

# Cyberon DSpotterSDK Maker Programming Guide (for Arduino Platform)

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Leading Speech Solution Provider  
<http://www.cyberon.com.tw>

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# 1 About DSpotterSDK Maker

Cyberon DSpotterSDK Maker is the C++ implementation of Cyberon DSpotter Engine on the Arduino platform. DSpotter is Cyberon's flagship high-performance embedded speech recognition solution specially optimized for mobile phones, automotives, smart home devices, consumer products, and interactive toys. With phoneme-based acoustic models, it enables developers to create applications of speaker-independent (SI) voice recognition capability without a costly data collection process for specific commands. With the keyword customization web tool, developers can easily and quickly create their own voice command models with text input. Other important features include always-on keyword-spotting capability, high noise immunity, adjustable sensitivity, voice quality assessment, and supporting more than 26 commonly used languages.

## 2 Related Files

### 2.1 Library

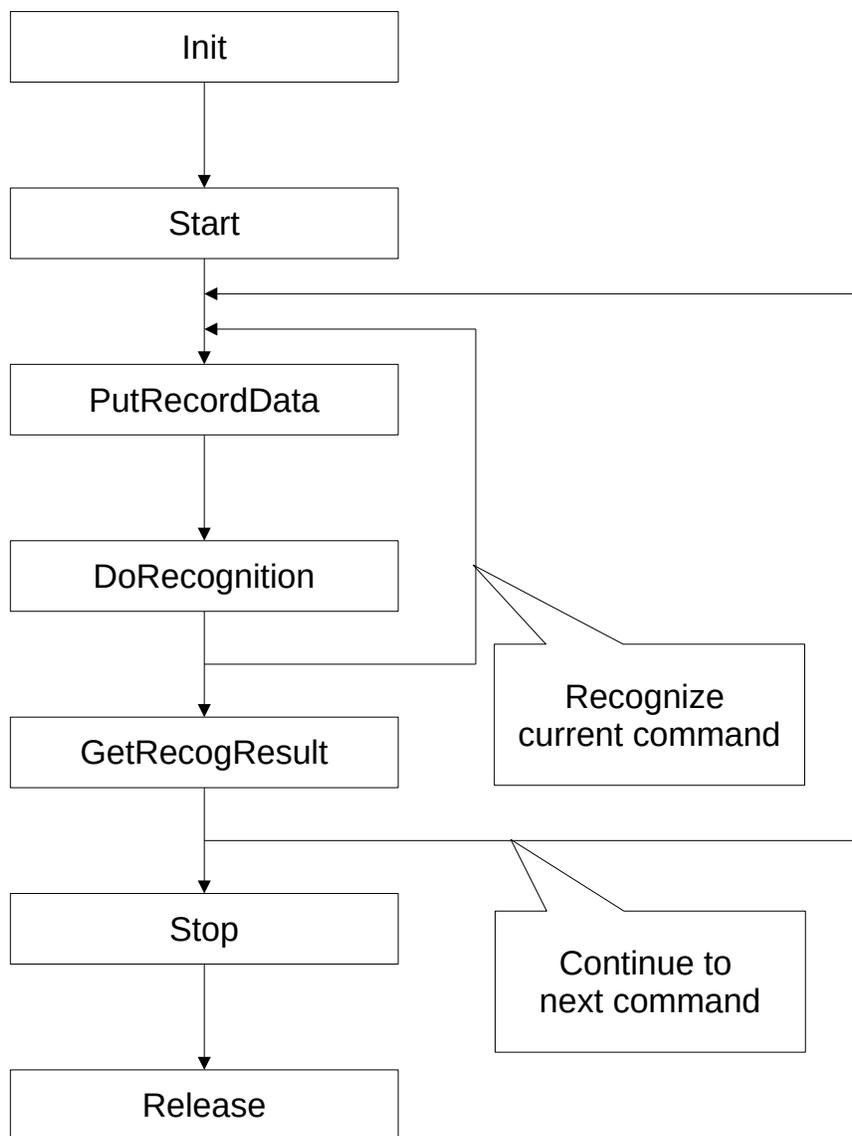
- **libDSpotterSDK\_Maker.a**: the static library for Arduino platform.
- **DSpotterSDK\_Maker.h**: the C++ API header for Arduino platform.

### 2.2 Data

- **CybLicense.h**: The license file.
- **Model\_L0.h**: the header file that contains a level 0 model array which packs both trigger group and command group models together. To use the model array, developers only need to assign it to the Init function. Note that this header file is in UTF8 format. The type of the model array is `uint32_t` and in little-endian manner.
- **Model\_L1.h**: the header file that contains a level 1 model array which packs both trigger group and command group models together. In comparison with the level 0 model under the same parameter settings, the level 1 model provides better recognition stability but also requires more computing and storage requirements.

### 3 DSpotterSDK Maker API

#### 3.1 Flow Chart of Calling API



## 3.2 Informing

### 3.2.1 *DSpotterSDK::GetVerInfo*

**Description**

Get the version information of DSpotterSDK Maker.

**Syntax**

```
static const char* DSpotterSDK::GetVerInfo()
```

**Parameters**

None.

**Returns**

The version string.

**Example**

```
char *lpchVerString = NULL;  
lpchVerString = DSpotterSDK::GetVerInfo();
```

### 3.2.2 *DSpotterSDK::GetSerialNumber*

**Description**

Get the serial number of the Arduino device.

**Syntax**

```
static const char* DSpotterSDK::GetSerialNumber()
```

**Parameters**

None.

**Returns**

The serial number string.

**Example**

```
char* lpchSerialString = NULL;  
lpchSerialString = DSpotterSDK::GetSerialNumber();
```

### 3.2.3 *DSpotterSDK::GetMemoryUsage*

#### Description

Get the memory usage of DSpotterSDK Maker.

#### Syntax

```
static int DSpotterSDK::GetMemoryUsage(const uint32_t* lpdwModel, int nRecordCacheTimeMS)
```

#### Parameters

- **lpdwModel(IN)**: The voice model.
- **nRecordCacheTimeMS(IN)**: The cache length of the recording data, unit is millisecond. It must be greater than or equal to 60.

#### Returns

The memory size in byte.

#### Example

```
#include "Model_L1.h"

#define DSPOTTER_MODEL g_lpdwModel_L1

#define RECORD_BUF_CACHE_TIME 90

int nMemSize = 0;

nMemSize = DSpotterSDK::GetMemoryUsage(DSPOTTER_MODEL, RECORD_BUF_CACHE_TIME);
```

## 3.3 Initializing and Releasing

### 3.3.1 *DSpotterSDK::Init*

#### Description

Initialize DSpotterSDK Maker.

#### Syntax

```
int Init(const uint32_t *lpdwLicense, int nLicenseSize, const uint32_t *lpdwModel,  
        int nRecordCacheTimeMS, unsigned char *lpbyMemPool, int nMemSize)
```

#### Parameters

- **lpdwLicense(IN)**: The license data.
- **nLicenseSize(IN)**: The size of the license data.
- **lpdwModel(IN)**: The voice model.
- **nRecordCacheTimeMS(IN)**: The cache length of the recording data, unit is millisecond. It must be greater than or equal to 60.
- **lpbyMemPool(IN)**: The memory buffer that will be used by DSpotterSDK Maker.
- **nMemSize(IN)**: The size of the memory buffer.

#### Returns

**Success**: Init OK.

**IllegalParam**: If pointer parameter is null or nRecordCacheTimeMS < 60.

**LeaveNoMemory**: If nMemSize less than the return value of GetMemoryUsage().

**LoadModelFailed**: If lpdwModel is not a valid voice model.

**LicenseFailed**: If lpdwLicense doesn't match the device ID.

#### Example

```
#include "Model_L1.h"  
  
#define DSPOTTER_MODEL g_lpdwModel_L1  
  
#define RECORD_BUF_CACHE_TIME 90  
  
#define DSPOTTER_MEM_SIZE 50000  
  
static DSpotterSDK g_oDspotter;  
  
static unsigned char g_byaDspotterMem[ DSPOTTER_MEM_SIZE ];  
  
static const uint32_t g_dwaLicense[] = { /*your device license*/ };  
  
int nMemsize=0;  
  
int nErr = 0;  
  
nMemSize = DSpotterSDK::GetMemoryUsage(DSPOTTER_MODEL, RECORD_BUF_CACHE_TIME);  
  
if (sizeof(g_byaDspotterMem) < nMemSize)  
    /*Not enough memory for DSpotterSDK, please enlarge DSPOTTER_MEM_SIZE*/
```

```
nErr = g_oDspotter.Init(g_dwaLicense, sizeof(g_dwaLicense), DSPOTTER_MODEL,  
    RECORD_BUF_CACHE_TIME, g_byaDspotterMem, sizeof(g_byaDspotterMem));  
  
if (nErr == DspotterSDK::Success)  
    /*Init success*/  
  
else  
    /*Init fail, error handling*/
```

### 3.3.2 *DspotterSDK::Release*

#### Description

Release DspotterSDK Maker, then the memory buffer(lpbyMemPool) can be reused by others.

#### Syntax

```
int Release()
```

#### Parameters

None.

#### Returns

Success, or negative value for error.

#### Example

```
static DspotterSDK g_oDspotter;  
  
g_oDspotter.Init(...);  
  
...  
  
// Call release after init  
g_oDspotter.Release();
```

## 3.4 Setting

### 3.4.1 *DSpotterSDK::SetCommandStageProperty*

#### Description

Set the flow property of command stage.

#### Syntax

```
int SetCommandStageProperty(int nTimeout=6000, bool bCommandStageRepeatUntilTimeout=false)
```

#### Parameters

- **nTimeout(IN)**: The maximum recording time in ms when there is no result at command stage. The valid range is 1000 to 30000. The default value is 6000.
- **bCommandStageRepeatUntilTimeout(IN)**: If false, the recognition flow will switch to trigger stage immediately after command recognized. If true, it will do recognition repeatedly at command stage until timeout. The default value is false.

#### Returns

Success, or negative value for error.

#### Example

```
#define COMMAND_STAGE_TIMEOUT 6000
#define COMMAND_STAGE_REPEAT 1
static DSpotterSDK g_oDSpotter;
g_oDSpotter.Init(...);
...
// Set command stage property between init and start.
g_oDSpotter.SetCommandStageProperty(COMMAND_STAGE_TIMEOUT, COMMAND_STAGE_REPEAT==1);
...
g_oDSpotter.Start();
```

### 3.4.2 *DSpotterSDK::SetAGC*

#### Description

Set the option of auto gain control (AGC).

#### Syntax

```
int SetAGC(bool bEnableAGC = false, int nScalePercentage = 100)
```

#### Parameters

- **bEnableAGC(IN)**: To enable or disable AGC.
- **nScalePercentage(IN)**: The scale percentage of gain is 100 ~ 1600. The default value is 100.

#### Returns

Success, or negative value for error.

#### Example

```
#define VOLUME_SCALE_RECOG 160
static DSpotterSDK g_oDspotter;
g_oDspotter.Init(...);
...
// Set AGC between init and start
#if VOLUME_SCALE_RECOG != 100
    g_oDspotter.SetAGC(true, VOLUME_SCALE_RECOG);
#endif
...
g_oDspotter.Start();
```

## 3.5 Recognizing

### 3.5.1 *DSpotterSDK::Start*

#### Description

Start the process of recognition. Please call Start() before starting the recording device.

#### Syntax

```
int Start()
```

#### Parameters

None.

#### Returns

Success, or negative value for error.

#### Example

```
static DSpotterSDK g_oDspotter;  
g_oDspotter.Init(...);  
...  
// Call start after init  
nErr = g_oDspotter.Start();  
if (nErr == DSpotterSDK::Success)  
    /*Start success*/  
else  
    /*Start fail, error handling*/  
if (!AudioRecordStart())  
    /*recording device start fail, error handling*/
```

### 3.5.2 *DSpotterSDK::Stop*

#### Description

Stop the process of recognition. PutRecordData() and DoRecognition() will do nothing after calling Stop().

#### Syntax

```
int Stop()
```

#### Parameters

None.

#### Returns

Success, or negative value for error.

#### Example

```
static DSpotterSDK g_oDspotter;  
g_oDspotter.Start();  
...  
// Call stop after start  
g_oDspotter.Stop();
```

### 3.5.3 *DSpotterSDK::PutRecordData*

#### Description

Put the recording data to the cached recording buffer.

#### Syntax

```
int PutRecordData(const short *lpsSample, int nNumSample)
```

#### Parameters

- **lpsSample(IN)**: The recording data buffer.
- **nNumSample(IN)**: The number of samples in the recording data buffer.

#### Returns

**Success**: Put OK.

**NotInit**: If call it before Init().

**Stopped**: If call it before Start().

**LeaveNoMemory**: If the cached recording buffer has no enough free space. The lost count will increment by 1. If it only appears temporarily, please enlarge the cache length of recording data. If it keeps appearing, it is usually because the computing resources of the MCU are exhausted.

#### Example

```
static short sampleBuffer[512];

int bytesAvailable = PDM.available();

if (bytesAvailable > sizeof(sampleBuffer))
    bytesAvailable = sizeof(sampleBuffer);

PDM.read(sampleBuffer, bytesAvailable);

#if defined(TARGET_PORTENTA_H7)
for (int i = 0; i < bytesAvailable/sizeof(short)/2; i++)
    sampleBuffer[i] = sampleBuffer[i*2]; // 2 to 1 channel
g_oDSpotter.PutRecordData(sampleBuffer, bytesAvailable/sizeof(short)/2);
#else // DSpotter needs mono channel, 16 KHz, 16 bits PCM data as input.
g_oDSpotter.PutRecordData(sampleBuffer, bytesAvailable/sizeof(short));
#endif
}
```

### 3.5.4 *DSpotterSDK::GetRecordLostCount*

**Description**

Get the lost count when putting the recording data.

**Syntax**

```
int GetRecordLostCount()
```

**Parameters**

None.

**Returns**

The data lost count.

**Example**

```
static DSpotterSDK g_oDspotter;  
static int nRecordLostCount = 0;  
  
...  
if (nRecordLostCount != g_oDspotter.GetRecordLostCount())  
{  
    nRecordLostCount = g_oDspotter.GetRecordLostCount();  
    Serial.println("Lost record frame!");  
}
```

### 3.5.5 *DSpotterSDK::DoRecognition*

#### Description

Get 10 millisecond data from the cached recording buffer and process it.

#### Syntax

```
int DoRecognition(int *pnCurrentState)
```

#### Parameters

- **pnCurrentState(OUT)**: The current stage.

#### Returns

**Success**: Get a recognition result.

**NotInit**: If call it before Init().

**Stopped**: If call it before Start().

**NeedMoreSample**: No result and need more sample to process.

#### Example

```
static DSpotterSDK g_oDspotter;  
  
nStage = DSpotterSDK::InitStage;  
  
...  
  
// Do VR  
  
nRet = g_oDspotter.DoRecognition(&nCurrentStage);  
  
// VR success, get keyword info  
if (nRet == DSpotterSDK::Success)  
{  
    /*Call GetRecogResult to get recognition result*/  
}  
  
// Check VR stage changes  
if (nStage != nCurrentStage)  
{  
    nStage = nCurrentStage;  
    Serial.println("Stage change");  
}
```

### 3.5.6 *DSpotterSDK::GetRecogResult*

#### Description

Get the information of recognition result.

#### Syntax

```
int GetRecogResult(int *pnID, char *lpszCommand, int nCmdLength,  
                  int *pnConfi, int *pnSGDiff, int *pnCmdEnergy)
```

#### Parameters

- **pnID(OUT)**: The ID of command.
- **lpszCommand(OUT)**: The command buffer.
- **nCmdLength(IN)**: The length of command buffer.
- **pnConfi(OUT)**: The confidence score of command.
- **pnSGDiff(OUT)**: The human voice similarity of command.
- **pnCmdEnergy(OUT)**: The energy of command.

#### Returns

Success, or negative value for error.

#### Example

```
static DSpotterSDK g_oDspotter;  
  
int nCurrentStage;  
  
int nCmdScore, nCmdSGDiff, nCmdEnergy, nID;  
  
...  
// Do VR  
  
nRet = g_oDspotter.DoRecognition(&nCurrentStage);  
  
// VR success, get keyword info  
if (nRet == DSpotterSDK::Success)  
{  
    char szCommand[64];  
    g_oDspotter.GetRecogResult(&nID, szCommand, sizeof(szCommand),  
                              &nCmdScore, &nCmdSGDiff, &nCmdEnergy);  
}
```

### 3.5.7 *DSpotterSDK::GetCommandCount*

#### Description

Get the count of recognition command at different stage.

#### Syntax

```
int GetCommandCount(int nStage);
```

#### Parameters

- **nStage(IN)**: DSpotterSDK::TriggerStage or DSpotterSDK::CommandStage.

#### Returns

The command count.

#### Example

```
static DSpotterSDK g_oDspotter;  
  
...  
// Show VR trigger/command count  
int nCnt = 0;  
for (int nStage = 0; nStage < 2; nStage++)  
{  
    Serial.println("The command count at " + String(nStage == 0 ? "trigger stage:"  
    : "command stage:"));  
    nCnt = g_oDspotter.GetCommandCount(nStage);  
    Serial.println(String(nCnt));  
}
```

### 3.5.8 *DSpotterSDK::GetCommand*

#### Description

Get the information of command.

#### Syntax

```
int GetCommand(int nStage, int nIndex, char *lpszCommand, int nCmdLength, int *pnID)
```

#### Parameters

- **nStage(IN)**: TriggerStage or CommandStage.
- **nIndex(IN)**: From 0 to GetCommandCount(nStage) - 1.
- **lpszCommand(OUT)**: The command buffer.
- **nCmdLength(IN)**: The length of the command buffer.
- **pnID(OUT)**: The ID of command.

#### Returns

Success, or negative value for error.

#### Example

```
static DSpotterSDK g_oDspotter;  
  
...  
// Get VR trigger/command word  
for (int nStage = 0; nStage < 2; nStage++)  
{  
    char szCommand[64];  
    int nID;  
    for (int i = 0; i < g_oDspotter.GetCommandCount(nStage); i++)  
    {  
        g_oDspotter.GetCommand(nStage, i, szCommand,  
                                sizeof(szCommand), &nID);  
    }  
}
```

## 4 Constant and Error Code

### 4.1 Constant

| Constant Symbol           | Value | Description   |
|---------------------------|-------|---------------|
| DSpotterSDK::InitStage    | -1    | Init Stage    |
| DSpotterSDK::TriggerStage | 0     | Trigger Stage |
| DSpotterSDK::CommandStage | 1     | Command Stage |

### 4.2 Error Code

| Error Symbol                    | Value | Description                |
|---------------------------------|-------|----------------------------|
| DSpotterSDK::Success            | 0     | Success                    |
| DSpotterSDK::NotInit            | -2001 | Not init yet               |
| DSpotterSDK::IllegalParam       | -2002 | Wrong parameter            |
| DSpotterSDK::LeaveNoMemory      | -2003 | Memory not enough          |
| DSpotterSDK::LoadModelFailed    | -2005 | Load model failed          |
| DSpotterSDK::NeedMoreSample     | -2009 | Need more sample           |
| DSpotterSDK::TrialLimitStage    | -2010 | Exceed recognition limits  |
| DSpotterSDK::Stopped            | -2030 | Not start yet              |
| DSpotterSDK::LicenseFailed      | -2200 | License failed             |
| DSpotterSDK::DeviceModelNotPair | -2201 | Device and model not match |

## 5 Supported Languages

|                      |                    |                 |
|----------------------|--------------------|-----------------|
| Arabic               | English(TWN)       | Polish          |
| Bahasa(Indonesia)    | English(UK)        | Portuguese(BRA) |
| Bahasa(Melayu)       | English(US)        | Portuguese(EU)  |
| Cantonese(HK)        | English(Worldwide) | Russian         |
| Chinese(CHN)         | Finnish            | Slovak          |
| Chinese(CHN)/English | French             | Spanish(EU)     |
| Chinese(TWN)         | German             | Spanish(LA)     |
| Czech                | Greek              | Swedish         |
| Danish               | Hindi              | Taiwanese       |
| Dutch                | Hungarian          | Thai            |
| English(AU)          | Italian            | Turkish         |
| English(IN)          | Japanese           | Ukrainian       |
| English(PHI)         | Japanese/English   | Vietnamese      |
| English(SEA)         | Korean             |                 |
| English(SG)          | Norwegian          |                 |

## 6 Release History

| Release no | Date of issue | Author | Comment                                |
|------------|---------------|--------|--|
| 1.2.0      | 30 Jan, 2023  | Tom    | Add appendix for license.              |
| 1.1.0      | 7 Dec, 2022   | Tom    | Update SDK name, fix some description. |
| 1.0.0      | 12 Aug, 2022  | Tom    | First release.                         |

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## A Appendix

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Date: 16. October 2013 Revision: V1.4.2

Project: CMSIS DSP Library Title: arm\_dot\_prod\_q15.c

Description: Q15 dot product.

Target Processor: Cortex-M4/Cortex-M3/Cortex-M0

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