An Alternate Method of Indicating Compression

The circuits within this application note feature THAT4301 Analog Engine® to provide the essential elements of voltage-controlled amplifier (VCA) and rms-level detector (RMS). Since writing this note, THAT has introduced several new models of Analog Engines, as well as new VCAs. With minor modifications, these newer ICs are generally applicable to the designs shown herein, and may offer advantages in performance, cost, power consumption, etc., depending on the design requirements. As well, a standalone RMS is available to complement our standalone VCAs. We encourage readers to consider the following alternatives in addition to the 4301:

- Low supply voltage and power consumption: 4320
- Low cost, supply voltage, and power consumption: 4315
- Low cost and power consumption: 4305
- High-performance (VCA only): 2180-series, 2181-series
- Dual (VCA only): 2162
- RMS (standalone): 2252

For more information about making these substitutions, please contact THAT Corporation's technical support group at apps_support@thatcorp.com.

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Indicating an above-threshold condition with an LED was discussed in Design Note 113. The method shown in that design note simply turned on an LED when the output of the threshold amplifier went below ground potential using one half of a cheap, readily available comparator, an LED, and some resistors. The circuit is cheap and simple, though it was recommended that the comparator's V_{OS} be trimmed, since the maximum VOS represented an error of ±½ dB.

While the approach suited many users, others preferred an indicator which displayed green for the under-threshold condition and red for above threshold. This design note discusses three alternative approaches to implementing this function using a bi-color LED to indicate either above or below threshold. As one might expect, the complexity of these different approaches is roughly proportional to their functionality.

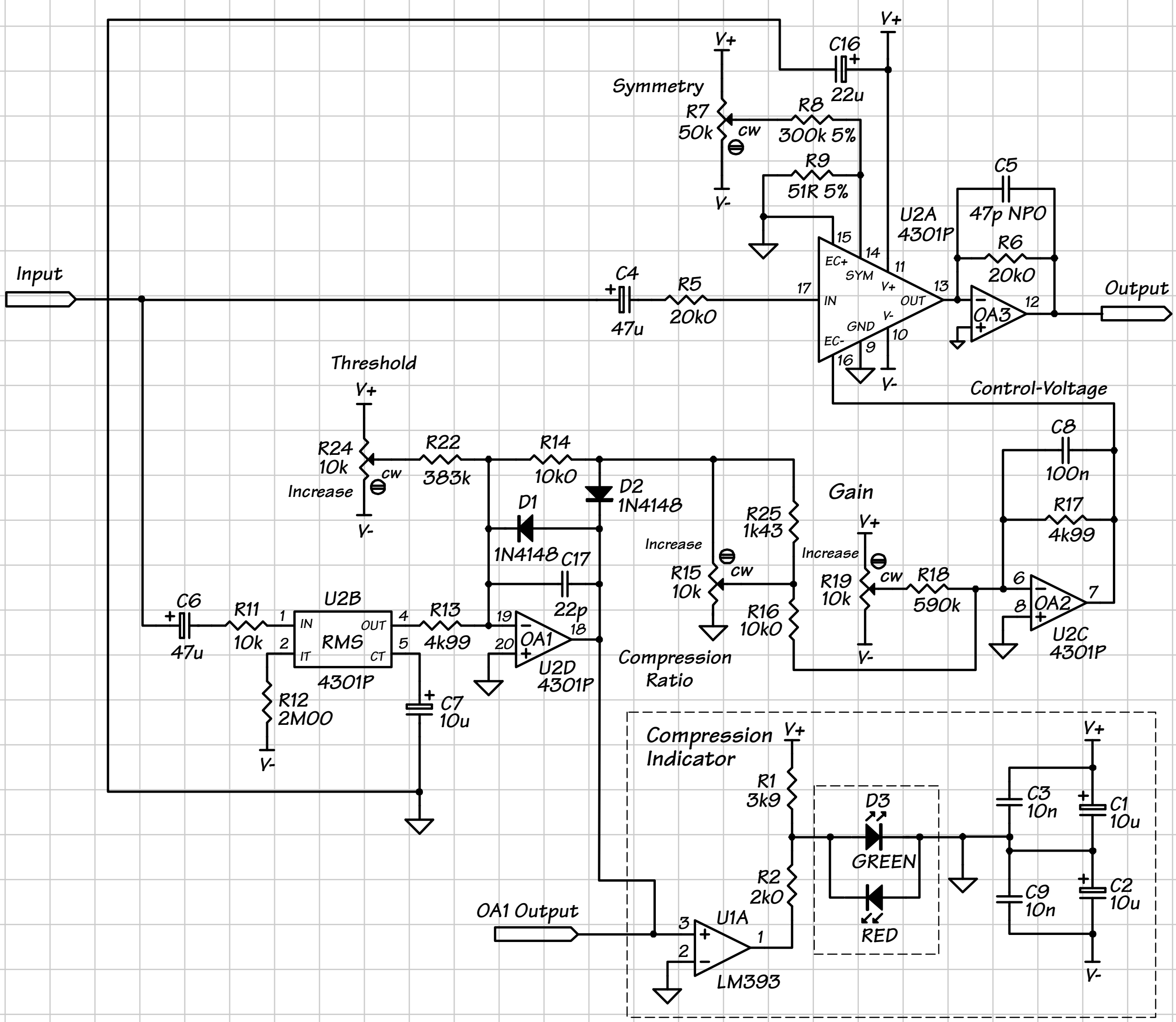

Figure 1. A hard knee compressor/limiter with a bi-color LED to indicate above/below threshold

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Figure 1 shows the simplest approach to using a bi-color LED, and uses just one more resistor than the circuit in Design Note 113. In this and the remaining implementations, we've used the actual op-amp output to derive the signal to indicate above threshold. When the circuit is below threshold, OA1's feedback loop is closed through D1, and the output sits at about 0.6V above ground. When the signal transitions to the above threshold condition, conduction in D1 stops and feedback is provided through D2. Consequently, the output of OA1 swings rapidly to a level of approximately -0.6 V. This large voltage transition (or 'snap-action') completely swamps out the V_{OS} error of U1A, and as a result, there is no need to consider trimming this error as was suggested in DN113.

Under below-threshold conditions, the output of U1A is high, and the current to drive the green LED is provided through R1, and dumped directly into ground. When the signal goes above threshold, the output of U1A goes low, sinking current through R2 to drive the red LED, and also absorbing the current which is still flowing through R1. The total current is just about 6 mA, which is the guaranteed sink capability of the LM 393.

The diode currents are different between the red and green LEDs. The green LED operates at just over 3 mA whereas the red LED operates at just over 2 mA. The effect of this difference is mitigated by the fact that red LEDs are more efficient that green LEDs, but it should be noted that both LEDs are being starved. In the past it has been difficult to find high efficiency bi-color LEDs, and this is probably because it is difficult to match the intensity of the pairs in a production environment.

Ground currents should be a special concern with this circuit, since this arrangement results in ground currents that swing by more than 5 mA, and the fast transitions of the LM 393 could result in substantial current spikes, possibly resulting in ground contamination. To combat this problem, C1-3 and C9 are included to keep these currents local to the LM 393. Don't be tempted to delete C16, since this bypassing capacitor has its own special considerations, and should be connected directly to the grounded side of C7 as is shown.

Figure 2 shows another method of implementing this function, but without dumping current into ground. This

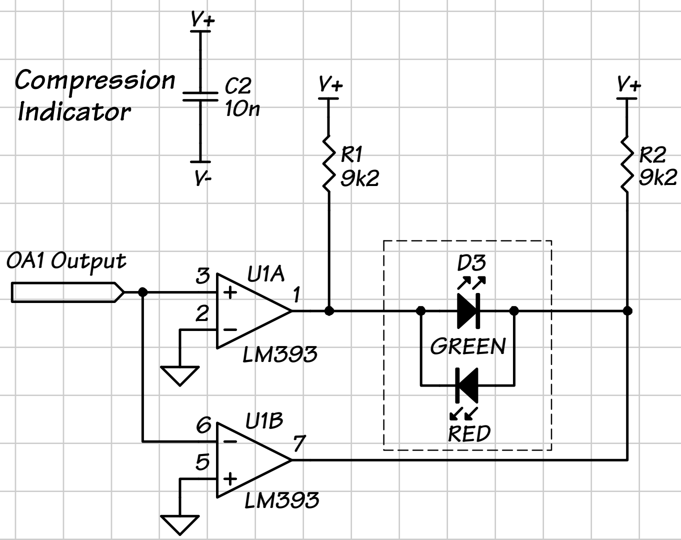

Figure 2.
Compression indicator with no ground current

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technique uses the same number of resistors as the previous method, but uses both gates of the LM 393. The positive input of U1A and the negative input of U1B are connected to the output of OA1, while the other two inputs are grounded. This circuit relies on the aforementioned 'snap-action' of the threshold amplifier to overcome any slight V_{OS} differential and prevent both gates from sinking current at the same time.

When the circuit is below threshold and the output of OA1 is high, pin 1 of U1A is high and pin 7 is sinking current. With ±15V supplies, the total current is about 6.5 mA, with approximately 3 mA of this going through the green LED. When the circuit goes above threshold, the action switches, and there is about 3 mA of current going through the red LED.

Since current draw is now constant and flowing directly between the supplies, the local decoupling is simplified. The electrolytic capacitors have been removed, and all that remains is a single ceramic capacitor between the supplies. This single capacitor explicitly addresses the switching transients of the LM 393, and should be connected directly between pins 4 and 8. This arrangement assumes that there will be other local decoupling to ground, and if that's not the case, the designer may want to add that as well.

While the solution in Figure 2 addresses the issue of ground currents, the LEDs are still driven at rather low current levels, though this may be acceptable in many applications. Figure 3 shows a circuit which uses the current more efficiently with the addition of a resistor and two PNP transistors. The 2N3906s are in a cross-coupled arrangement which steers all of the current coming from R1 into the appropriate LED.

Consider the below -threshold case where pin 1 of U1A is high and pin 7 is sinking current. Pin 7 pulls R3 low, driving Q2 into saturation, which in turn effectively shorts R2 to the emitter of Q1, shutting it off. As a consequence, all of the current through R1 is shunted through the green LED, except for the base current of Q2. The situation is reversed in the above threshold condition. This results in about 6 mA of current driving the LEDs, which is optimal for most devices.

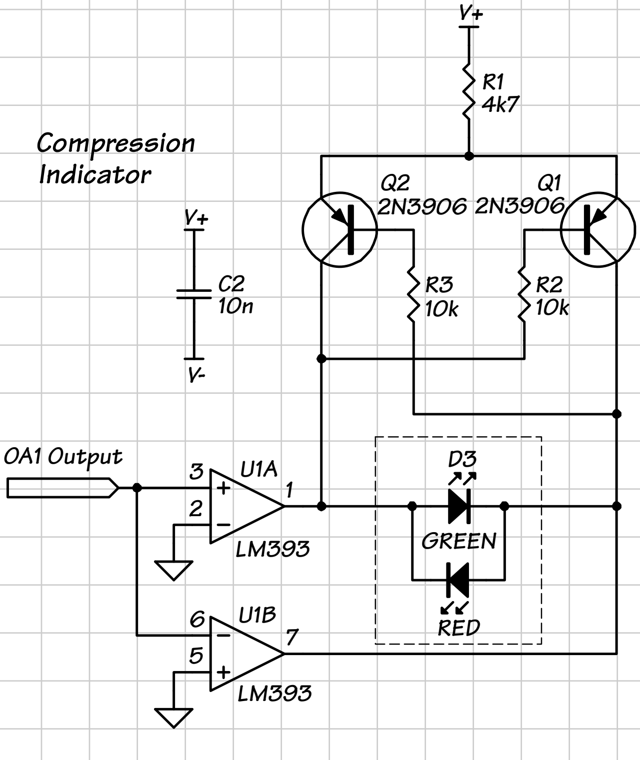

Figure 3. Compression indicator with no ground current and optimal LED drive

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