INCREASING THE AMPACITY

OF THE CotoMOS® CS128 OPTO-ISOLATED SSR BY PARALLEL OPERATION.

The CotoMOS ® CS128 is a DIP/SMD packaged, optically isolated solid state relay (OISSR) capable of switching a 4.5 A load current (I_L), thanks in part to its extremely low on-resistance (R_{on}) – typically about 0.03 Ω. Since the power dissipated in its junctions is equal to I_L^2 x R_{on} the CS128 can switch an amazing amount of electrical power in a very small package, even without heat-sinking.

Safety in numbers – switching more power by parallel operation.

But what if you need to switch even more power? Can multiple CS128 relays be stacked together in parallel to reduce the combined on-resistance (just like conventional resistors in parallel), and divide the current between each relay? *Most solid state relay manufacturers have avoided this question in the past.* This reluctance may stem from the characteristics of OISSR's, where the turn-on times of individual relays depend on both the level of the LED drive current, and inherent timing differences between individual relays.   In parallel arrays of OISSR's, the devices that turn on the quickest will carry a higher inrush current than slower devices, potentially causing them to overheat and fail.

Tests by Coto have shown that this potential failure mechanism is not a significant problem for the CS128 provided certain conditions are met. The temperature rise in degrees Celsius above ambient (Δt) of an array of parallel CS128 OISSR's operated in AC mode has been shown by lab testing to depend on five factors: the total current though the array, (I_{tot}); the frequency of the current, (f); the duty cycle (d), expressed as a percentage; the number of relays in parallel, (n); and the presence or absence of forced air cooling when a rectangular current waveform is applied.

Analyzing the lab test data results in this simple empirical formula for estimating Δt:

$$\Delta t = \frac{I_{tot}^{1.1}\; f^{0.1}\; \sqrt[3]{d}}{K\, n^{0.8}}$$

where I_{tot}, f, d and n are the parameters described above, and K is a factor depending on the presence of active cooling (2.05) or no cooling (0.65). To obtain the best model accuracy, the parameter values should be limited to: $1 < I_{tot} < 30$ A, $0.01 < f < 100$ Hz (use 0.01 for DC), $0.01 < d < 100\%$, and $1 < n < 6$.   Note that at frequencies above 100 Hz, overheating of the fastest relays can occur during parallel operation, for the reasons described previously.

> **. . . An array of six parallel CS128 relays can switch 36X the power of a single relay! . . .**

Example

For example, consider a proposed set-up of 4 parallel CS128's carrying a rectangular 60Hz current peaking at 15A with a duty cycle of 40% and no active cooling. The equation predicts a temperature rise of 51ºC above ambient, which could take the relays close to the operational temperature limit of 85ºC.   Better in this case to use six parallel relays (predicted Δt = 37ºC,) or add some active cooling.

Summary

Multiple CS128 solid state relays can be operated in parallel to increase switching power, provided the switching frequency is limited to 100Hz at currents close to the individual relays' current switching limit. The combined benefit of the reduced resistance of a parallel array of CS128's and the division of current between them means an array of six can switch 36X the power of a single relay!

For a deeper look into this topic including the experimental test results and Δt model development, please see Coto's full Applications Note AN1604-1 entitled "Parallel Operation of CotoMOS® CS128 Solid State Optically Isolated Relays to Increase Current Switching Capacity". Consult the CotoMOS® CS128 product specification sheet for full product details.

CS128 Datasheet