This user's guide describes the operation of the TI's Haptic Control Console software. Haptic Control Console (HCC) is an evaluation and development suite for TI Haptic Drivers. HCC supports the evaluation of TI haptic drivers and third-party haptic actuators for developing advanced tactile feedback.

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1 Description
Haptic Control Console (HCC) is an evaluation and development suite for TI Haptic Drivers. HCC supports the evaluation of TI haptic drivers and 3rd party haptic actuators for developing advanced tactile feedback. Users can connect TI Haptic Driver evaluation modules (EVM) to HCC through USB to set up, control, and evaluate the entire device. HCC includes custom device control consoles, detailed register maps, and basic RAM management (for applicable devices). See board compatibility in Table 1.

2 Features
HCC:
- Supports evaluation of haptic actuators, including eccentric rotation mass motors (ERM), linear resonance actuators (LRA), piezos, and solenoids.
- Includes device management features including custom device control consoles, complete register map access, and RAM management.
- Is compatible with TI evaluation modules in Table 1.
- Includes firmware update utility for compatible EVMs. An adapter board may be required.

3 Related Products
- DRV2510-Q1 – DRV2510Q1EVM
- DRV2511-Q1 – DRV2511Q1EVM
- DRV2604 – DRV2604EVM-CT
- DRV2605 – DRV2605EVM-CT
- DRV2604L – DRV2604LEVM-CT, DRV2604LDGSEVM-M
- DRV2605L – DRV2605LEVM-CT, DRV2605LDGSEVM-M, DRV2605LEVM-MD
- DRV2624 – DRV2624EVM-CT, DRV2624EVM-MINI
- DRV2625 – DRV2625EVM-CT, DRV2625EVM-MINI
- DRV2667 – DRV2667EVM-CT

4 Supported Evaluation Modules and Required Hardware

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5 Getting Started: General Overview

HCC GUI can be downloaded from Haptics Control Console Software.

After the user downloads the HCC GUI and goes through the setup wizard, the program will open a new window (see Figure 1).

![Figure 1. Empty Haptics Control Console](image)

1. Select Tools → Console to see a list of the haptic drivers that the HCC GUI supports (see Figure 2).

![Figure 2. Supported Haptic Drivers](image)

2. Plug in the board (in this example, the DRV2624EVM-CT) through the micro USB connector. Once plugged in, the board must be set to GUI mode by holding down the plus (+) button for approximately three seconds. The LEDs will flash and then the right half of the LEDs will remain on to indicate the board is in GUI mode. For devices other than the DRV2625EVM-CT, DRV2510Q1EVM, and DRV2511Q1EVM, the USB2ANY is required to transfer data between the haptic driver and the computer. After the user plugs in the device (through the USB2ANY or directly to the computer), the name of the driver will appear next to USB (see Figure 3). For the USB2ANY, the driver will be DRV-USBCOM-EVM if the firmware is flashed correctly. The user must then select Connect to begin interacting with the device. At the bottom of the screen, the connection to the device is monitored.
**NOTE:** At the top left of the console window (after DRVXXXX), the window must indicate USB (for example, see Figure 4). If it says Simulator, the board is not fully connected and the user will not be able to program the device. If it does not read properly the first time, try removing the USB from the computer, restarting the HCC program, and connecting again.

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**Figure 3. HCC Window After Board Connection**

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**Figure 4. Console Window for DRV2624 With Proper Connection**

The console window for the DRV2624 is divided into three sections: Initialization, Work Mode, and Board Status.

(1) The console window may look different for other drivers.
3. Click the Start button in the Work Mode section to begin testing the board, and click it again to stop.

![Haptic Control Console GUI](image)

**Figure 5. Program Windows Under the Tools Tab**

In the Console option in the Tools tab is the Register Map, which shows a complete overview of the registers and their values for the selected board. The Register Map updates in real time and has a search bar for easy access (users may have to expand the window to view the search bar). For each register, there is a Name, Address, Value, and Description. More information about each register is also available in the respective data sheets.

![Register Map Window](image)

**Figure 6. Register Map Window**

Users can change the register addresses and values from hexadecimal to decimal and vice-versa by selecting the Hex button in the toolbar (next to Register Map). For drivers with RAM, the RAM Manager allows the user to upload custom waveforms to the device. The DRV2604, DRV2604L, DRV2624, and DRV2667 can use the RAM manager. For detailed instructions on how to properly load the waveforms through the RAM Manager, view the data sheet of the board being used.
The I2C Sniffer (or Register Sniffer) records the data exchange between the device and HCC by displaying the data operations for each register. By default the sniffer is off and the user must right-click the window and select Start to begin observing the transactions (see Figure 7).

![Figure 7. Output of I2C Sniffer](image)

Besides the Register Map, the user has direct control over the registers through the Register Access window (see Figure 8) when a board is connected. Users can perform single- or multi-byte writes and reads. There is also an option to poll the I\(^2\)C to constantly monitor the communication lines.

The log is a useful tool for users who are experiencing difficulties. It will show errors for improper connections and other errors, such as when the user selects the Ethernet button when no Ethernet cable is attached. When something is not functioning correctly, the user should check the log for more information.

![Figure 8. Register Access Window for Register R/W](image)

**NOTE:** In the Preferences tab, there is an option called Force USB Data, which forces HCC to send data even if a haptic device is not recognized as present. When troubleshooting connection issues, users should consider this feature.
6 USB2ANY Setup Instructions

6.1 Updating the Firmware

The default USB2ANY code does not work with Haptic Control Console. Use these instructions to update the USB2ANY firmware:

1. Hold down the BSL button located next to the USB-Mini socket while plugging in the USB-Mini.
2. Open HCC and go to Help --> Firmware Update.
3. Click Scan Device. A return message should say "TI Standard BSL device found."
4. Click Open FW and select "DRV-USBCOM-EVM_v1p4".
5. Click Update and the firmware should update.

6.2 Connecting the USB2ANY

The USB2ANY now appears as the DRV-USBCOM-EVM in the Haptic Control Console Window. See Table 1 for specific EVMs. Connect wires between SDA, SCL, and GND from the USB2ANY to the EVM selected. These pins are shown in Figure 9.
7  Board Specific Information

7.1  DRV260x and DRV260xL

7.1.1  Getting Started

The USB2ANY is required to interact with the DRV260x EVMs and DRV260xL EVMs through HCC. For simplicity, this guide will refer to the DRV2605EVM.

1. Connect the USB2ANY by using three jumper cables to connect SDA, SCL, and GND on the DRV2605LEVM to the three pins by the same name on the USB2ANY. See the USB2ANY datasheet for a detailed map of the board (pending USB2ANY release).

The DRV2605EVM will be ready to accept I²C transactions once it is powered on and in GUI mode. To set the board to GUI mode:

1. Press and hold the increment mode button (+) for approximately three seconds until the mode LEDs flash and the colored LEDs flash once.
2. Press and hold the increment mode button (+) one more time until the mode LEDs flash and the colored LEDs flash twice. For more information, see the Additional Hardware Modes section of DRV2605 Haptic Driver for ERM and LRA With Built-In Library and Smart-Loop Architecture.

2. Press B1 once in GUI mode to control the ERM, and press B2 to control the LRA.

The actuator must be chosen through the hardware by physically pressing the buttons. Changing the Actuator in the settings tab on HCC will not change which actuator is in operation on the board, only which signal is being sent from the driver. The user must separately chose the actuator through HCC and chose the same actuator on the board using buttons B1 or B2.

7.1.2  Consol Window Overview

The console window is divided into two sections: Settings and Work Mode. The Settings section contains four tabs (Actuator, Voltage, Calibration, and Advanced) that are used to set the registers of the DRV260x device. The Work Mode section has a drop down menu containing the different types of trigger modes, PWM input, Analog input, Real Time Playback, Diagnostics, Actuator Life Test, and Audio to Haptics (for DRV2605 and DRV2605L only). The user should first input the settings according to the actuator being driven and then choose the appropriate work mode.

7.1.2.1  Console Window Settings

In the Actuator tab, the user can choose whether they want to drive an ERM (eccentric rotating mass) or an LRA (linear resonant actuator) by selecting the Actuator tab and choosing accordingly. From here, they can select closed or open loop to run the device with or without the auto-resonance frequency tracking. The DRV2605 and DRV2605L have a selection of six ERM and one LRA libraries for the user to choose from in the Library drop-down tab. For LRA mode, users should also enter the resonance frequency of the LRA being driven. This frequency is used in the calculation for Rated Voltage and DRIVE_TIME.

In the Voltage tab, the user can adjust rated voltage (full-scale output during closed-loop) and the overdrive voltage (maximum voltage allowed to actuator). In open loop the output voltage is determined by the overdrive voltage. The corresponding register addresses and values are also shown.

The Calibration tab is used to calibrate the ERM or LRA being tested. The result of the calibration will appear letting the user know if the calibration was successful or failed. In the event of failing calibration make sure the ERM and LRA parameters are correct and the actuator is attached to a stable mechanical ground. If the calibration still fails move to the Advanced tab and refer to the datasheet.

The Advanced tab contains advanced settings used for calibrating the actuator. The DRIVE_TIME should be set appropriately based on the LRA frequency or the frequency in which the user wants to sample the BEMF voltage of the ERM. The DRIVE_TIME is one half of the period of the resonance frequency of the LRA. The DRV26xx devices use this DRIVE_TIME as an initial guess of the LRA frequency as the auto-resonance tracking algorithm begins. BLANKING and IDISS are described in the datasheet. The ZC_DET_TIME only appears in the DRV260xL console window and represents the minimum length of time devoted for detecting a zero crossing.
For a more detailed explanation of the registers used in the Actuator, Voltage, Calibration, and Advanced tabs, the user should utilize the Register Map (Tools → Register Map → DRV260X) or the data sheet.

### 7.1.2.2 Console Window Work Mode

Within the Work Mode section, the user has several options according to how they wish to control the actuator. For the DRV2605 and DRV2605L, the internal libraries are available for use in the first three tabs (Internal Trigger, External Edge Trigger, and External Level Trigger). The DRV2604 and DRV2604L contain RAM for the user to load custom waveforms (through the RAM Manager) while the DRV2605 and DRV2605L have ROM that contains the licensed Immersion® TouchSense® waveform library. The first three tabs are not usable for the user with the DRV2604 and DRV2604L until they upload waveforms onto the board.

To control the actuator using an outside waveform, select External PWM or External Analog accordingly and then reference the Hardware Configuration section of the DRV2605EVM-CT or DRV2605LEVM-CT user's guides for information on how to connect the hardware.

Real Time Playback gives the user direct control over the chosen actuator. Remember, the user must have the same actuator chosen on the board (B1 for ERM, B2 for LRA) and on HCC in the Actuator tab.

The Diagnostic mode will run diagnostics and show the results for success or fail.

The Actuator Life Test mode gives users the ability to run long lifetime tests with specified ON and OFF times. Enter the desired times to be tested and then the number of cycles to test. The last mode, Audio to Haptics, shows the settings for the Audio to Haptics function. Refer to the datasheet for explanations of these settings.

### 7.2 DRV2505LEVM-MD

#### 7.2.1 Getting Started

The DRV2605LEVM-MD is capable of directly connecting to the HCC GUI without external I2C control and therefore does not need the USB2ANY. First, connect the DRV2605LEVM-MD to the PC USB port. Next, the user switch must be pressed. When the user switch is pressed, the board goes to USB communication mode, which disables the capacitive touch buttons. A power cycle or software reset is required to go back to capacitive-touch mode. The user switch is a pushbutton labeled USER SW and LED1 turns on to indicate that the firmware is active for USB transactions.

![HCC After DRV2605LEVM-MD Connection to PC](image)

**Figure 10. HCC After DRV2605LEVM-MD Connection to PC**

After selecting the user switch and ensuring the LED1 light is on, open up HCC and select 0.TI-Haptics DRV2605LEVM-MD and then Connect in the drop-down window next to USB.

After connecting, the DRV2605LEVM-MD console window automatically appears. If properly connected, the console window displays a Console: DRV2605LEVM-MD – USB title. If the DRV2605L console window appears instead of the DRV2605LEVM-MD, then the board needs a firmware update to communicate properly with HCC. To perform a firmware update, go to Help → Firmware Update and then follow the instructions listed at the bottom of the window and try the process again.
7.2.2 Console Window Driver and Settings

In the console window, there are two main tabs: Driver and Settings. Within the Settings tab, the user can properly initialize the board for use with the actuators and run Auto Calibration to ensure optimum performance. Settings can also be imported and exported in the Settings tab. In the Driver tab, there are two modes: Effect Sequence Playback and Real Time Playback (RTP). In Effect Sequencer mode, the user can set different waveform sequences to different actuators, and then trigger all of the actuators to vibrate with one click. In RTP mode, all the actuators will vibrate at the same amplitude with one click.

7.3 DRV2624 and DRV2625

7.3.1 Getting Started

To control the board with HCC, the user must first plug in the board and then set it to GUI mode. For the DRV262xEVM-CT, set the board to GUI mode by holding down the (+) button for approximately three seconds. The LEDs will flash and then the right half of the LEDs will remain on to indicate the board is in GUI mode. Once the user plugs in the device, the name of the driver will appear next to USB (shown in Figure 3). The user must then select "Connect" in order to begin programming the device. At the bottom of the screen, the connection to the device is monitored. If using the DRV262XEV-Mini, please connect the NRST pin to VDD or a GPIO because HCC does not control the NRST pin. Also, connect the SDA, SCL, and GND lines to the USB2ANY (required for the mini-board). If HCC recognizes the DRV-USBCOM-EVM but not the DRV262XEV-Mini, try using the console window simulator and forcing the USB communication (Tools → Preferences → Force USB Data). The DRV262X must be externally powered to receive I2C commands.

7.3.2 Console Window Overview

The DRV2624 and DRV2625 have the same console window layout. The console is divided into three sections. The initialization section is divided into four tabs: Actuator, Voltage, Interrupt, and Advance. This section is used to change the actuator settings. The work mode section is used to start and stop different processes available for driving actuators. The final section contains reset buttons, NRST high/low, and a pulse trigger button.

7.3.2.1 Initialization: Actuator

Within the Actuator tab, the user can select the settings at which they would like to operate their chosen haptic actuator. By selecting Open Loop instead of Closed Loop, the user bypasses the auto-resonance tracking and can manually set the frequency. The TRIG PIN FUNC refers to the type of trigger used to start all processes (RTP, Waveform Sequencer, Calibration and Diagnostics). The trigger can be controlled by software using the GO bit (internal trigger), or by hardware using the TRIG/INTZ pin (external trigger pulse or level). For more information, refer to the DRV262x data sheet. The AUTO BRK OL box will enable auto-braking out of open loop operation. The AUTO BRK INTO STBY will enable braking when the part is put into standby. The user cannot select the Voltage, Interrupt, or Advance tabs until a frequency value is input.
7.3.2.2 Initialization: Voltage

Within the voltage tab, the user can adjust rated voltage (full-scale output during closed-loop) and the overdrive voltage (maximum voltage allowed to actuator). In open loop the output voltage is determined by the overdrive Voltage. The corresponding register names, values, and addresses are also shown (see Figure 11).

![Figure 11. Initialization: Voltage Tab](image)

7.3.2.3 Initialization: Interrupt

The Interrupt tab contains five different interrupt notifications. The details of each type of notification can be found in the register map with the name of the register as shown in Figure 12. The register map window may need to be enlarged to reveal the search bar. More information can be found in the device data sheet.

![Figure 12. Result From Searching OC_DETECT in Register Map](image)

7.3.2.4 Initialization: Advanced

The final tab in the Initialization section gives the user advanced control over the actuator. Some actuators may require fine-tuning for proper auto-calibration. The specifics of each parameter can be found by looking up the register in the register map or referring to the datasheet.
7.3.3  Work Mode: Overview

Within the Work Mode section, there are several options: Real Time Playback, Waveform Sequence, Diagnostic, AutoCalibration, and Actuator Life Test. Users should fill out the Initialization section before moving to the work mode section. Next, users should use the auto-calibration mode.

7.3.3.1  Work Mode: Auto-Calibration

Before testing the device, the user should run auto-calibration. The auto-calibration routine expects the actuator to have reached a steady acceleration before the calibration factors are calculated. Because the start-time characteristic can be different for each actuator, the AUTO_CAL_TIME parameter can change the duration of the automatic level-calibration routine to optimize calibration performance. The calibration routine will return and automatically populate the A_CAL_COMP, A_CAL_BEMF, and BEMF_GAIN registers with the appropriate value for the actuator.

7.3.3.2  Work Mode: Real Time Playback

After adjusting the settings, Real Time Playback allows the user to proportionally control the actuator. The user can adjust the playback strength of the actuator by moving the sliding bar and the value is stored in the RTP_INPUT register. If an LRA is operating in closed loop mode, the Report Freq box shows the resonant frequency. The user can observe the usefulness of Auto-Resonance Detection by operating a LRA in open loop mode at a frequency different than the resonant frequency and observing the drop in performance.

7.3.3.3  Work Mode: Waveform Sequence

For the DRV2625, the waveforms stored in ROM memory appear in the drop-down menu. The DRV2624 contains 1 kB of integrated RAM for custom waveforms instead of the library. For the drivers with RAM such as the DRV2624, the Waveform Sequence tab will not be usable until the user loads waveforms onto the board using the RAM Manager (Tools → RAM Manager → DRV2624).
As shown in Figure 14, the user can select from 123 waveforms using the drop down menu to navigate the waveforms and can repeat the waveform up to three times per sequence. Additionally, the user can enable a delay into the sequence by selecting the Delay box, and can use the slide bar to set a delay from 0 to 1270 ms. There are also several other controls such as play interval, scaling, and main repeat (repeats the entire sequence) to provide ease of use and control.

Scaling will control the output magnitude. The Playback Interval controls the time step of waveforms. When switching from 5 ms to 1 ms, the waveforms will be approximately five times shorter.

7.3.4 **Work Mode: Diagnostic**

In the Diagnostic tab, the user can determine the actuator impedance. The DRV262x device is capable of determining whether the actuator is not present (open) or shorted. If a fault is detected during the diagnostic process, the DIAG_RESULT bit is asserted. The DRV262x device also features actuator resistance measurement, which is available in the DIAG_Z_RESULT parameter. More information is available in the DRV262x data sheet.

7.3.5 **Work Mode: Actuator Life Test**

The final option in Work Mode, the Actuator Life Test, lets the user run the actuator for a number of cycles to observe the performance over time.

7.4 **Board Status and Pulse Trigger**

The DRV2624 and DRV2625 devices have an automatic go-to-standby state and a battery preservation function to help reduce power consumption without user intervention. The NRST pin allows for a full shutdown state for additional power savings and the user can set it HIGH or LOW. In order to utilize the Pulse Trigger button, the user must set the TRIG_PIN_FUNC to 0 (Ext-pulse Trigger) within the Actuator tab of the Initialization section. The Pulse button will pulse a high signal on the TRIG pin.
7.4 **DRV2667**

7.4.1 **Getting Started**

A USB2ANY is needed to connect the DRV2667 to the computer. Connect the USB2ANY by using three jumper cables to connect SDA, SCL, and GND on the DRV2667EVM-CT to the three pins by the same name on the USB2ANY. See the USB2ANY datasheet for a detailed map of the board (pending USB2ANY release). The DRV2667EVM will be ready to accept I2C transactions once it is powered on. The DRV2667EVM does not need to be in GUI mode to communicate with HCC over the USB2ANY through I2C. See External I2C Input on the DRV2667EVM for more information. After connecting the USB2ANY to the DRV2667EVM and both boards to the computer, the user must press Connect to begin controlling their device through the GUI.

7.4.2 **Console Window Overview**

After connecting to the DRV2667EVM, the console window will appear. The console window is divided into two sections, settings and work mode. In the settings section, the user can adjust the gain, which adjusts the output voltage from the driver that goes into the Piezo. A breakdown of the gain is shown below:

- 28.8 dB, 50 Vpp
- 34.8 dB, 100 Vpp
- 38.4 dB, 150 Vpp
- 40.7 dB, 200 Vpp

Refer to the **Adjusting the Boost Voltage Using Software** section of the DRV2667EVM-CT user's guide to adjust these settings via software or hardware. Within work mode, there are three options: Internal trigger, External Analog, and FIFO Playback. In order to operate the Internal Trigger RAM mode, the user must upload waveforms using the RAM Manager. In External Analog mode, waveforms must be input into the device. In FIFO Playback mode, the user can control the actuator by adjusting the settings and selecting Start.
7.4.2.1 Work Mode: Internal Trigger – Uploading Waveforms

To upload waveforms through the RAM Manager, the user must go to Tools → RAM Manager → DRV2667. Here the user can load waveforms from binary files (.bin) by selecting Import and then Write RAM. The user can create custom waveforms for non-commercial use through the WaveSynthesizer (see Figure 15) by selecting Advanced in the DRV2667 RAM Manager.

![WaveSynthesizer for DRV2667](image)

Figure 15. WaveSynthesizer for DRV2667
The user can create waveforms by adjusting the frequency, amplitude, duration, and number of times the waveform will repeat and then selecting Create. For haptic applications of piezos, the frequency of the waveforms is generally 100 to 200 Hz. Higher frequency waveforms may emit audible noise. Once created, the waveform will appear in the Waveforms block with the name Effect 1. Subsequent waveforms will be named Effect 2, Effect 3, and so on. The most recently created waveform will appear in the graph at the bottom. After creating the desired waveforms, selecting Write RAM will make the created waveforms selectable in the DRV2667 console window.

Alternatively, the waveforms could be controlled from the WaveSynthesizer window via the Waveform Sequencer block. The user must move the waveforms from the Waveform block to the Waveform Sequencer block by selecting the name of the waveform and clicking the appropriate arrow. To play the waveforms on the attached piezo, select Start Waveforms.
7.4.2.2 Work Mode: External Analog

In External Analog mode, waveforms must be input into the device. The Analog.PWM Input section of the DRV2667EVM-CT user's guide is referenced below for more information:

![Diagram of DRV2667EVM-CT](image)

The DRV2667EVM-CT accepts analog or PWM inputs for the analog IN+ and IN– pins of the DRV2667. To use the IN+ and IN– pins of the DRV2667 follow the instructions below:

1. Enter Design and Test Modes. Select Mode 7 (00111'b) using the increment mode button (+).
2. Select the gain and voltage using buttons B1–B4:
   - B1 – 28.8 dB, 50 Vpp
   - B2 – 34.8 dB, 100 Vpp
   - B3 – 38.4 dB, 150 Vpp
   - B4 – 40.7 dB, 200 Vpp
3. Turn on the signal source to begin output.

7.4.2.3 Work Mode: FIFO Playback

For immediate control of the piezo, FIFO Playback mode outputs a 200-Hz sine wave or a custom waveform to the piezo. The duration can be adjusted from 5 to 20 ms.

7.5 DRV2510 and DRV2511

7.5.1 Getting Started

The user must plug the DRV2510EVM or DRV2511EVM into the computer through a micro USB cable. After 0.TI DRV251XQ1 EVM appears in the toolbar next to USB, select Connect. The console window should appear with the title Console: DRV251XEVM – USB. If the console window displays Simulator instead of USB, the board is not connected correctly. In addition to the USB, the DRV251xEVM must receive a separate power source for the driver. VDD is provided through jumper J5. The user can now connect the solenoid or voice coil and operate it through HCC.

**NOTE:** If initially on, the user must toggle Enable off and then back on the first time for the DRV to respond.

7.5.2 Console Overview

The console window is divided into two tabs: Standard Drive and WaveBuilder. Within Standard Drive, the user can control the PWM input frequency and voltage percentage (duty cycle). The WaveBuilder tab allows users to create custom waveforms for evaluation purposes.
7.5.2.1 Standard Drive Tab

In the Standard Drive tab the frequency can be adjusted for better resolution. Because solenoids do not undergo high frequencies, users can keep the PWM frequency at 32 kHz and create a square wave output by using the different types of PWM Playback. The PWM Playback can be changed by clicking on the Continuous button at the bottom of the window (see Figure 18). The three different modes are Continuous, Pulse, and Single output. If operating in Continuous mode, the user can adjust the frequency to approximately 200 Hz for best performance with solenoids. The Single and Pulse modes should use a higher PWM frequency with a setting that creates an output at the desired frequency. The recommended range for most solenoids is less than 200 Hz. Click the black box to enable and disable the output. There is a toggle switch for Enable and Hi-Z. To drive an output signal, the Enable slider must be in the ON position and the Hi-Z slider must be in the OFF position.

![Figure 18. DRV2510 Console Window](image)

**NOTE:** To change the PWM Input Frequency, the user must press the Enter key on their keyboard for HCC to recognize the new frequency. If the user enters a new frequency without pressing enter, the old frequency will be played.

7.5.2.1.1 Standard Drive Tab Diagnostics

In the status section of the DRV2510, there is a grid of eight different boxes labeled Active, Hi-Z, Diag Active, and so on that the user can find more information on by searching STA in the DRV2510 register map or by referencing the DRV2510 data sheet. If a fault is triggered, it will turn red on the console window. The DRV2511 does not have diagnostic reporting.
7.5.2.2 WaveBuilder Tab

The WaveBuilder tab allows users to create custom waveforms for evaluation purposes. The output PWM frequency is set at 32 kHz allowing high resolution. The control buttons do the following:

• Clear Plot: erases any data in the plot.
• Add Many Points from Text Box: loads the points into the plot.
• Add Single Point: appends the point in the box directly below the button to the plot.
• Start Waveform: enables the output.
• Triangle, Sine, and Impulse: appends preset waveforms to the plot area when clicked.
  – Use care when adding points to the graph because users cannot delete single points, users can only clear the whole plot.
• Time Between Steps: sets the time each point will last at that magnitude.
  – Users can also select the number of times to repeat the output or set an infinite loop.
• The large box in the middle can be filled with points separated by commas to build the desired evaluation waveform.

In the status section of the DRV2510, there is a grid of eight different boxes labeled Active, Hi-Z, Diag Active, and so on, and the user can find more information about each one by searching STA in the DRV2510 Register Map. If a fault is triggered, it will turn red on the console window. The DRV2511 does not have diagnostic reporting.

Revision History
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (December 2017) to A Revision

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• Added new section: Section 6
STANDARD TERMS FOR EVALUATION MODULES

1. **Delivery:** TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software.

1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 **Limited Warranty and Related Remedies/Disclaimers:**

2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects within ten (10) business days after the defect has been detected.

2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 **Regulatory Notices:**

3.1 **United States**

3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

**CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*
FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

http://www.tij.co.jp/lds/ti_ja/general/eStore/notice_01.page

3.3.2 Notice for Users of EVMs Considered “Radio Frequency Products” in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry’s Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.
【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術基準適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿6丁目24番1号
西新宿三井ビル

3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lads/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lads/ti_ja/general/eStore/notice_02.page

3.4 European Union
3.4.1 For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):
This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 EVM Use Restrictions and Warnings:
4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
4.3 Safety-Related Warnings and Restrictions:
4.3.1 User shall operate the EVM within TI’s recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User’s handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. Accuracy of Information: To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
6. **Disclaimers:**

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED “AS IS” AND “WITH ALL FAULTS.” TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSES OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. **User’s Indemnity Obligations and Representations.** User will defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, “Claims”) arising out of or in connection with any handling or use of the EVM that is not in accordance with these terms. This obligation shall apply whether Claims arise under statute, regulation, or the law of tort, contract or any other legal theory, and even if the EVM fails to perform as described or expected.

8. **Limitations on Damages and Liability:**

8.1 **General Limitations.** In no event shall TI be liable for any special, collateral, indirect, punitive, incidental, consequential, or exemplary damages in connection with or arising out of these terms or the use of the EVMs, regardless of whether TI has been advised of the possibility of such damages. Excluded damages include, but are not limited to, cost of removal or reinstallation, ancillary costs to the procurement of substitute goods or services, retesting, outside computer time, labor costs, loss of goodwill, loss of profits, loss of savings, loss of use, loss of data, or business interruption. No claim, suit or action shall be brought against TI more than twelve (12) months after the event that gave rise to the cause of action has occurred.

8.2 **Specific Limitations.** In no event shall TI’s aggregate liability from any use of an EVM provided hereunder, including from any warranty, indemnity or other obligation arising out of or in connection with these terms, exceed the total amount paid to TI by User for the particular EVM(s) at issue during the prior twelve (12) months with respect to which losses or damages are claimed. The existence of more than one claim shall not enlarge or extend this limit.

9. **Return Policy.** Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. **Governing Law:** These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.
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