ICE Box Quick Start Guide

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Please read Limited Warranty and General Warnings and Cautions prior to operating the ICE Box.

Links

Click here for specifications on the ICE Box Card Chassis.
Click here for the ICE GUI Installation.
Click here for the ICE-QT1 Board.
Click here for the ICE-CS1 Board.
Click here for the ICE-QT1 Board API.
Click here for the ICE-CS1 Board API.
Click here for the ICE-PB1 Board API.

Contact sales [at] vescent [dot] com for questions and corrections, or to request added functionality.

Description

The ICE (Integrated Control Electronics) box is a compact suite of digitally controlled electronics that will precisely drive and stabilize our D2-100 DBR lasers and an associated array of photonics tools. It will simplify your experimental design and reduce SWaP while still providing the same high performance we offer in our D2 modular units. The ICE-Box conveniently houses and interfaces up to eight ICE daughter boards plus the Master and Control board to allow integrated control over complex laser experiments. Easily control four lasers and more (figure 1) from a single device through serial commands, the front-panel, or a GUI.

Fig. 1: The ICE Box controlling an atom-locked 4 laser system in maser/slave configuration
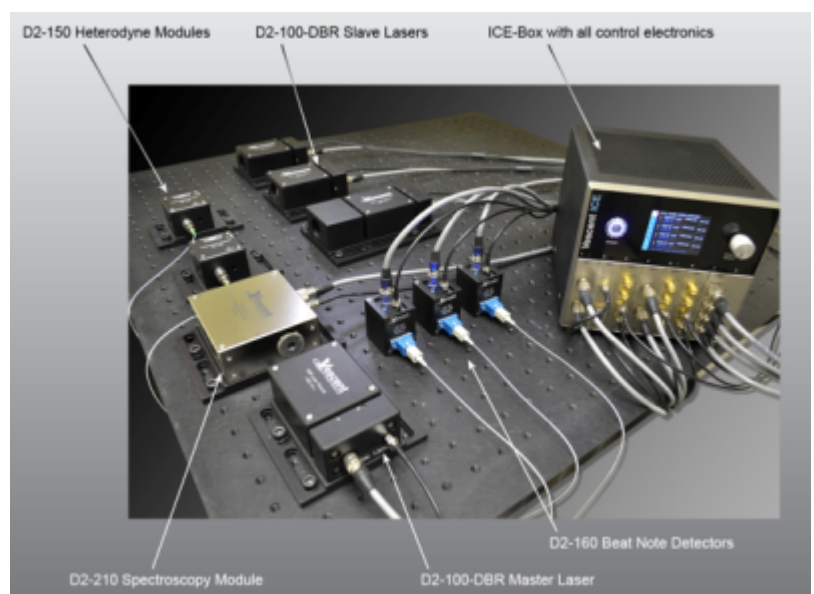
Overview

This guide will walk you through getting started with the ICE Box, setting up GUI controls, and locking a D2-100 DBR laser to spectroscopy using the ICE CS1, PB1, and QT1 cards. Preparing and aligning the laser system associated with obtaining this lock will not be covered in this quick start guide, but information on doing so can be found here. Further information on the functionality of individual ICE cards not covered in this guide can be found in their respective manuals (coming soon!).

Purchase Includes

- ICE Box Integrated Control Electronics Card Chassis
- USB Type-B Cable
- Power Cable (if purchased with ICE PS2 Power Supply)
- All required connection cables for included ICE Cards.

List of Symbols

⚠️	Warning. Pay special attention to procedures and notes.
⚡	Potential for electrical hazard.

Getting Started

After unpacking your ICE Box and ICE PS2 Power Supply, you should begin by familiarizing yourself with the connections on the back of the box. The sections below will guide you through setting up the ICE Box, and obtaining a lock to spectroscopy using the ICE Box GUI. The laser system used in this example is a D2-100 (780nm) DBR laser, and a D2-210 (Rb) spectroscopy module.

Powering on the ICE Box

To power on the ICE Box, connect the ICE PS2 power supply to a standard wall outlet, then connect the ICE Box to the ICE PS2 power supply with the included power supply cable. Toggling the rocker switch on the back of the ICE PS2 power supply will turn the power supply on, after which the front

rocker switch can be toggled to place the ICE system into standby mode. In standby mode, the ICE Box is not powered on, but can activate either by [serial API commands](#), or by pressing the circular power button on the front of the ICE Box. The four LEDs on the front of the ICE PS2 power supply indicate whether the ICE Box is in standby mode (top LED on), or receiving full power (bottom three LEDs on).

Making Connections to a Laser System

While the ICE Box is fully powered off, connect the temperature control of the D2-100 to the "Ch 1 & 2" Hirose connector on the ICE-QT1 card using an 8-pin Hirose cable. Attach an SMA cable to the "Laser Out" SMA on the ICE-CS1 card, then remove the 50Ω shorting cap from the D2-100 and connect the SMA cable to the laser. Finally, connect any of the 6-pin Hirose power connectors on the ICE-PB1 card to the power connector of the D2-210 spectroscopy module, and an SMA cable from the signal output of the D2-210 to the "Error In" connector on the CS1 card. Power on the ICE system. Descriptions of each card can be found below.

ICE-QT1

On the ICE-QT1 board there are two 8-pin Hirose connectors labeled "Ch 1 & 2", and "Ch 3 & 4" respectively. Each Hirose connector can control two TEC plants for a total of four plants per QT1 board. One ICE-QT1 board is able to temperature control two D2-100 lasers.

Fig. 2: The ICE QT1 Board

ICE-CS1

On the ICE-CS1 board there are two SMA connectors: "Error In" and "Laser Out". The "Error In" SMA takes the error signal from a photodetector such as the one in the D2-210, and the "Laser Out" SMA is for current controlling a laser diode such as the D2-100. Each D2-100 laser in your system needs its own ICE-CS1 or ICE-CP1 card to act as a current controller, depending on whether it's being locked to spectroscopy, or to a maser laser in an offset phase lock.

Fig. 3: The ICE CS1 Board

ICE-PB1

The ICE-PB1 board has Four 6-pin Hirose power connectors. This ICE card is primarily used to power system auxiliaries, such as the D2-210 spectroscopy module, or the D2-260 beatnote detector. Each connector on the ICE-PB1 board can power one auxiliary device, allowing four devices per board.

Fig. 4: The ICE PB1 Board

Installing and Using the ICE Control GUI

The ICE Control GUI can be found on our Github page here, and installed by scrolling to the bottom of the page and choosing between the three file formats. If you are using a Windows 10 machine, it will be easiest to download "ICE_Control_v1.2_32bit.zip", which includes an executable file. Once you have downloaded the .zip file, extract it to whichever directory will be most convenient to run an executable from. The executable must be left in the extracted folder, as it will have trouble finding some of its dependencies if you move it. It is important to note that you must both save the file (the Windows Default is to "Open" files), and also extract the file before the ICE Control GUI can be used. You will not be able to open the ICE Control GUI if you do not perform both of these steps.

Fig. 5: The download page for the ICE Control GUI

Once you're finished downloading and unzipping, navigate to the extracted file and double click "ICE_Control", which should be an executable with the Vescent Logo as its icon. A blank command prompt window will appear, and the ICE Control GUI will take a minute or two to open. It is not necessary to type any commands into the command prompt window.
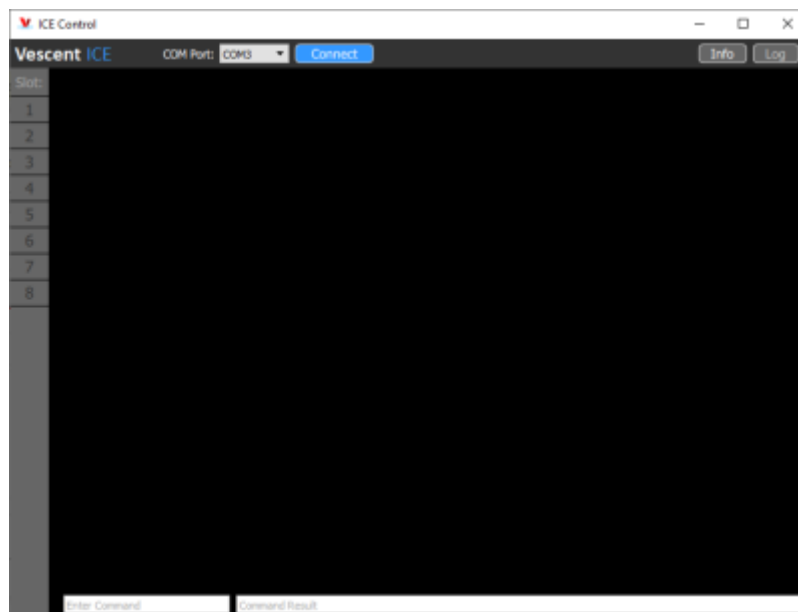

Fig. 6: The ICE Control GUI before Connecting to an ICE Box

Now that the ICE Control GUI is open, plug the powered on ICE Box into your computer using the included USB Type-B to USB Type-A cable and determine which COM port was assigned to it. To find the ICE Box's COM port on Windows, type "Device Manager" into the search bar at the bottom of the screen, press enter, and then expand the "Ports (COM & LPT)" drop down menu (figure 7). Unplug the

USB cable from your ICE Box and watch the list of COM ports to see which one disappears. Plug your ICE Box back in and observe the new COM port device appear in the menu. The COM port of each device is listed in parentheses at the end of each line. Select the correct COM port from the Drop Down menu in the ICE Control GUI and press "Connect".
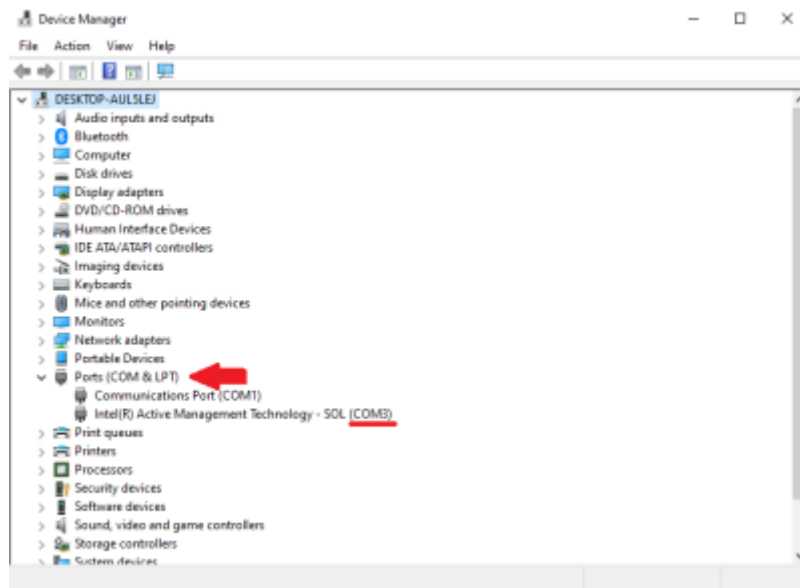

Fig. 7: Device Manager window highlighting the Ports drop down

The list of board slot numbers on the left hand side of the ICE Control GUI will illuminate, indicating which boards are installed. Boards can be selected from this list by clicking on the numbers to navigate to the control options for the corresponding ICE board.

Locking a Laser to Spectroscopy

After making all the necessary connections you will need to find spectroscopy. This can be done by enabling the laser through the ICE CS1 menu and setting the **Laser Current** to a value which gives the desired output (see figure 10). From there, modify the setpoint temperature of the QT1 card to the temperature specified in your D2-100's documentation. To do this, first ensure that the **T Min** and **T Max** temperatures are configured to safe values for your system, then click on the **TSet(C)** field to enter a new value with the keyboard. For the D2-100 it is recommended to set **Stage 1** (Top) to 25°C, and to keep **Stage 2** (Bottom) between 15°C and 30°C.

Fig. 8: QT1 GUI showing TSet(C) and T Min/T Max locations

If using a D2-100 DBR laser purchased from Vescent, refer to the documentation which came with the laser to find the approximate **Stage 2** setpoint. Once the desired value is entered, click the **Servo: Off/On** button to engage the temperature servo. The **Temp(C)** field displays the measured temperature of the thermal plant, and **TError(mK)** displays the difference between **TSet(C)** and **Temp(C)** while the values are within the range of the monitor. **TError(mK)** is plotted in the graph below.

Fig. 9: QT1 GUI showing engaged servo and live error graph

If your D2-100 documentation is unavailable, start by setting **Stage 2** to 15°C, engage the servo, then increase it 0.5°C at a time until spectroscopy is found or 30°C is reached. Assuming that **Ramp** is enabled, and the value of **Range** is non-zero, this should be a reliable method to find spectroscopy.

Fig. 10: Rb Spectroscopy (top) and Peak Lock Differential signal (bottom)

Once spectroscopy has been found, align the feature you want to lock to with the center line on the GUI plots. You can do this either by changing the **Laser Current** supplied to the diode, or by shifting the **Center** dial in the **Ramp** box. Turning **Range** up and down will make your ramp amplitude larger or smaller and show you more or less of your spectroscopy. Whatever is lined up with the center line on the plots is the feature the ICE Box will try to lock to. If you want to lock to a peak, align the top graph with the peak you want, and note that the bottom graph's peak lock signal should be near the middle of a slope.

The intuitive thing to do is to center right on the feature you want, but you actually want to be a little bit offset from that. The ICE Box gives a slight kick when the servo is engaged, so if you're perfectly centered on a feature it can sometimes bump you over to the next peak. It doesn't matter which side you offset from (a little right or left will be fine) as long as you're still on the correct slope. The servo will always kick towards the center of the selected slope. It's recommend to aim for a roughly 5% offset from center when aligning the feature you wish to lock to.

Fig. 11: CS1 GUI showing the Ramp Box, and the Center Line to which the Servo Locks

Engage the **Servo** button and watch the signals. The top graph should go to a value that corresponds to the feature you were trying to lock to, and the bottom graph should go to zero.
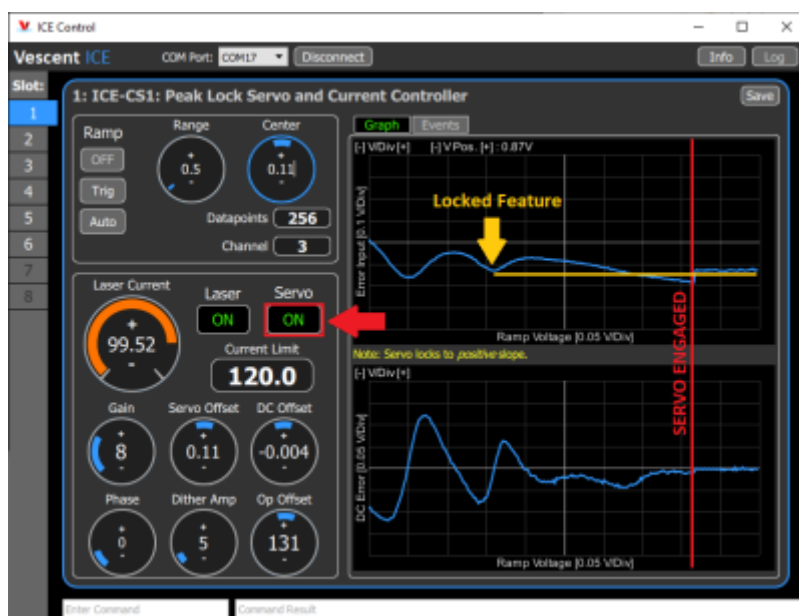

Fig. 12: When the ICE Box locks to spectroscopy, the top graph will flatten out at a DC offset corresponding to the locked feature (Yellow Line)

If these do not happen, it might mean that your **Op Offset** and **Gain** settings are not optimal such as in figure 13. To optimize these, turn your gain down as low as it will go without losing lock, and then adjust the **Op Offset** so that the signal on the bottom graph goes to zero. You may not be able to get it exact due to the digitization of that setting, but there will be a setting for which it is closest and changing up or down will flip what side of the line you are on. Once you've done this, turn **Gain** back up until the signal looks nice. Getting **Gain** to the right setting is a little difficult to do with just the ICE Box, but a good way to approximate it is to increase **Gain** until you lose lock, and then back off by ~40-50%. The optimal **Gain** setting ultimately comes down to your measurements of noise on externals such as a beat note between two lasers.

Fig. 13: Demonstration of how incorrect Offset and Gain can affect your lock

Finally, if you are only seeing the spectroscopy on the top graph of the CP1 GUI, and not the peak lock signal on the bottom graph, or if your peak lock signal appears to be small or weak, it is likely that your Phase and Dither settings are incorrect. Generally, it is best to optimize the Phase setting by adjusting the corresponding dial on the GUI, and then minimizing your Dither such that you are still able to reliably lock to the desired feature. The 4MHz frequency dither which is used to generate the peak lock signal is written onto the D2-100 being controlled by the ICE box, so the smaller the dither amplitude can be the better.

> ⚠ If using the mouse to drag the position of the GUI dials for dither and phase, note that the corresponding values are not updated until the mouse is released. For this reason, it's recommended that the + and - buttons on the face of the dial are used when attempting to optimize phase and dither.

Front Panel

The front panel can be seen in figure 14. The functions and connections are as follows:

1. Power Button
2. Interchangeable ICE Cards
3. ICE Box On Board GUI Monitor
4. Rotary Knob and Button for On Board GUI Navigation
5. ICE Card Slot Indicator

Fig. 14: Front Panel of the ICE Box

Rear Panel

The rear panel can be seen in figure 15. The functions and connections are as follows:

1. DB-9 Connector for TTL Serial Communications [1]
2. USB 2.0 Type-B port for Serial Communications
3. BNC Interlock
4. 5V/500mA fan connection pins
5. D-Sub Combo Power Connector

> ⚠️ The DB-9 Connector (1) is **NOT** for powering the ICE Box. Do not confuse it with the daisy chain power system used in the D2 product line. Attempting to use this connector for power may damage your ICE Box.
>
> Use the D-Sub Combo Power Connector (5) and the ICE-PS2 power supply as described here.

Fig. 15: The Rear Panel of the ICE Box

Contact sales [at] vescent [dot] com for questions and corrections, or to request added functionality.

[1)]
not compatible with RS-232

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