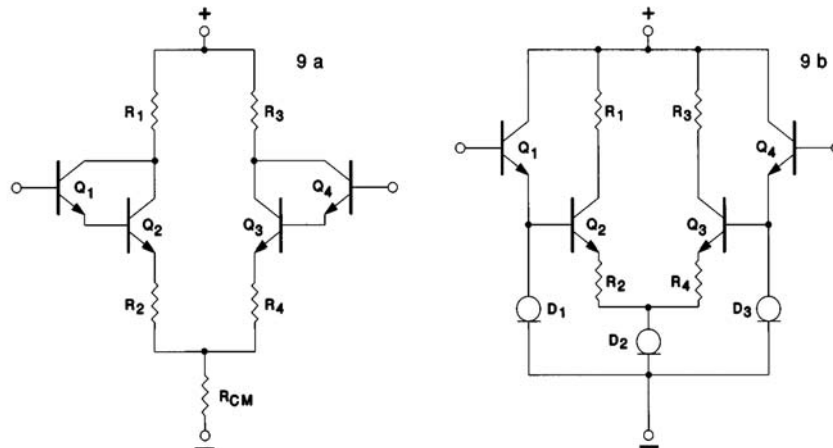


Figure 9. Biasing of Darlington Input Differential Amplifiers

**DC Coupling**—The loss in gain of a circuit using standard DC coupling (Figure 10a) can be greatly improved by replacing the coupling resistors  $R_2$  and  $R_3$  with a CLD and zener diode (Figure 10b).

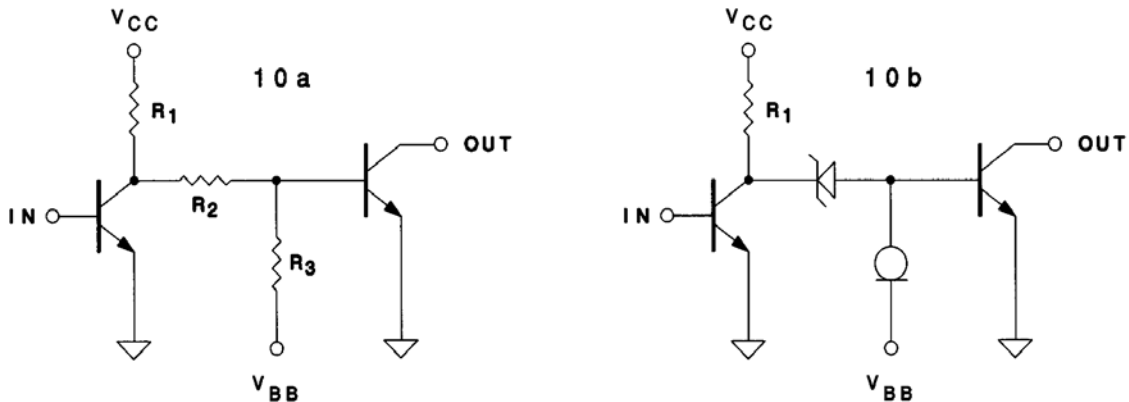


Figure 10. DC Coupling

## Typical Applications (Continued)

**Collector Load**—The voltage gain of a common emitter amplifier can be increased five to ten times by replacing the collector load resistor with a CLD (Figure 11). To maintain this gain the amplifier must be lightly loaded (high Z load) and must be prevented from bottoming or switching off.

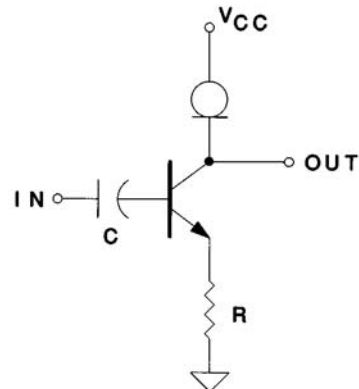


Figure 11. Collector Load

**Drain Load**—Using a CLD as a load for an FET amplifier will increase the voltage gain (Figure 12).

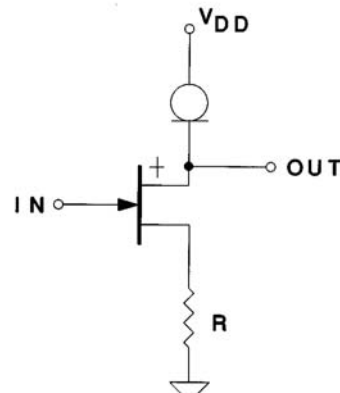


Figure 12. Drain Load

**Emitter/Source Follower Load**—Using a CLD as an emitter/source follower load increases the input impedance and gain of the circuit (Figure 13) and decreases the transistor dissipation under heavy load conditions.

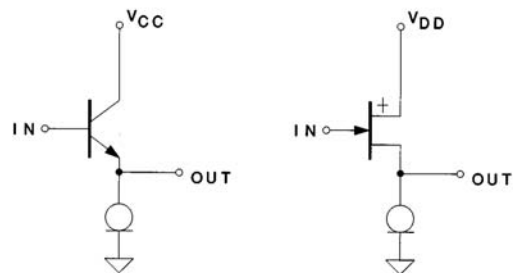


Figure 13. Emitter/Source Follower Load

## Typical Applications (Continued)

### The CLD in Waveform Generators

**Square-Wave-Generator**—A simple sine to square-wave generator can be built using two CLDs back-to-back, as shown in (Figure 14).

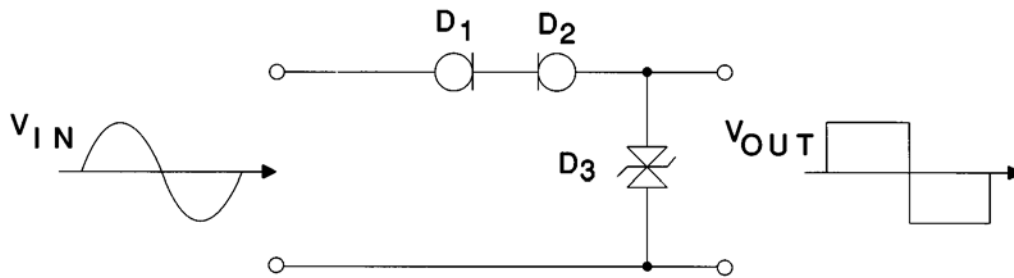


Figure 14. Square-Wave Generator

**Triangle-Wave-Generator**—A simple sine or square to triangle-wave generator can be built using two CLDs back-to-back, as shown in (Figure 15).

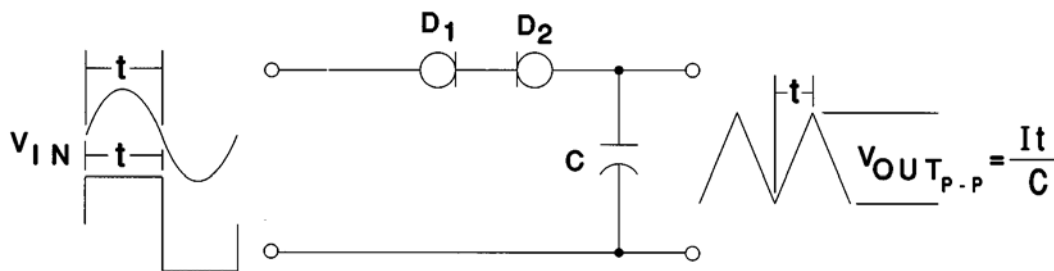


Figure 15. Triangle-Wave Generator

**Stairstep Generator**—A CLD is used to optimize the performance of a four-layer diode stairstep generator (Figure 16). The CLD allows the use of input pulses only a few volts above the breakdown voltage of the four-layer diode. Another stairstep generator (Figure 17, page 144) uses bipolar transistors and a CLD. This circuit requires that sync pulses be applied to  $Q_2$  to reset the train of steps.

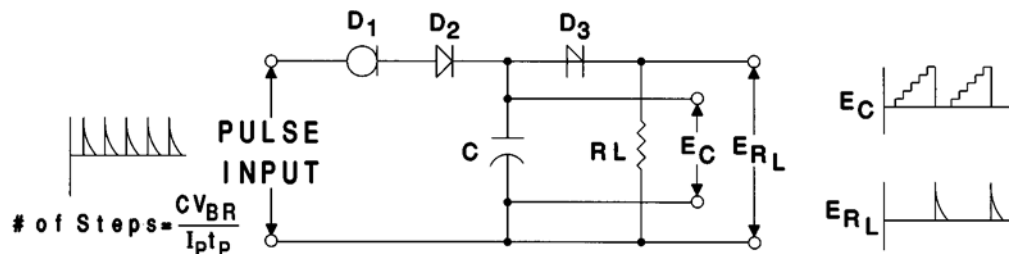


Figure 16. Stairstep Generator

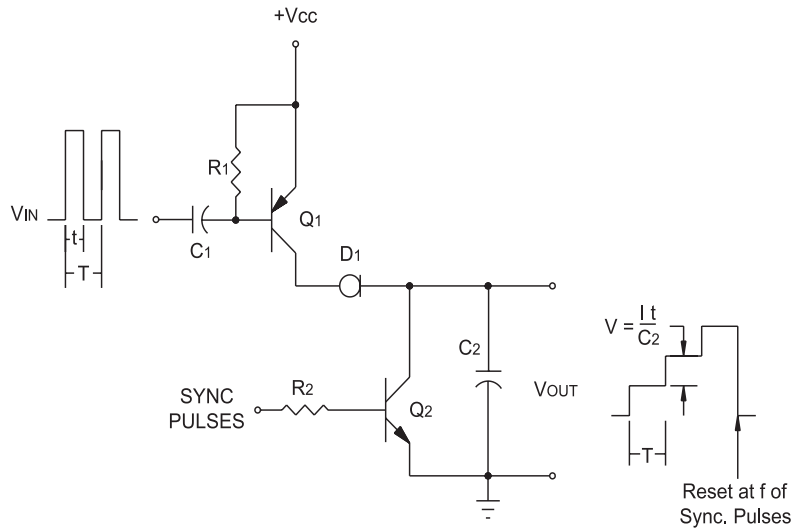


Figure 17. Stairstep Generator

**Sawtooth Generator**—The CLD can be used to produce a very linear sawtooth or ramp generator. The negative and positive going ramps are shown in Figures 18 & 19, respectively.

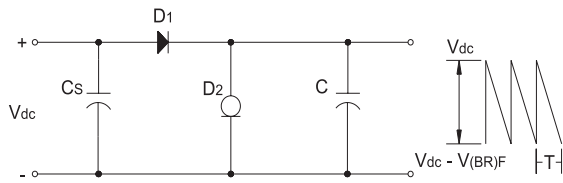


Figure 18. Negative-Going Ramp

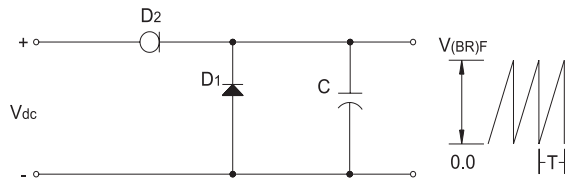


Figure 19. Positive-Going Ramp

## Miscellaneous Applications

**Two-Step Battery Charger**—A pair of CLDs, along with a zener diode, provides for an excellent two-step battery charger, as shown in Figure 20.

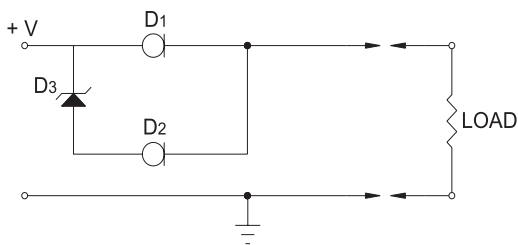


Figure 20. Two-Step Battery Charger

## Miscellaneous Applications (Continued)

**Low Voltage/Low Noise Voltage Reference**—The CLD can be used to produce a low voltage reference when operated to drive a known resistance (Figure 21). This circuit produces much lower noise than a standard low voltage reference designed with a zener diode. A low noise capacitor across R will further reduced noise.

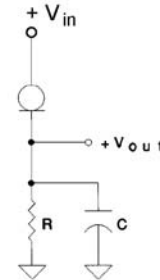


Figure 21. Low Voltage/Low Noise Voltage Reference

### Voltage Reference with a Zener Diode—

A CLD combined with a standard zener diode (Figure 22) produces an excellent voltage reference with the following advantages:

- Variations of  $V_{in}$  have almost no effect on  $V_{out}$ , and  $V_{in}$  can be increased up to about 100 volts (the POV of the CLD) without concern about the dissipation of the zener diode.
- Supply line noise and ripple is decoupled from the load by more than 100 dB to about 200 KHz.
- The supply line is also decoupled from the load by more than 100 dB reducing the possibility of feedback due to common supply lines.

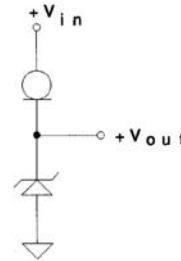


Figure 22. Voltage Reference with a Zener Source

**Non-Destruct Fuse**—The CLD can be used as a non-destruct fuse, limiting current to a safe value.

## Other Useful Applications and Notes

- AC clipper circuit.
- Constant current source for driving LEDs.
- Current limiter for jell battery charger.
- Improved speed and reduced power consumption in logic circuitry by active pull-up, as in a comparator.
- Replacing holding coil in telephone connection devices.
- Current source for biasing switching diodes.
- Due to its positive temperature coefficient, the CCL0035 or the CCL0130 can be used for biasing a bipolar transistor to achieve constant gain over a temperature coefficient range.
- Because of its nearly zero temperature coefficient, the CCL0750 is ideal for certain applications.