TECH NOTE

Temperature Transition Time of the LDT-53500 Laser Diode Thermoelectric Chillers

OVERVIEW

This technical note presents measurement results of the temperature transition time of thermal loads driven using the LDT-53500 Series Laser Diode Thermoelectric Chillers.

BACKGROUND

The LDT-53500 series are re-circulating fluid based thermoelectric chillers intended for cooling high power laser diodes. The LDT-53500 series consists of two models, LDT-53520 and LDT-53540, with cooling powers of 200W and 375W respectively. For laser diode test applications requiring multiple temperature tests it is important for the chiller to quickly respond to changes in temperature set point. The LDT-53500 series uses a PID control loop to improve both performance of transition times between temperature set points and minimize overshoot at the temperature set points. In addition the LDT-53500 series can use either the internal thermistor or an external thermistor at the thermal load for temperature feedback control.

MEASUREMENT SETUP

Figure 1 shows the temperature transition time measurement setup diagram. A thermal load is cooled by a LDT-53500 chiller. An ambient thermistor and a load thermistor are connected to an Agilent 34970A Data Acquisition Switch Unit, which is connected to a PC through a GPIB cable. A data logging program is used to capture the temperature of the ambient thermistor and the load thermistor.

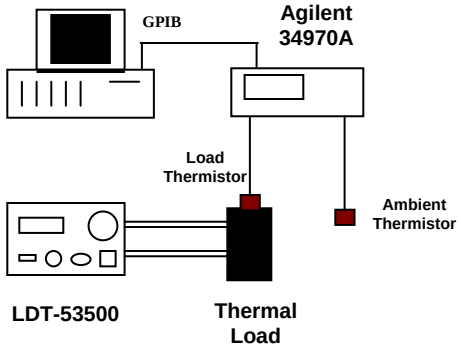

Figure 1: Measurement setup diagram

Three tests were performed on each chiller. The first two tests used the internal thermistor as the feedback control with the first test using a thermal load that was approximately 25% of the maximum power of the chiller and the second test using a thermal load that was approximately 50% of the maximum power thermal load. The third and final test used the external thermistor as the feedback control and an approximate 50% maximum power thermal load. A summary of the test results can be found in Table 1. The temperature was initially set to 25°C and allowed to stabilize for 10 minutes before the data logging software started to acquire the temperature. In the 90-minute test period, the temperature set point was then increased to 45°C, decreased to 25°C, decreased to 5°C, and finally adjusted back to 25°C. Each temperature set point change was given time to allow the temperature to settle at the new set point. The measurement data was graphed and the transition time was calculated.

Table 1: Descriptions of test cases

Test	Setup Descriptions	Figure
1	LDT-53520 chiller, 50W load, and internal thermistor.	2
2	LDT-53520 chiller, 100W load, and internal thermistor.	2
3	LDT-53540 chiller, 100W load, and internal thermistor.	3
4	LDT-53540 chiller, 200W load, and internal thermistor.	3
5	LDT-53520 chiller, 100W load, and external thermistor.	4
6	LDT-53540 chiller, 200W load, and external thermistor.	5

Due to cooling capacity limitations of the LDT-53500, a 5°C set point could not be reached for 50% maximum power thermal loads. For the test cases with 50% maximum power thermal load, the temperature set point was changed to 10°C. To learn more about the cooling capacity of the LDT-53500 series please see ILX Technical Note "*Cooling Capacity of LDT-53500 Laser Diode Thermoelectric Chillers*".

RESULTS

Figures 2 through 5 show the temperature versus time for each test case. In all cases, the temperature overshoot was less than 0.3°C. The transition time was calculated as the difference between the time the temperature was changed to the new set point and the time that it settled at the new temperature.

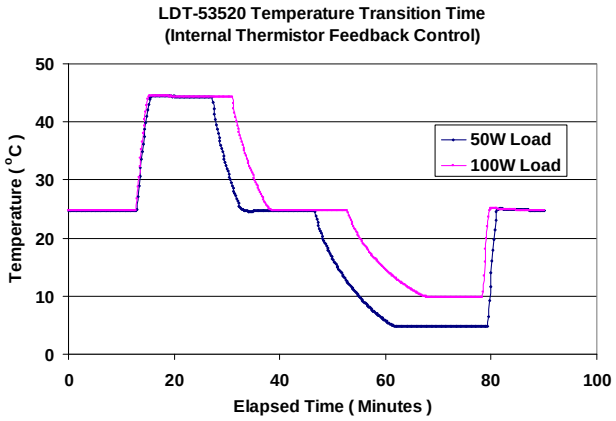

Figure 2: LDT-53520 temperature transition time using internal thermistor feedback control

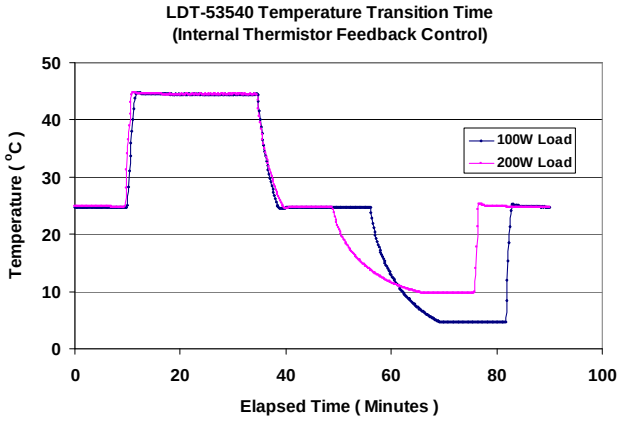

Figure 3: LDT-53540 temperature transition time using internal thermistor feedback control

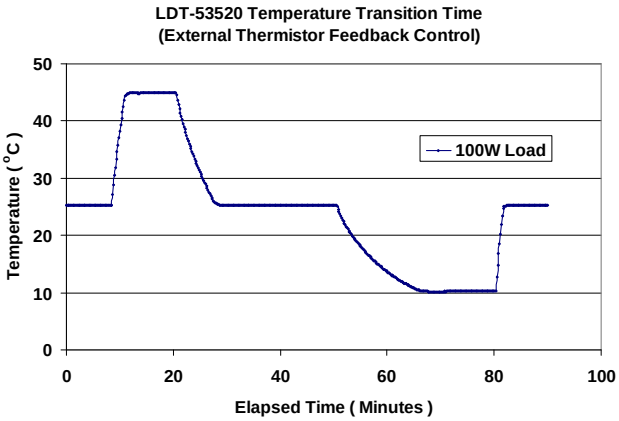

Figure 4: LDT-53520 temperature transition time using external thermistor feedback control

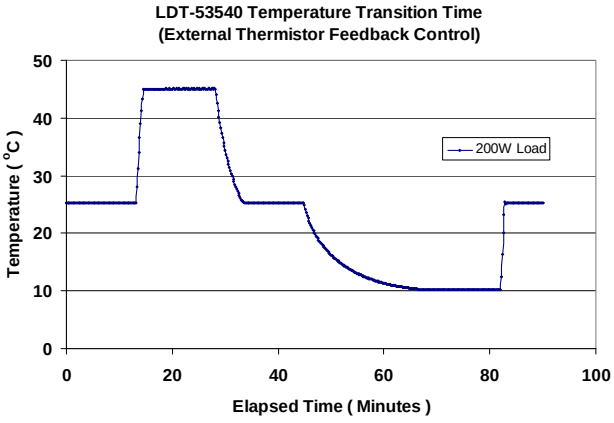

Figure 5: LDT-53540 temperature transition time using external thermistor feedback control

Table 2 summarizes the temperature transition time for each test case. When changing from a lower temperature to a higher temperature the transition time is faster than changing from a higher temperature to a lower temperature due to the self heating from the thermal load.

Table 2: LDT-53500 temperature transition time in different test cases

Test	Transition Time (mm:ss)			
	25°C → 45°C	45°C → 25°C	25°C → 5/10 °C	5/10°C → 25 °C
1	03:00	06:10	15:00	02:10
2	02:40	07:30	15:10	01:40
3	01:50	04:30	13:10	01:30
4	01:30	05:40	17:10	01:00
5	02:40	08:10	15:40	01:30
6	01:40	05:40	21:00	01:10

Generally, the LDT-53540 has shorter transition times than the LDT-53520 because the LDT-53540 has more cooling capacity. However, it takes longer for the LDT-53540 to cool down a 50% maximum power thermal load from 25°C to 10°C. This is because the 50% thermal load is approximately 87% of the maximum cooling capacity of the LDT-53540, compared to the 50% thermal load of the LDT-53520 being only 77% of the maximum cooling capacity. Table 3 on the following page shows the percentage of thermal load versus maximum cooling capacity. Here ΔT is the temperature difference between ambient temperature and chiller temperature set point. The maximum cooling capacity is calculated using the equations shown in the figures of the ILX Technical Note "*Cooling Capacity of LDT-53500 Laser Diode Thermoelectric Chillers*".

Also from Table 2, the external feedback control has similar transition time as the internal feedback control. The exception is that the 25°C to 10°C transition time is 4 minutes longer for the external feedback control to cool down a 50% thermal load using LDT-53540. When operated using an external temperature sensor as the feedback control, the LDT-53500 chiller temperature output will be lower than using the internal temperature sensor. The temperature is lower due to the LDT-53500 compensating for additional heat sources introduced into the system. Since the LDT-53540 was operating near the maximum cooling capacity every degree lower in temperature the maximum cooling capacity of the chiller is reduced.

Table 3: Maximum chiller cooling capacity for cooling the 50% maximum power thermal load to 5°C (or 10°C)

Test	ΔT (°C)	Maximum Cooling Capacity (W)	Thermal Load Power (W)	Percentage (%)
1	18.3	98	50	51
2	13.9	130	100	77
3	17.9	168	100	60
4	12.9	230	200	87
5	12.8	138	100	72
6	13.3	225	200	89

CONCLUSIONS

The data presented in this technical note shows typical transition times of the LDT-53500 chiller. Transition time is affected by thermal load, temperature set point, and in some cases use of the external temperature sensor. By selecting a higher cooling capacity chiller, a lower power thermal load, and the internal thermistor feedback control will shorten the transition time from higher temperatures to lower temperatures.