

Vaunix Technology Corporation
Lab Brick® Microwave Frequency Synthesizer
Win32 SDK

Overview

The Lab Brick Microwave Frequency Synthesizer Win32 SDK supports developers who want to control Lab Brick Microwave Frequency Synthesizers from 32 bit Windows programs, or who want to control the synthesizers from LabVIEW¹ or other National Instruments programming environments. For 64 bit Windows² applications use the Vaunix Windows x64 SDK. The Win32 SDK includes a dll which provides a Win32 API to find, initialize, and control the synthesizers, along with header files and an example Win32 C program which demonstrates the use of the API. Three versions of the 32 bit dll are available. The version with ANSI-C style dll linkage, which should be used with LabWindows,³ is generally the easiest version to use with Python and similar programming environments, and should be preferred for new development projects.

The version of the dll which uses Microsoft's C++ style dll linkage includes standard Microsoft style function name decoration and is well suited for use as a component of C++ applications. The STDCALL version is provided to support operation with Microsoft's Visual Basic for Applications language.

If you need a similar library for use with the Linux family of operating systems please contact Vaunix technical support.

Using the SDK

The SDK consists of a dll, named VNX_fmssynth.dll, along with this documentation, a C style header file, a library file for linking to the dll, and a VC 2008 example program. Unzip the SDK into a convenient place on your hard disk, and then copy the dll and library file into the directory of the executable program you are creating. Add the header file (VNX_fmssynth.h) to your project, and include it with the other header files in your program. Make sure that the linker directives include the path of the library file.

Overall Strategy and API architecture

The API provides functions for identifying how many and what type of LabBrick microwave frequency synthesizers are connected to the system, initializing the synthesizers so that you can send them commands and read their state, functions to control the operation of the synthesizers, and finally a function to close the software connection to each synthesizer when you no longer need to communicate with it.

The API can be operated in a test mode, where the functions will simulate normal operation but will not actually communicate with the hardware devices. This feature is provided as a

¹ LabView is a trademark of National Instruments

² Windows is a trademark of Microsoft

³ LabWindows is a trademark of National Instruments

convenience to software developers who may not have a LabBrick frequency synthesizer with them, but still want to be able to work on an applications program that uses the LabBrick. Of course it is important to make sure that the API is in its normal mode in order to access the actual hardware!

Be sure to call `fnLMS_SetTestMode(FALSE)`, unless of course you want the API to operate in its test mode. In test mode there will be 2 devices, an LMS-103 and an LMS-123.

The first step is to identify the synthesizers connected to the system. Call the function `fnLMS_GetNumDevices()` to get the number of synthesizers attached to the system. Note that USB devices can be attached and detached by users at any time. If you are writing a program which needs to handle the situation where devices are attached or detached while the program is operating, you should periodically call `fnLMS_GetNumDevices()` to see if any new devices have been attached.⁴

Allocate an array big enough to hold the device ids for the number of devices present. While you should use the `DEVID` type declared in `VNX_fmynth.h` it's just an array of uints at this point. You may want to just allocate an array large enough to hold `MAXDEVICES` device ids, so that you do not have to handle the case where the number of attached devices increases.

Call `fnLMS_GetDevInfo(DEVID *ActiveDevices)`, which will fill in the array with the device ids for each connected frequency synthesizer. The function returns an integer, which is the number of devices present on the machine.

The next step is to call `fnLMS_GetModelName(DEVID deviceID, char *ModelName)` with a null `ModelName` pointer to get the length of the model name, or just use a buffer that can hold `MAX_MODELNAME` chars. You can use the model name to identify the type of synthesizer. Call `fnLMS_GetSerialNumber(DEVID deviceID)` to get the serial number of the synthesizer. Based on that information, your program can determine which device to open.

Once you have identified the synthesizer you want to send commands to, call `fnLMS_InitDevice(DEVID deviceID)` to actually open the device and get its various parameters like frequency setting, sweep parameters, etc. After the `fnLMS_InitDevice` function has completed you can use any of the get functions to read the settings of the synthesizer. The `fnLMS_InitDevice` function generates a number of I/O operations over the USB bus in order to read the settings of the Lab Brick. Applications should be designed to use the `InitDevice` function infrequently. Optimally, `fnLMS_InitDevice` is called at the beginning of the program to open the device, and then `fnLMS_CloseDevice` called once at the end of the program.

To change one of the settings of the synthesizer, use the corresponding set function. For example, to set the synthesizer frequency, call `fnLMS_SetFrequency(DEVID deviceID, int`

⁴ Usually it is a good idea to call `fnLMS_GetNumDevices()` at around 1 second intervals. While a short interval reduces the chances, it is still possible that the user will remove one device and replace it with another however, so to completely handle all the cases which can result from users hot plugging devices your application needs to check to see not only if the number of devices is different, but if the same number of devices are present, that they are not different devices.

frequency). The first argument is the device id of the synthesizer, the second is the desired output frequency. Frequency is specified in 10 Hz increments, where:

$$\text{frequency} = \text{Frequency (Hz)} / 10$$

For example, to specify an output frequency of 5.5 GHz, frequency = 550000000.

To set the output power level, call `fnLMS_SetPowerLevel(DEVID deviceID, int powerlevel)` with the output power level you want. The powerlevel is encoded as the number of .25db increments, with a resolution of .5db. To set a power level of +5 db, for example, powerlevel would be 20. To set a power level of -20 db, powerlevel would be -80.

Note that the LabBrick synthesizers have a maximum and minimum settable power level. You can query the limits with calls to `fnLMS_GetMaxPwr(DEVID deviceID)` and `fnLMS_GetMinPwr(DEVID deviceID)`. Both functions use the same encoding of the powerlevel as the `SetPowerLevel` function.

When you are done with the device, call `fnLMS_CloseDevice(DEVID deviceID)`.

Status Codes

All of the set functions return a status code indicating whether an error occurred. The get functions normally return an integer value, but in the event of an error they will return an error code. The error codes can be distinguished from normal data by their numeric value, since all error codes have their high bit set, and they are outside of the range of normal data.

Functions that return a floating point result use specific, negative numeric values to indicate if an error occurred.

A separate function, `fnLMS_GetDeviceStatus(DEVID deviceID)` provides access to a set of status bits describing the operating state of the synthesizer. This function can be used to check if a device is currently connected or open.

The values of the status codes are defined in the `VNX_fmynth.h` header file.

Functions – Selecting the Device

`VNX_FSYNSTH_API void fnLMS_SetTestMode(bool testmode)`

Set testmode to FALSE for normal operation. If testmode is TRUE the dll does not communicate with the actual hardware, but simulates the basic operation of the dll functions. It does not simulate the operation of frequency step sweeps generated by the actual hardware, but it does simulate the behavior of the functions used to set the parameters for the stepped sweeps.

`VNX_FSYNSTH_API int fnLMS_GetNumDevices()`

This function returns a count of the number of connected synthesizers.

VNX_FSYNSTH_API int fnLMS_GetDevInfo(DEVID *ActiveDevices)

This function fills in the ActiveDevices array with the device ids for the connected synthesizers. Note that the array must be large enough to hold a device id for the number of devices returned by fnLMS_GetNumDevices. The function also returns the number of active devices, which can, under some circumstances, be less than the number of devices returned in the previous call to fnLMS_GetNumDevices.

The device ids are used to identify each device, and are used in the rest of the functions to select the device. Note that while the device ids may be small integers, and may, in some circumstances appear to be numerically related to the devices present, they should only be used as opaque handles.

VNX_FSYNSTH_API int fnLMS_GetModelName(DEVID deviceID, char *ModelName)

This function is used to get the model name of the synthesizer. If the function is called with a null pointer, it returns just the length of the model name string. If the function is called with a non-null string pointer it copies the model name into the string and returns the length of the string. The string length will never be greater than the constant MAX_MODELNAME which is defined in VNX_fmsynth.h This function can be used regardless of whether or not the synthesizer has been initialized with the fnLMS_InitDevice function.

VNX_FSYNSTH_API int fnLMS_GetSerialNumber(DEVID deviceID)

This function is used to get the serial number of the synthesizer. It can be called regardless of whether or not the synthesizer has been initialized with the fnLMS_InitDevice function. If your system has multiple synthesizers, your software should use each device's serial number to keep track of each specific device. Do not rely upon the order in which the devices appear in the table of active devices. On a typical system the individual synthesizers will typically be found in the same order, but there is no guarantee that this will occur.

VNX_FSYNSTH_API int fnLMS_GetDeviceStatus(DEVID deviceID)

This function can be used to obtain information about the status of a device, even before the device is initialized. (Note that information on the sweep activity of the device is not guaranteed to be available before the device is initialized.)

VNX_FSYNSTH_API int fnLMS_InitDevice(DEVID deviceID)

This function is used to open the device interface to the synthesizer and initialize the dll's copy of the device's settings. If the fnLMS_InitDevice function succeeds, then you can use the various fnLMS_Get* functions to read the synthesizer's settings. This function will fail, and return an error code if the synthesizer has already been opened by another program.

VNX_FSYNSTH_API int fnLMS_CloseDevice(DEVID deviceID)

This function closes the device interface to the synthesizer. It should be called when your program is done using the synthesizer.

VNX_FSYNSTH_API int fnLMS_GetDLLVersion()

This function returns the version of the dll. The version is stored in the lowest two bytes of the integer, encoded as Major.Minor version. An example is shown below:

```
#define LMS_DLLVERSION 0x00000105          // version 1.5
```

Functions – Setting parameters on the Synthesizer

VNX_FSYNSTH_API LVSTATUS fnLMS_SetFrequency(DEVID deviceID, int frequency)

This function is used to set the output frequency of the synthesizer. Frequency is encoded as an integer number of 10 Hz steps:

$\text{frequency} = \text{Frequency (Hz)} / 10$

For example, to specify an output frequency of 6 GHz, frequency = 600000000. The value of frequency must be within the range of the attached synthesizer or an error will be returned.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetPowerLevel(DEVID deviceID, int powerlevel);

This function is used to set the output power level of the programmable synthesizer. The power level is specified in .25db units. The encoding is:

$\text{powerlevel} = \text{desired output power in db} / .25\text{db}$

For example, if you want a -7.5 db level output then you should set powerlevel to -30.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetStartFrequency(DEVID deviceID, int startfrequency)

This function sets the frequency at the beginning of a frequency sweep. The encoding of startfrequency is the same as the fnLMS_SetFrequency function. Note that the start frequency should be less than the end frequency when you want the frequency to step upwards during the sweep. For a sweep where the frequency decreases, then the start frequency should be larger than the end frequency.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetEndFrequency(DEVID deviceID, int endfrequency)

This function sets the frequency at the end of a frequency sweep. The encoding of endfrequency is the same as the fnLMS_SetFrequency function.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetSweepTime(DEVID deviceID, int sweeptime)

This function sets the length of time that the frequency sweep will occur in. The sweep time variable is encoded as a number of milliseconds. The minimum sweep time is 1 millisecond.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetRFOn(DEVID deviceID, bool on)

This function turns the RF stages of the synthesizer on (on = TRUE) or off (on = FALSE).

VNX_FSYNSTH_API int fnLMS_SetUseInternalRef(DEVID deviceID, bool internal);

This function configures the synthesizer to use the internal reference if internal = 1. If internal = 0, then the synthesizer is configured to use an external frequency reference. Not all hardware configurations support an external reference.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetSweepDirection(DEVID deviceID, bool up)

This function is used to set the direction of the frequency sweep. To create a sweep with increasing frequency, set up = TRUE. Note that the sweep start frequency value must be less than the sweep end frequency value for a sweep with increasing frequency. For a sweep that decreases in frequency, the sweep start value must be greater than the sweep end value.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetSweepMode(DEVID deviceID, bool mode)

This function is used to select either a single frequency sweep, or a repeating series of sweeps. If mode = TRUE then the sweep will be repeated, if mode = FALSE the sweep will only happen once.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetSweepType(DEVID deviceID, bool swptype)

This function is used to select between a single directional frequency sweep, or a sweep which returns to its original frequency after each sweep. If swptype = TRUE then the sweep will be bidirectional, if swptype = FALSE the sweep will only go in one direction. For a bidirectional sweep a graph of frequency vs. time for a repeating sweep will appear like a triangle wave, for a non-bidirectional sweep, the graph of frequency vs. time will appear like a sawtooth wave.

VNX_FSYNSTH_API LVSTATUS fnLMS_StartSweep(DEVID deviceID, bool go)

This function is used to start and stop the frequency sweeps. If go = TRUE the synthesizer will begin sweeping, FALSE stops the sweep. You must set the sweep parameters before calling this function to start the sweep.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetFastPulsedOutput(DEVID deviceID, float pulseontime, float pulseretime, bool on)

This function is the preferred way to control the internal pulse modulation option. The pulseontime parameter is the length of the pulse on time in seconds. The pulseretime parameter is the length of the repetition period in seconds. Both values can range from 100 nanoseconds (0.100e-6) to 1000 seconds (1.0e3). Set on = TRUE to start the pulsed output modulation.

VNX_FSYNSTH_API LVSTATUS fnLMS_SetPulseOnTime(DEVID deviceID, float pulseontime)

This function is used to set the length of the RF pulse on time of the device's internal modulation for devices that support pulsed output modulation. The pulseontime parameter is

the length of the pulse on time in seconds, with a 100 nanosecond minimum. This function is not recommended for general use. Instead use the `fnLMS_SetFastPulsedOutput` function.

VNX_FSYNSTH_API LVSTATUS `fnLMS_SetPulseOffTime`(DEVID deviceID, float pulseofftime)

This function is used to set the length of the RF pulse off time of the device's internal modulation. The pulseofftime parameter is the length of the pulse off time in seconds, with a 100 nanosecond minimum. The repetition period of the pulse modulation is equal to pulseontime + pulseofftime. This function is not recommended for general use. Instead use the `fnLMS_SetFastPulsedOutput` function.

VNX_FSYNSTH_API LVSTATUS `fnLMS_EnableInternalPulseMod`(DEVID deviceID, bool on)

This function is used to turn on and off the internal output modulation. If on = TRUE the synthesizer will pulse its RF output on and off according to the values set for the pulse on time and pulse off time using either the `fnLMS_SetFastPulsedOutput` function or the functions to set pulse on and off time directly. To stop the internal pulse modulation, set on = FALSE. Always disable internal pulse modulation before setting the pulse on and off time using the `fnLMS_SetPulseOnTime` and `fnLMS_SetPulseOffTime` functions.

VNX_FSYNSTH_API `fnLMS_SetUseExternalPulseMod`(DEVID deviceID, bool external);

This function configures the synthesizer to use the external pulse modulation input signal if external = TRUE. If external = FALSE, then the synthesizer is configured to use the internal pulse modulation. Not all hardware configurations support an external pulse modulation input. Both the internal and external pulse modulation can operate at the same time, allowing more complex modulation patterns.

VNX_FSYNSTH_API LVSTATUS `fnLMS_SaveSettings`(DEVID deviceID)

The LabBrick synthesizers can save their settings, and then resume operating with the saved settings when they are powered up. Set the desired parameters, then use this function to save the settings.

Functions – Reading parameters from the Synthesizer

VNX_FSYNSTH_API int `fnLMS_GetFrequency`(DEVID deviceID)

This function returns the current frequency setting of the selected device. When a sweep is active this value may change dynamically to an intermediate value which does not reflect the current setting of the device. The return value is in 10 Hz units.

VNX_FSYNSTH_API int `fnLMS_GetStartFrequency` (DEVID deviceID)

This function returns the current frequency sweep starting value setting of the selected device. The return value is in 10 Hz units.

VNX_FSYNSTH_API int fnLMS_GetEndFrequency (DEVID deviceID)

This function returns the current frequency sweep end setting of the selected device. The return value is in 10 Hz units.

VNX_FSYNSTH_API int fnLMS_GetSweepTime(DEVID deviceID)

This function returns the current sweep time in milliseconds. A one second sweep time, for example, would be returned as 1000.

VNX_FSYNSTH_API float fnLMS_GetPulseOnTime(DEVID deviceID)

This function returns the pulse on time, which is the length of time that RF output is enabled when internal pulse modulation is operating, in seconds.

VNX_FSYNSTH_API float fnLMS_GetPulseOffTime(DEVID deviceID)

This function returns the pulse off time, which is the length of time that RF output is disabled when internal pulse modulation is operating, in seconds. The pulse repetition period is equal to the pulse on time added to the pulse off time.

VNX_FSYNSTH_API int fnLMS_GetPulseMode(DEVID deviceID)

This function returns an integer value which is 1 when the synthesizer internal pulse modulation is active, or 0 when the internal pulse modulation is off.

VNX_FSYNSTH_API int fnLMS_GetUseInternalPulseMod(DEVID deviceID)

This function returns an integer value which is 1 when the synthesizer is configured to use its internal pulse modulation , or 0 when the external pulse modulation input is selected to control the output.

VNX_FSYNSTH_API int fnLMS_GetHasFastPulseMode(DEVID deviceID)

This function returns an integer value which is 1 when the synthesizer has the internal pulse modulation option, or 0 when the option is not installed.

VNX_FSYNSTH_API int fnLMS_GetRF_On(DEVID deviceID)

This function returns an integer value which is 1 when the synthesizer is “on”, or 0 when the synthesizer has been set “off” by the fnLMS_SetRFOn function.

VNX_FSYNSTH_API int fnLMS_GetUseInternalRef(DEVID deviceID);

This function returns an integer value which is 1 when the synthesizer is configured to use its internal frequency reference. It returns a value of 0 when the synthesizer is configured to use an external frequency reference.

VNX_FSYNSTH_API int fnLMS_GetPowerLevel(DEVID deviceID);

This function returns the current power level setting as an integer number of .25 db units relative to the maximum power output level. As an example, an output power level of -15

dbm on a LMS device with +10 dbm maximum output would result in the value 100 being returned since the output power level is 25 db less than the maximum, while an output power level setting of +3.5 dbm on the same device would result in the value 26 being returned. The output power resolution is .5 db.

VNX_FSYNSTH_API int fnLMS_GetAbsPowerLevel(DEVID deviceID);

This new function returns the current absolute output power level setting as an integer number of .25 db units. As an example, an output power level of -15 dbm would result in a value of minus 60 dbm being returned, while an output power level of +3.5 dbm would result in the value 14 being returned. The output power resolution is .5 db.

VNX_FSYNSTH_API int fnLMS_GetMaxPwr(DEVID deviceID);

This function returns the maximum output power level that the synthesizer can provide, encoded in the same format as the fnLMS_GetPowerLevel function. For a synthesizer with +10 dbm maximum output power level this function returns the integer value 40. This is a read only value.

VNX_FSYNSTH_API int fnLMS_GetMinPwr(DEVID deviceID);

This function returns the minimum output power level that the synthesizer can provide, encoded in the same format as the fnLMS_GetPowerLevel function. Typically this value is a negative number. For example, a device with -45 dbm minimum output power would return an integer value of -180. This is a read only value.

VNX_FSYNSTH_API int fnLMS_GetMaxFreq (DEVID deviceID)

This function returns the maximum output frequency that the device can provide. The value is represented in 10 Hz units.

VNX_FSYNSTH_API int fnLMS_GetMinFreq(DEVID deviceID)

This function returns the minimum output frequency that the device can provide. The value is represented in 10 Hz units.