Application Note 11

Fiber Optics & Photonics

Temperature Monitoring Using a Simple GUI for Newport Current Controllers and Power Meters

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Temperature Monitoring Using a Simple GUI for Newport Current Controllers and Power Meters

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Introduction

This application note describes a simple Graphical User Interface (GUI) developed to allow the users to monitor thermoelectric current I_{TE} and thermoelectric cooler (TEC[1]) temperature T over time t, or optical power P over T, with Newport controller and power meter products. The I_{TE}/T vs. t measurement function can be useful during the initial setup of the TEC controller. The P vs. T function is important in finding out the thermal characteristics of the device under test. Together, they provide useful information about the thermal characteristics of the system, including the TEC, controller, mounts, heat sink, and the device itself. This application note assumes that the reader has a basic understanding in TEC control and photonic and optoelectronic devices.

Need of Temperature Monitoring for Applications Using TECs

There are numerous technical applications where adequate temperature tuning and controlling are required. This is not an exception to photonics and optoelectronic applications, where Newport LDD/TEC controllers and power meters are most often used. Temperature modifies dynamics of the device and optical characteristics, and thus thermal control is typically required in order to achieve consistent performance or to meet operation specifications within a range of temperature.

However, measuring the relationship between power produced or current drawn by the device and temperature does not always reflect the true thermal characteristics of the device itself. Depending on the design of the device package, thermal loading, heat sinking, the choice of the TEC, and the parameters used for the controller, the thermal behavior of the whole measurement system can vary significantly, adding measurement errors unrelated to the device itself. One needs to optimize the parameters used for the controller beforehand to minimize the system related fluctuations.

A sample program was developed with these goals in mind-first. Following the development of the program, two experiments were performed to demonstrate the capability of the program. The results are summarized in the following sections.

Development of a GUI and Equipments Used for The Experiment

Equipment used for the development and the experiments: Newport 2832-C power meter and Model 8000 modular controller, and a personal computer with a GPIB communication interface. Model 8350 40 W Temperature Controller Module and 8630 Combination Laser Diode Drive/TEC Module were used in the 8000 controller. Substitution can be 1832-C, 1835-C, 2835-C, 1932-C for the power meter, Model 6000 controller for the current and temperature controller.

The GUI consists of three main tabs, each of which is very intuitive to use. The first is the **Instrument Setup** tab, where the user specifies the model numbers and the GPIB addresses of the controller and the power meter. (Figure 1) The program assigns the entered GPIB addresses to the instruments. After the "Initialize GPIB" button is clicked using a mouse, the GPIB communication is initialized and the "Start Measurement" buttons on the other tabs are enabled.

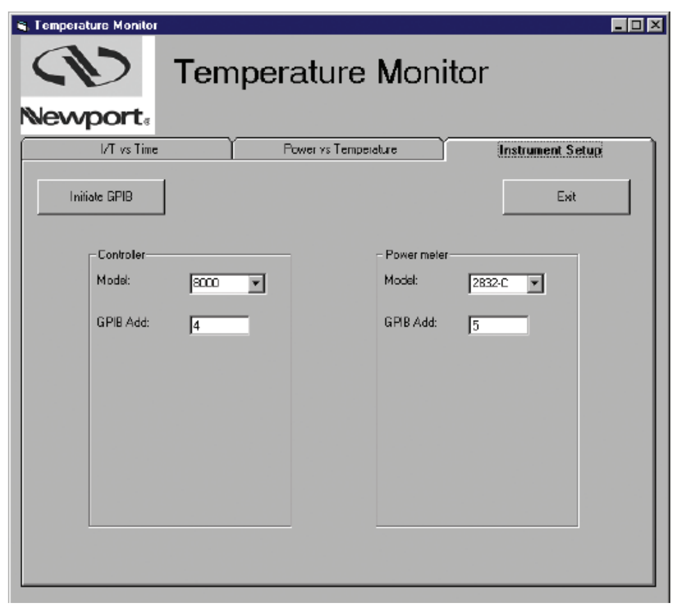

Figure 1. The instrument setup tab of the Temperature Monitor program.

[1] *Newport Corporation often uses the acronym TEC for "temperature controller".*

Figure 2 and 3 displays the **I/T vs Time** tab and the **Power vs Temperature** tab, respectively. Note that the "Start Measurement" button in the Power vs Temperature is not enabled if the Power Meter Model box in the **Instrument Setup** indicates "None".

On the I/T vs Time tab, "TEC Ch" is the temperature controller channel from which the data are taken, "Target T" is the target temperature, "Initial Wait Time" is the waiting time before starting the measurement, "DAQ Interval (per sec)" indicates the number of data taken per second, and "Num Data Points" is the number of data that will be taken. In Power vs Temperature, "Temp Range" specifies the temperature range at which the measurement takes, "Temp Step" is the temperature increment step from one temperature to the next one, "Initial Wait Time" is the waiting time before measuring the first data, "Power Meter Ch" and "TEC Ch" are the channel of the power meter and the temperature controller, respectively, "Data point at each temperature" is the number of data taken at each temperature, "DAQ Interval (per sec)" is the number of data taken at each temperature, and "Final Temp" is the temperature returned to after the measurement is completed.

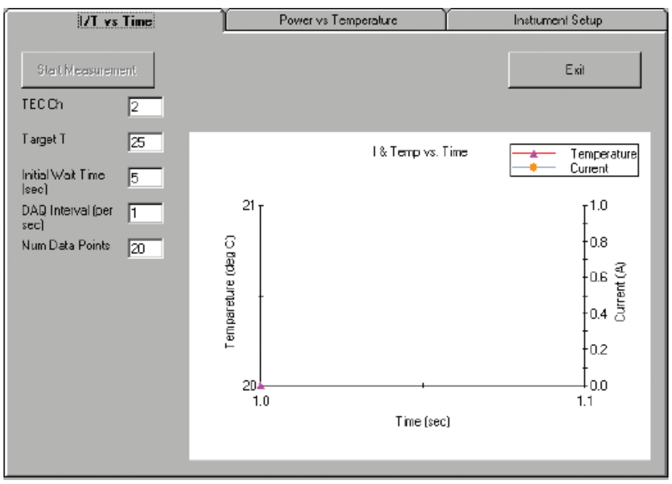

Figure 2. The I/T vs time t measurement tab.

Temperature Tuning a Laser Diode

The I/T vs. *t* measurement is especially useful when setting the initial parameters for the TEC unit. One will be typically interested in setting the parameters such that the temperature does not fluctuate more than required for a given time duration and that the time to reach to the desired temperature range as quickly as possible.

Below is an example data obtained using the program when a commercially available 980 nm pump laser diode was temperature controlled with the gain value of 1, tuned to 25 °C. Initially the device was operated at a higher temperature than the target temperature. The TEC is mounted inside the butterfly package, on which the laser diode is mounted. The laser module was mounted

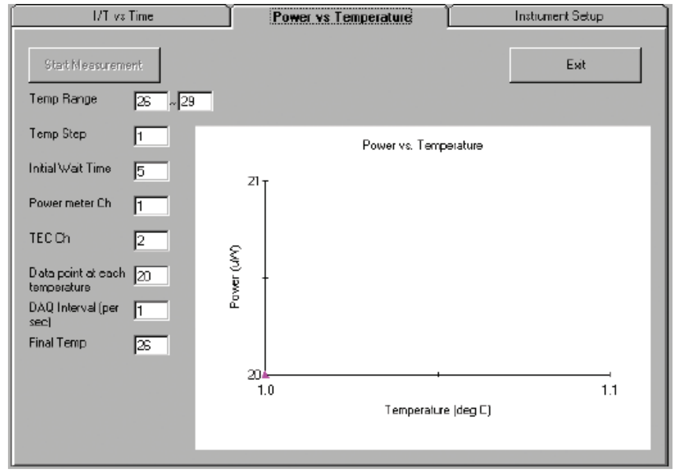

Figure 3. The Power P vs Temperature T tab.

on a Newport 740 Series Mount. The laser diode was controlled by the 8630 LDD/TEC Combination Module. The plot vividly shows the temperature and the current traces manifesting the fluctuations before settling at the specified temperature. With different gain settings, the TEC unit will exhibit different transient responses. Therefore it is possible to determine the optimal gain value by comparing the characteristics at each gain value. With a long Initial Wait Time or having the TEC turned on at the target temperature prior to the measurement, it is possible to observe the steady state performance of the TEC. An example of this capability is shown in the next section.

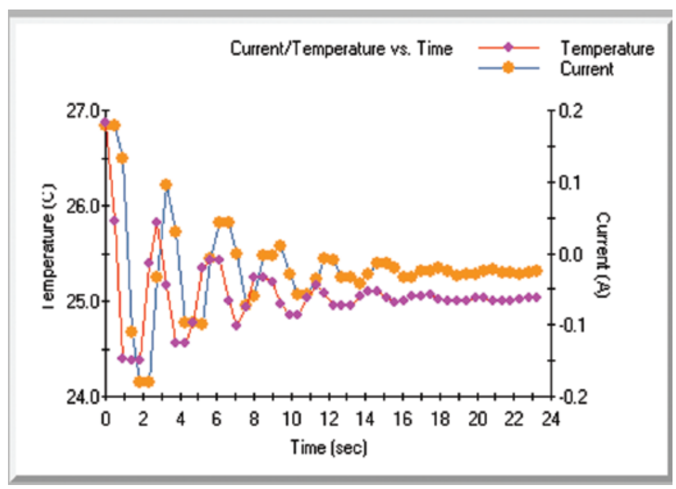

Figure 4. A plot of the temperature and current vs time, showing the transient fluctuations of the temperature, measured on a butterfly packaged 980 nm laser diode.

The following plot is the temperature dependence of the 980 nm laser diode at low power, slightly above the threshold level. It is clear that the optical power grows as the temperature goes down, just as expected.

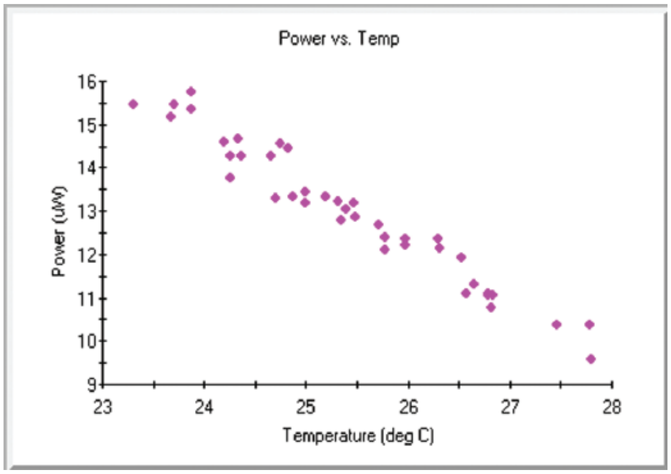

Figure 5. Change in optical power of the 980 nm laser diode as a function of temperature.

Temperature and Power Monitoring-Nonlinear Crystal Waveguide

In another application, we used this program for temperature tuning a periodically poled nonlinear crystal waveguide for second harmonic generation (SHG). The crystal generates blue light at around 490 nm, and is packaged in a butterfly-like covar package. The package consists of a metal base (43 *mm* x 18 *mm* x 2 *mm*), a package body with dimensions of 32 *mm* x 15 *mm* x 8 *mm*, and a 32 *mm* x 15 *mm* x 3 *mm* Peltier cooler sandwiched between them. The interfaces were bonded using thermally conductive epoxy. The crystal was clamped in the package body with a small metal clamp. The temperature sensor was placed inside the base of the package body, right underneath the center of the crystal on the metal. The package was mounted on a custom aluminum mount with a proper heat sink.

A singlemode fiber pigtailed output from the 980 nm pump laser is used as the input source. In periodically poled nonlinear crystals, the temperature changes affect the indices of refraction and the periodicity of the poled structure, which in turn affects the second harmonic conversion efficiency. The crystals were prepared such that the phase matching condition occurs at the temperature around 50 °C.

First, it is of importance to see whether the controller can keep the temperature with a tight tolerance, because the SHG intensity can be fairly sensitive to the temperature change. Figure 6 shows the I/T vs. *t* plot measured for one minute, when the gain setting was set as 60S*low*, which means that the proportional gain of 60 and the “slow” integral gain control were applied. More details about the gain setting can be found in User’s Manuals of the Newport controller products. The temperature was set at 46 degrees, and the plot shows that the temperature was maintained at approximately 46.04 ± 0.04 °C maximum.

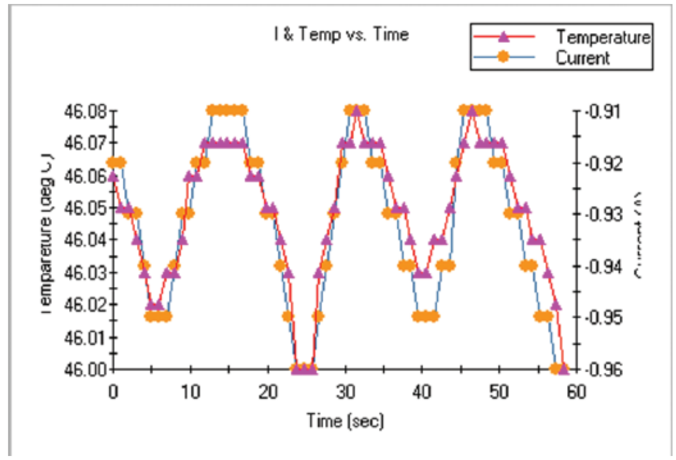

Figure 6. The steady state temperature of the nonlinear crystal package, controlled at 46 deg C.

Figure 7 demonstrates how the SHG intensity changes over a range of temperature, with the measurement step of 1 degree from 45 to 48 degrees. Since it takes some fluctuations before settling down at the specified temperature, naturally the data are filled with smaller, random temperature steps. The result is a smooth plot of P *vs*. T as shown in the plot. The peak conversion occurs approximately at 46.2 °C.

Just by obtaining a single temperature scan, it is possible to find the temperature where the optimal conversion occurs. Otherwise, temperature tuning can be very tedious because one will have to wait for a long time until the temperature stabilizes at each temperature before measurement is done.

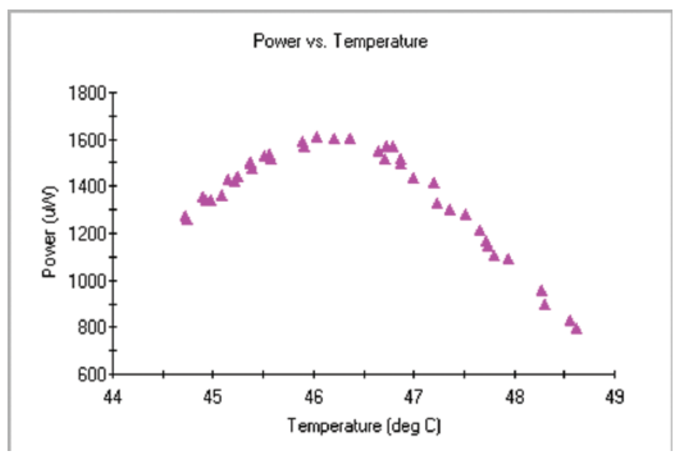

Figure 7. A P vs. T plot of the 490 nm intensity of a SHG crystal waveguide.

Conclusion

A simple GUI was developed using Newport model 8000 modular controller and 2832-C power meter that measures the T/ITE vs. t and P vs. T. These measurements are very helpful in setting up and characterizing the TEC unit, and finding out the thermal characteristics of the device under test. A brief operational description was provided, followed by a demonstration of the program using a commercially available laser diode module and a nonlinear crystal waveguide. This program can provide the user with more flexibility and capability in using Newport controllers and power meters in numerous other applications.

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