Introduction

The STM32L476 Discovery kit (32L476GDISCOVERY) helps the user to discover the STM32L4 ultra-low-power features and to develop and share applications.

It is based on the STM32L476VGT6 microcontroller with three \( \text{I}^2\text{C}s \), three SPIs, six USARTs, CAN, SWPMI, two SAIls, 12-bit ADCs, 12-bit DAC, LCD driver, internal 128 Kbytes of SRAM and 1 Mbyte of Flash memory, Quad-SPI, touch sensing, USB OTG FS, LCD controller, FMC, JTAG debugging support.

The 32L476GDISCOVERY includes an ST-LINK/V2-1 embedded debugging tool interface, LCD (24 segments, 4 commons), LEDs, push-button, joystick, USB OTG FS, audio DAC, MEMS (microphone, 3-axis gyroscope, 6-axis compass), Quad-SPI Flash memory, embedded ammeter measuring STM32 consumption in low-power mode.

External boards can be connected through the extension and probing connectors.

Figure 1. STM32L476 Discovery board

Picture is not contractual.
Contents

1 Features ................................................. 6
2 Product marking ........................................... 7
3 System requirements ...................................... 7
4 Development toolchains ................................... 7
5 Demonstration software .................................... 8
6 Ordering information ....................................... 8
7 Delivery recommendations .................................. 8
8 Conventions ............................................... 8
9 Bootloader limitations ..................................... 9
10 Hardware layout and configuration ......................... 10
   10.1 Embedded ST-LINK/V2-1 ............................... 13
       10.1.1 Drivers ............................................. 13
       10.1.2 ST-LINK/V2-1 firmware upgrade ................. 14
       10.1.3 Using ST-LINK/V2-1 to program/debug the STM32L476VGT6 on board .................................................................................................................. 14
       10.1.4 Using ST-LINK/V2-1 to program/debug an external STM32 application board ........................................................................................................... 15
   10.2 Power supply ............................................. 16
   10.3 Clock source ............................................. 18
   10.4 Reset source ............................................. 18
   10.5 User interface: LCD, joystick, LEDs .................... 19
   10.6 Boot0 configuration ...................................... 19
   10.7 Quad-SPI NOR Flash memory ............................ 19
   10.8 USB OTG FS ............................................. 19
   10.9 USART configuration ..................................... 20
   10.10 Audio DAC and MEMS microphone .................... 20
# UM1879 Rev 4 3/41

## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.11</td>
<td>9-axis motion sensors</td>
<td>20</td>
</tr>
<tr>
<td>10.12</td>
<td>I2C extension connector CN2</td>
<td>20</td>
</tr>
<tr>
<td>10.13</td>
<td>MCU current ammeter</td>
<td>21</td>
</tr>
<tr>
<td>10.14</td>
<td>Extension connector P1 and P2</td>
<td>22</td>
</tr>
<tr>
<td>10.15</td>
<td>Solder bridges</td>
<td>23</td>
</tr>
<tr>
<td>11</td>
<td>Schematics</td>
<td>25</td>
</tr>
<tr>
<td>Appendix A</td>
<td>Power consumption measurements</td>
<td>35</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Mechanical drawing</td>
<td>37</td>
</tr>
<tr>
<td>Appendix C</td>
<td>Compliance statements</td>
<td>38</td>
</tr>
<tr>
<td>C.1</td>
<td>FCC Compliance Statement</td>
<td>38</td>
</tr>
<tr>
<td>C.1.1</td>
<td>Part 15.19</td>
<td>38</td>
</tr>
<tr>
<td>C.1.2</td>
<td>Part 15.105</td>
<td>38</td>
</tr>
<tr>
<td>C.1.3</td>
<td>Part 15.21</td>
<td>38</td>
</tr>
<tr>
<td>C.2</td>
<td>IC Compliance Statement</td>
<td>38</td>
</tr>
<tr>
<td>C.2.1</td>
<td>Compliance Statement</td>
<td>38</td>
</tr>
<tr>
<td>C.2.2</td>
<td>Déclaration de conformité</td>
<td>39</td>
</tr>
<tr>
<td>Revision history</td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>
List of tables

Table 1. Ordering information ................................................................. 8
Table 2. ON/OFF conventions ................................................................. 8
Table 3. Jumper states ........................................................................... 13
Table 4. Debug connector CN4 ................................................................. 15
Table 5. Reset related jumper ................................................................. 18
Table 6. Connector CN2 ........................................................................... 21
Table 7. Extension connector ................................................................. 22
Table 8. Solder bridges ............................................................................. 23
Table 9. Typical power consumption of the STM32L476 Discovery board .... 36
Table 10. Document revision history ......................................................... 40
## List of figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.</td>
<td>STM32L476 Discovery board</td>
<td>1</td>
</tr>
<tr>
<td>Figure 2.</td>
<td>Hardware block diagram</td>
<td>10</td>
</tr>
<tr>
<td>Figure 3.</td>
<td>STM32L476 Discovery board top layout</td>
<td>11</td>
</tr>
<tr>
<td>Figure 4.</td>
<td>STM32L476 Discovery board bottom layout</td>
<td>12</td>
</tr>
<tr>
<td>Figure 5.</td>
<td>Updating the list of drivers in device manager</td>
<td>14</td>
</tr>
<tr>
<td>Figure 6.</td>
<td>CN1, CN3 (ON), CN4 connections</td>
<td>14</td>
</tr>
<tr>
<td>Figure 7.</td>
<td>CN1, CN3 (OFF), CN4 connections</td>
<td>15</td>
</tr>
<tr>
<td>Figure 8.</td>
<td>Board jumper location</td>
<td>17</td>
</tr>
<tr>
<td>Figure 9.</td>
<td>Connector CN2</td>
<td>20</td>
</tr>
<tr>
<td>Figure 10.</td>
<td>STM32L476 Discovery board design top sheet</td>
<td>25</td>
</tr>
<tr>
<td>Figure 11.</td>
<td>ST-LINK/V2-1 with support of SWD only</td>
<td>26</td>
</tr>
<tr>
<td>Figure 12.</td>
<td>STM32L476VGT6 MCU</td>
<td>27</td>
</tr>
<tr>
<td>Figure 13.</td>
<td>IDD measurement / MFX (Multi Function eXpander)</td>
<td>28</td>
</tr>
<tr>
<td>Figure 14.</td>
<td>Joystick ACP, LEDs and push-button</td>
<td>29</td>
</tr>
<tr>
<td>Figure 15.</td>
<td>LCD display</td>
<td>30</td>
</tr>
<tr>
<td>Figure 16.</td>
<td>OTG USB FS</td>
<td>31</td>
</tr>
<tr>
<td>Figure 17.</td>
<td>Audio DAC and microphone MEMS</td>
<td>32</td>
</tr>
<tr>
<td>Figure 18.</td>
<td>Quad-SPI Flash memory</td>
<td>33</td>
</tr>
<tr>
<td>Figure 19.</td>
<td>Gyroscope, accelerometer, magnetometer MEMS</td>
<td>34</td>
</tr>
<tr>
<td>Figure 20.</td>
<td>Power consumption tree</td>
<td>35</td>
</tr>
<tr>
<td>Figure 21.</td>
<td>STM32L476 Discovery board mechanical drawing</td>
<td>37</td>
</tr>
</tbody>
</table>
1 Features

- STM32L476VGT6 microcontroller featuring 1 Mbyte of Flash memory and 128 Kbytes of RAM in LQFP100 package
- On-board ST-LINK/V2-1 supporting USB reenumeration capability
- Three different interfaces supported on USB:
  - Virtual Com Port
  - Mass storage
  - Debug port
- Arm® Mbed enabled™ (see http://mbed.org)
- LCD 24 segments, 4 commons in DIP 28 package
- Seven LEDs:
  - LD1 (red/green) for ST-LINK/V2-1 USB communication
  - LD2 (red) for 3.3 V power on
  - LD3 overcurrent (red)
  - LD4 (red), LD5 (green) two user LEDs
  - LD6 (green), LD7 (red) USB OTG FS LEDs
- Push-button (reset)
- Four-direction joystick with selection
- USB OTG FS with Micro-AB connector
- SAI Audio DAC, stereo with output jack
- Digital microphone MEMS
- Accelerometer and magnetometer MEMS
- Gyroscope MEMS
- 128-Mbit Quad-SPI Flash memory
- STM32 current ammeter with 4 ranges and auto calibration
- \( \text{i}^2\text{C} \) extension connector for external board
- Four power supply options:
  - ST-LINK/V2-1
  - USB FS connector
  - External 5V
  - CR2032 battery (not provided)
- Extension connectors
- Comprehensive free software including a variety of examples, part of STM32Cube™ package

---

a. Arm and Mbed are registered trademarks or trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.
2 Product marking

Evaluation tools marked as “ES” or “E” are not yet qualified and are therefore not ready to be used as reference design or in production. Any consequences arising from such usage will not be at STMicroelectronics’ charge. In no event will STMicroelectronics be liable for any customer usage of these engineering sample tools as reference designs or in production.

‘E’ or ‘ES’ marking examples of location:
- on the targeted STM32 that is soldered on the board (for illustration of STM32 marking, refer to the section Package information in the STM32 datasheet at www.st.com).
- next to the evaluation tool ordering part number, that is stuck or silkscreen printed on the board

This board features a specific STM32 device version, which allows the operation of any bundled commercial stack/library available. This STM32 device shows a "U" marking option at the end of the standard part number and is not available for sales.

In order to use the same commercial stack in his application, a developer may need to purchase a part number specific to this stack/library. The price of those part numbers includes the stack/library royalties.

3 System requirements

- Windows® OS (7, 8 and 10), Linux® 64-bit or macOS®(a)
- USB Type-A to Micro-B cable

4 Development toolchains

- Keil® MDK-ARM(b)
- IAR™ EWARM(b)
- GCC-based IDEs including free SW4STM32 from AC6
- Arm® Mbed™ online (see http://mbed.org)

---

a. macOS® is a trademark of Apple Inc., registered in the U.S. and other countries.
b. On Windows only
5 Demonstration software

The demonstration software, included in the STM32Cube MCU Package corresponding to the on-board MCU, is preloaded in the STM32 Flash memory for easy demonstration of the device peripherals in standalone mode. The latest versions of the demonstration source code and associated documentation can be downloaded from the www.st.com/stm32l4-discovery web page.

6 Ordering information

To order the 32L476GDISCOVERY Discovery kit, refer to Table 1.

Table 1. Ordering information

<table>
<thead>
<tr>
<th>Order code</th>
<th>Target STM32</th>
</tr>
</thead>
<tbody>
<tr>
<td>32L476GDISCOVERY</td>
<td>STM32L476VGT6</td>
</tr>
</tbody>
</table>

7 Delivery recommendations

Some verifications are needed before using the board for the first time to make sure that nothing has been damaged during the shipment and that no components are unplugged or lost. When the board is extracted from its plastic bag, check that no component remains in the bag. In particularly, make sure that the following jumpers on top side of the board are plugged: CN3, JP3, JP5, and JP6.

The battery CR2032 is not provided.

8 Conventions

Table 2 provides conventions used in the present document.

Table 2. ON/OFF conventions

<table>
<thead>
<tr>
<th>Convention</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumper JPx ON</td>
<td>Jumper fitted</td>
</tr>
<tr>
<td>Jumper JPx OFF</td>
<td>Jumper not fitted</td>
</tr>
<tr>
<td>Solder bridge SBx ON</td>
<td>SBx connections closed by solder</td>
</tr>
<tr>
<td>Solder bridge SBx OFF</td>
<td>SBx connections left opened</td>
</tr>
</tbody>
</table>
9 **Bootloader limitations**

Boot from system Flash memory results in executing **bootloader** code stored in the system Flash memory protected against writing and erasing. This allows in-system programming (ISP), that is, flashing the STM32 user Flash memory. It also allows writing data into RAM. The data come in via one of communication interfaces such as USART, SPI, I²C bus, USB or CAN.

Bootloader version can be identified by reading the Bootloader ID at the address 0x1FFF6FFE.

The STM32L476VGT6 part soldered on the 32L476GDISCOVERY main board is marked with a date code corresponding to its date of manufacturing. STM32L476VGT6 parts with the date code prior or equal to week 22 of 2015 are fitted with **bootloader V 9.0** affected by the limitations to be worked around, as described hereunder. Parts with the date code starting from week 23 of 2015 contain bootloader V 9.2 in which the limitations no longer exist.

To locate the visual date code information on the STM32L476VGT6 package, refer to its datasheet (DS10198) available at [www.st.com](http://www.st.com), section Package Information. Date code related portion of the package marking takes YWW format, where Y is the last digit of the year and WW is the week. For example, a part manufactured in week 23 of 2015 bares the date code 523.

Bootloader ID of the bootloader V 9.0 is 0x90.

The following limitations exist in the bootloader V 9.0:

1. **RAM data get corrupted when written via USART/SPI/I²C/USB interface**

   **Description:**
   Data write operation into RAM space via USART, SPI, I²C bus or USB results in wrong or no data written.

   **Workaround:**
   To correct the issue of wrong write into RAM, download the STSW-STM32158 bootloader V 9.0 patch package from the [www.st.com](http://www.st.com) website and load "Bootloader V9.0 SRAM patch" to the MCU, following the information in readme.txt file available in the package.

2. **User Flash memory data get corrupted when written via CAN interface**

   **Description:**
   Data write operation into user Flash memory space via CAN interface results in wrong or no data written.

   **Workaround:**
   To correct the issue of wrong write into Flash memory, download the STSW-STM32158 bootloader V 0.9 patch package from the [www.st.com](http://www.st.com) website and load "Bootloader V9.0 CAN patch" to the MCU, following the information in readme.txt file available in the package.
The STM32L476 Discovery board is designed around the STM32L476VGT6 (100-pin LQFP package). The hardware block diagram (see Figure 2) illustrates the connection between the STM32L476VGT6 and the peripherals (9-axis motion sensors, digital microphone MEMS, LCD segment, 128 Mbytes of Quad-SPI Flash memory, SAI Audio DAC stereo with 3.5mm output jack, USB OTG FS, IDD current measurement, LEDs, push-button, joystick) and the Figure 3 will help to locate these features on the STM32L476 Discovery board.
Figure 3. STM32L476 Discovery board top layout
Figure 4. STM32L476 Discovery board bottom layout

- SB1 (ST-LINK PWR)
- SB5, SB6, SB9, SB10 (default)
- SB3, SB4, SB7, SB8 (reserved)
- SB12 (reserved)
- SB11 (STM_RST)
- SB18 (T_SWO)
- SB19, SB20 (32.768kHz CLK)
- SB21, SB22 (8MHz CLK)
- SB25, SB24 (OTG FS)
- CR1 battery connector
- SB2 (EXT/RF E2P)
- SB14 (T_SWO)
- SB16, SB13 (USART RX,TX)
- SB17, SB15 (MFX USART RX,TX)
- SB23 (B1-RESET)
- SB26, SB27 (reserved)
- SB28 (2.5V REG inhibit)
- SB29 (2.5V REG input)
10.1 Embedded ST-LINK/V2-1

The ST-LINK/V2-1 programming and debugging tool is integrated on the STM32L476 Discovery board. Compared to ST-LINK/V2 the changes are listed below.

The new features supported on ST-LINK/V2-1 are:
- USB software re-enumeration
- Virtual Com Port interface on USB
- Mass storage interface on USB
- USB power management request for more than 100mA power on USB

These features are no more supported on ST-LINK/V2-1:
- SWIM interface
- Application voltage lower than 3 V

For all general information concerning debugging and programming features common between V2 and V2-1 refer to ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32 User manual (UM1075).

There are two different ways to use the embedded ST-LINK/V2-1 depending on the jumper states:
- Program/debug the STM32L476VGT6 on board (Section 10.1.3)
- Program/debug an STM32 in an external application board using a cable connected to SWD connector CN4 (Section 10.1.4)

<table>
<thead>
<tr>
<th>Jumper state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both CN3 jumpers ON</td>
<td>ST-LINK/V2-1 functions enabled for on-board programming (default)</td>
</tr>
<tr>
<td>Both CN3 jumpers OFF</td>
<td>ST-LINK/V2-1 functions enabled for external board through external CN4 connector (SWD supported)</td>
</tr>
</tbody>
</table>

10.1.1 Drivers

The ST-LINK/V2-1 requires a dedicated USB driver, which can be found on the www.st.com website.

In case the STM32L476 Discovery board is connected to the PC before the driver is installed, some interfaces may be declared as "Unknown" in the PC device manager. In this case the user must install the driver files, and update the driver of the connected device from the device manager.
1. Prefer using the “USB Composite Device” handle for a full recovery.

10.1.2 ST-LINK/V2-1 firmware upgrade

The ST-LINK/V2-1 embeds a firmware upgrade mechanism for in-situ upgrade through the USB port. As the firmware may evolve during the life time of the ST-LINK/V2-1 product (for example a new functionality, bug fixes, support for new microcontroller families), it is recommended to visit the www.st.com website before starting to use the STM32L476 Discovery board and periodically, in order to stay up-to-date with the latest firmware version.

10.1.3 Using ST-LINK/V2-1 to program/debug the STM32L476VGT6 on board

To program the STM32L476VGT6 on board, simply plug in the two jumpers on CN3, as shown in Figure 6 in red, and connect the STM32L476 Discovery board to the PC through the Mini-B USB ST-LINK/V2-1 CN1 connector.

Make sure the jumpers JP3, JP6.3V3, and JP5.ON are set.

Do not use the CN4 connector.

Figure 6. CN1, CN3 (ON), CN4 connections
10.1.4 Using ST-LINK/V2-1 to program/debug an external STM32 application board

To use the ST-LINK/V2-1 to program the STM32 on an external application board (out of the STM32L476VGT6 on board), remove the two jumpers from CN3 as shown in Figure 7 in red, and connect the board to the CN4 software debug connector according to Table 4.

Make sure the jumpers JP6.3V3, and JP5.OFF are set.

JP3, must be ON if CN4 pin 5 (NRST) is used in the external application board.

Table 4. Debug connector CN4

<table>
<thead>
<tr>
<th>Pin</th>
<th>CN4</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vapp</td>
<td>VDD from application</td>
</tr>
<tr>
<td>2</td>
<td>SWLCK</td>
<td>SWD clock</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>SWDIO</td>
<td>SWD data input/output</td>
</tr>
<tr>
<td>5</td>
<td>NRST</td>
<td>RESET of target MCU</td>
</tr>
<tr>
<td>6</td>
<td>SWO</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Figure 7. CN1, CN3 (OFF), CN4 connections
10.2 Power supply

The power supply is provided with four options:

- ST-LINK/V2-1: CN1
- CR2032 battery (not provided): CR1
- External 5V: 5V_I
- USB FS connector: USB USER CN7

- ST-LINK/V2-1:
  JP6 needs to be placed in position 3V3. JP3 is closed. JP5 is in position ON. CN3 jumpers are ON.
  The STM32L476G Discovery board can be powered from the ST-LINK USB connector CN1 (5V_USB_ST_LINK). Only the ST-LINK circuit has the power before the USB enumeration, as the host PC only provides 100mA to the board at that time.
  During the USB enumeration, the STM32L476 Discovery board requires 300 mA of current to the host PC. If the host is able to provide the required power, the STM32L476 is powered and the red LED LD2 is turned ON, thus the STM32L476 Discovery board and its extension board can consume no more than 300 mA current. If the host is not able to provide the required current, the STM32L476 and the extension board are not power supplied. As a consequence the red LED LD2 remains turned OFF. In such case it is mandatory to use an external power supply, as explained in the next section.

---

Warning: If the maximum current consumption of the STM32L476 Discovery board and its extension board exceeds 300 mA, it is mandatory to power the STM32L476 Discovery board using an external power supply connected to 5V_I.

---

Note: In case this board is powered by a USB charger or a USB battery connected on CN1, there is no USB enumeration, the led LD2 remains OFF and the STM32L476 is not powered. In this specific case only, fit the jumper JP2 to allow the STM32L476 to be powered anyway. Remove this jumper JP2 if then a host PC is connected to the ST-LINK/V2-1 CN1 connector to supply the board.

- CR2032 battery inserted in CR1 (bottom side):
  - The CR2032 battery is not provided
  - JP6 needs to be placed in position BATT. JP3 is opened. JP5 is in position ON
  - The battery supplies the 3V3 and 3V power domains on board. All the peripherals are powered, except the ST-LINK, which can only be supplied through the USB connector CN1

- External 5V_I or USB USER CN7 (USB FS connector):
  - External 5V_I: The pin 3 5V_I of P2 header can be used as input for an external power supply. In this case, the STM32L476 Discovery board must be powered by a power supply unit or by an auxiliary equipment complying with the standard EN-60950-1: 2006+A11/2009, and must be Safety Extra Low Voltage (SELV) with a limited power capability.
  - To use the USB USER CN7 to power supply the board, a jumper needs to be placed between V_USB pin 4 and the pin 3 5V_I of P2 header (see Figure 8).
In this condition it is still possible to use the USB ST-LINK for communication, for programming or debugging, but it is mandatory to power supply the board first using 5V_I or USB USER CN7 then connect the USB ST-LINK cable to the PC. Proceeding this way ensures that the enumeration occurs thanks to the external power source.

The following power sequence procedure must be respected:

1. Connect the external power source to 5V_I or USB USER CN7.
2. Power on the external power supply 5V_I or USB USER CN7.
3. Check that LD2 is turned ON.
4. Connect the PC to USB ST-LINK connector CN1.

If this order is not respected, the board may be supplied by 5V_USB_ST_LINK first then by 5V_I or USB USER CN7 and the following risks may be encountered:

1. If more than 300 mA current is needed by the board, the PC may be damaged or the current supply can be limited by the PC. As a consequence the board is not powered correctly.
2. 300 mA is requested at enumeration (since JP2 must be OFF) so there is risk that the request is rejected and the enumeration does not succeed if the PC cannot provide such current. Consequently the board is not power supplied (LED LD2 remains OFF).

**Note:** The headers pins 5V (except in battery mode), 3V3, 2V5, 3V can be used as output power supply when an extension board is connected to the P1 and P2 headers. The power consumption of the extension board must be lower than 100 mA.
10.3 Clock source

The STM32L476VGT6 MCU uses:

- A 32.768 KHz low-speed source:
  - By default, the X3 crystal on board
  - From an external oscillator through P2 header (pin 7 labeled ‘PC14’). The configuration needed is:
    SB19 opened, SB20 closed, R26 removed

- A system clock source:
  - By default, generated by an internal STM32L476VGT6 oscillator. The configuration needed is:
    SB18 opened, SB21 and SB22 closed
  - Or driven by an X2 Crystal on board (not fitted). The configuration needed is:
    SB18, SB21 and SB22 opened
    X2, R88, R89, C77, C78 fitted
  - Or driven by a MCO signal (8MHz) from the ST-LINK MCU STM32F103CBT6 (U3). The configuration needed is:
    SB18 closed, SB22 opened
    R89 not fitted
  - Or driven externally from PH0 through the P2 header, pin 9 labeled ‘PH0’. The configuration needed is:
    SB22 closed, SB18 opened
    R89 not fitted

Note: Refer to Oscillator design guide for STM8S, STM8A and STM32 microcontrollers Application note (AN2867).

10.4 Reset source

The reset signal NRST of the STM32L476 Discovery board is low active and the reset sources include:

- The reset button B1, connected by default to NRST (SB23 closed)
- The embedded ST-LINK/V2-1
- The external reset pin 11 of P2 header connector, labeled ‘NRST’
- The external reset from SWD connector CN4, pin 5

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Description</th>
</tr>
</thead>
</table>
| JP3    | When JP3 is closed, the SWD connector CN4 pin 5 and the embedded ST-LINK/V2-1 are connected to NRST. Default Setting: closed
|        | JP3 is opened, no connection between CN4 and ST-LINK/V2-1 to NRST. This must be used when the ST-LINK/V2-1 is not powered (i.e STM32L476 Discovery board) is powered by the CR2032 battery |
10.5 User interface: LCD, joystick, LEDs

The STM32L476 Discovery board features sept LEDs with the following functionalities:

- LD1 COM: LD1 default status is red. LD1 turns to green to indicate that communications are in progress between the PC and the ST-LINK/V2-1
- LD2 PWR: the red LED indicates that the board is powered
- LD3 OC: the red LED indicates a fault when the board is in current limit (510 mA)
- LD4 user: the red LED is a user LED connected to the I/O PB2 of the STM32L476VGT6
- LD5 user: the green LED is a user LED connected to the I/O PE8 of the STM32L476VGT6
- LD6, LD7: USB OTG FS LEDs, see Section 10.8

Four-direction joystick (B2) with selection and a reset push-button (B1) are available as input devices.

An LCD 4x24 segments, 4 commons, multiplexed 1/4 duty, 1/3 bias is mounted on the DIP28 connector U5.

10.6 Boot0 configuration

Boot0 is by default grounded through a pull-down R91.

It is possible to set Boot0 high, removing R91 and putting a jumper between P1 header pin 6 BOOT0 and pin 5 3V.

10.7 Quad-SPI NOR Flash memory

128-Mbit Quad-SPI NOR Flash memory is connected to Quad-SPI interface of STM32L476VGT6.

10.8 USB OTG FS

The STM32L476 Discovery board supports USB OTG Full Speed communication via a USB Micro-AB connector (CN7) and a USB power switch (U14) connected to VBUS. The board can be powered by this USB connection as described in Section 10.2.

A green LED LD6 will be lit in one of these cases:
- The power switch (U14) is ON and STM32L476 Discovery board works as a USB host
- VBUS is powered by another USB host when STM32L476 Discovery board works as a USB device

Red LED LD7 will be lit when an overcurrent occurs.

In order to connect the OTG_FS_VBUS and OTG_FS_ID signals from the connector CN7 to the OTG FS hardware IP of STM32L476VGT6, remove the LCD from its socket U5, and close SB24 and SB25.

The default configuration is: the LCD is connected to U5, and SB24 and SB25 are opened. In this case the OTG_FS_VBUS and OTG_FS_ID signals from CN7 are connected to the OTG FS peripheral of the STM32L476VGT6 available on PC11 and PC12.
10.9 **USART configuration**

The USART interface available on PD5 and PD6 of the STM32L476VGT6 can be connected to the ST-LINK MCU to use the Virtual Com Port function.

To use the Virtual Com Port function with:

- The on-board STM32L476VGT6: set SB13 and SB16 ON (SB15, SB17 must be OFF).
- An external MCU: remove solder from SB13 and SB16, solder a two pins header on JP4, then RX and TX of the external MCU can be connected directly to RX and TX of JP4.

(For more details see *Section 11: Schematics)*

10.10 **Audio DAC and MEMS microphone**

An audio stereo DAC CS43L22 (U13) is connected to SAI interface of STM32L476VGT6.

The STM32L476VGT6 controls the audio DAC via the I2C1 bus which is shared with the I2C extension connector CN2.

I2C1 is also available on the connector P1, pins labeled ‘PB6’ (I2C1_SCL) and ‘PB7’ (I2C1_SDA).

The stereo output jack connector is CN6.

*Note:* I2C address of CS43L22 is 0x94.

A MEMS audio sensor omnidirectional digital microphone provides a digital signal in PDM format to the STM32L476VGT6.

10.11 **9-axis motion sensors**

STM32L476 Discovery board supports some 9-axis motion sensors, composed of:

- L3GD20 (U7): a three-axis digital output gyroscope
- LSM303C (U6): a 3D accelerometer and 3D magnetometer module

which are connected to STM32L476VGT6 through SPI.

10.12 **I2C extension connector CN2**

*Figure 9. Connector CN2*
10.13 **MCU current ammeter**

The jumper JP5, labeled Idd, allows the consumption of STM32L476VGT6 to be measured directly by a built-in current ammeter circuit able to measure from 60nA to 50mA or by removing the jumper and connecting an ammeter:

- Jumper on position OFF: STM32L476VGT6 is powered (default).

- Jumper on position ON: an on-board module is designed to measure from 60nA to 50mA by using several MOSFETs and switching automatically depending on the read value.

- No jumper on JP5: an ammeter must be connected to measure the STM32L476VGT6 current through pin 1 and 2 (if there is no ammeter, the STM32L476VGT6 is not powered).

---

### Table 6. Connector CN2

<table>
<thead>
<tr>
<th>Pin number</th>
<th>Description</th>
<th>Pin number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I2C1_SDA (PB7)</td>
<td>5</td>
<td>+3V3</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
<td>6</td>
<td>NC</td>
</tr>
<tr>
<td>3</td>
<td>I2C1_SCL (PB8)</td>
<td>7</td>
<td>GND</td>
</tr>
<tr>
<td>4</td>
<td>EXT_RST(PD0)</td>
<td>8</td>
<td>NC</td>
</tr>
</tbody>
</table>
10.14 Extension connector P1 and P2

The P1 and P2 headers can connect the STM32L476 Discovery board to a standard prototyping/wrapping board. STM32L476VGT6 GPIOs are available on these connectors. P1 and P2 can also be probed by an oscilloscope, logical analyzer or voltmeter.

Table 7. Extension connector

<table>
<thead>
<tr>
<th>Pin number</th>
<th>function</th>
<th>Pin number</th>
<th>function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3V3</td>
<td>1</td>
<td>5V_U</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(5V_USB_ST_LINK)</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>2</td>
<td>GND</td>
</tr>
<tr>
<td>3</td>
<td>2V5</td>
<td>3</td>
<td>5V_I</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(5V_INPUT)</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>4</td>
<td>VUSB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(USB OTG FS VBUS)</td>
</tr>
<tr>
<td>5</td>
<td>3V</td>
<td>5</td>
<td>5V</td>
</tr>
<tr>
<td>6</td>
<td>BOOT0</td>
<td>6</td>
<td>GND</td>
</tr>
<tr>
<td>7</td>
<td>PB3</td>
<td>7</td>
<td>PC14</td>
</tr>
<tr>
<td>8</td>
<td>PB2</td>
<td>8</td>
<td>PC15</td>
</tr>
<tr>
<td>9</td>
<td>PE8</td>
<td>9</td>
<td>PH0</td>
</tr>
<tr>
<td>10</td>
<td>PA0</td>
<td>10</td>
<td>PH1</td>
</tr>
<tr>
<td>11</td>
<td>PA5</td>
<td>11</td>
<td>NRST</td>
</tr>
<tr>
<td>12</td>
<td>PA1</td>
<td>12</td>
<td>GND</td>
</tr>
<tr>
<td>13</td>
<td>PA2</td>
<td>13</td>
<td>PE11</td>
</tr>
<tr>
<td>14</td>
<td>PA3</td>
<td>14</td>
<td>PE10</td>
</tr>
<tr>
<td>15</td>
<td>PB6</td>
<td>15</td>
<td>PE12</td>
</tr>
<tr>
<td>16</td>
<td>PB7</td>
<td>16</td>
<td>PE13</td>
</tr>
<tr>
<td>17</td>
<td>PD0</td>
<td>17</td>
<td>PE14</td>
</tr>
<tr>
<td>18</td>
<td>NC</td>
<td>18</td>
<td>PE15</td>
</tr>
<tr>
<td>19</td>
<td>GND</td>
<td>19</td>
<td>GND</td>
</tr>
<tr>
<td>20</td>
<td>GND</td>
<td>20</td>
<td>GND</td>
</tr>
</tbody>
</table>
## 10.15 Solder bridges

*Table 8* describes each solder bridge. The default state is indicated in bold.

<table>
<thead>
<tr>
<th>Bridge</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB1 (ST-LINK PWR)</td>
<td>ON</td>
<td>ST-LINK module is powered</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>ST-LINK module is not powered</td>
</tr>
<tr>
<td>SB2 (EXT/RF E2P)</td>
<td>ON</td>
<td>5V connected to CN2.8</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>5V is not connected to CN2.8</td>
</tr>
<tr>
<td>SB3, SB4, SB7, SB8</td>
<td>OFF</td>
<td>Reserved, do not modify</td>
</tr>
<tr>
<td>(RESERVED)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB5, SB6, SB9, SB10</td>
<td>ON</td>
<td>Reserved, do not modify</td>
</tr>
<tr>
<td>(DEFAULT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB11 (STM_RST)</td>
<td>ON</td>
<td>No incidence on NRST signal of STM32F103CBT6</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>NRST signal of STM32F103CBT6 is connected toGND</td>
</tr>
<tr>
<td>SB12</td>
<td>OFF</td>
<td>Reserved</td>
</tr>
<tr>
<td>SB16, SB13 (USART RX, TX)</td>
<td>ON</td>
<td>PA2, PA3 of STM32F103CBT6 are connected to PD6, PD5 of STM32L476VGT6</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>PA2, PA3 of STM32F103CBT6 are not connected to PD6, PD5 of STM32L476VGT6</td>
</tr>
<tr>
<td>SB17, SB15 (MFX USART RX,TX)</td>
<td>ON</td>
<td>PA2, PA3 of STM32L476VGT6 are connected to MFX USART RX,TX</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>PA2, PA3 of STM32L476VGT6 are not connected to MFX USART RX,TX</td>
</tr>
<tr>
<td>SB14 (T_SWO)</td>
<td>ON</td>
<td>PA10 of STM32F103CBT6 is connected to PB3 ofSTM32L476VGT6</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>PA10 of STM32F103CBT6 is not connected to PB3 ofSTM32L476VGT6</td>
</tr>
<tr>
<td>SB18 (MCO)</td>
<td>ON</td>
<td>If SB22 is also ON, MCO is connected to PH0</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>MCO is not connected to PH0</td>
</tr>
<tr>
<td>SB19, SB20 (32.768kHz CLK)</td>
<td>ON</td>
<td>PC14, PC15 are connected to X3 crystal</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>PC14, PC15 are not connected to X3 crystal</td>
</tr>
<tr>
<td>SB21, SB22 (8MHz CLK)</td>
<td>ON</td>
<td>PH0, PH1 are connected to X2 crystal (X2 is not fitted)</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>PH0, PH1 are not connected to X2 crystal</td>
</tr>
<tr>
<td>SB23 (B1-RESET)</td>
<td>ON</td>
<td>B1 push-button is connected to NRST of STM32L476 Discovery board</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>B1 push-button is not connected to NRST ofSTM32L476 Discovery board</td>
</tr>
</tbody>
</table>
Table 8. Solder bridges (continued)

<table>
<thead>
<tr>
<th>Bridge</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB24, SB25 (OTG FS)</td>
<td>ON</td>
<td>OTG_FS_VBUS signal is connected to PA9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OTG_FS_ID signal is connected to PA10</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>OTG_FS_VBUS signal is not connected to PA9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OTG_FS_ID signal is not connected to PA10</td>
</tr>
<tr>
<td>SB26</td>
<td>ON</td>
<td>Reserved, do not modify</td>
</tr>
<tr>
<td>SB27</td>
<td>OFF</td>
<td>Reserved, do not modify</td>
</tr>
<tr>
<td>SB28 (2.5V REG inhibit)</td>
<td>ON</td>
<td>U12 (2.5V regulator) input is inhibited</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>U12 input is not inhibited</td>
</tr>
<tr>
<td>SB29 (2.5V REG input)</td>
<td>ON</td>
<td>5V is connected to U12 input</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>5V is not connected to U12 input</td>
</tr>
</tbody>
</table>
Figure 10. STM32L476 Discovery board design top sheet
Figure 11. ST-LINK/V2-1 with support of SWD only
Figure 12. STM32L476VGT6 MCU
Figure 13. IDD measurement / MFX (Multi Function eXpander)

- **Project:** STS9P2UH7
- **Title:** IDD measurement / MFX
- **Date:** 6/15/2015
- **Sheet:** 41 of 44

**Description:**
- The diagram illustrates the IDD measurement setup for MFX (Multi Function eXpander).
- Key components include MFX_V2, GPIO1-10, GPIO12-15, and decoupling capacitors close to TSZ122.
- Differential amplifiers process the data, and current direction is indicated.
- Shunts are placed to measure current.

**Notes:**
- Two footprints superimposed allow to also populate with SO-8 package.
- STS9P2UH7 P MOS transistors.
Figure 14. Joystick ACP, LEDs and push-button

- **EXT/RF E2P Connector**
- **USER & WAKE-UP Button**
- **Joystick**
- **Input pins with pull-down**
- **Not Fitted**

Components and Pins:
- **EXT_RST**
- **PB2**
- **PB1**
- **PB0**
- **PA0**
- **PA1**
- **PA2**
- **PA3**
- **PA5**
- **PA4**
- **PD0**
- **R52**
- **R53**
- **C41**
- **C44**
- **C45**
- **C46**
- **R54**
- **R55**
- **R56**
- **R57**
- **R58**
- **C42**
- **C43**
- **R45**
- **R46**

**Input Pads:**
- **CENTER**
- **UP**
- **DOWN**
- **LEFT**
- **RIGHT**
- **JOY_CENTER**
- **JOY_UP**
- **JOY_DOWN**
- **JOY_LEFT**
- **JOY_RIGHT**

**LEDs:**
- **LD_R**
- **LD_G**
- **LD4**
- **LD5**

**Other Components:**
- Power supply connections
- Other general electronic components not labeled

**References:**
- SB23
- C45
- LD_R
- LD_G
- PB2
- PE8
- 3V
Figure 15. LCD display
Figure 17. Audio DAC and microphone MEMS
Figure 18. Quad-SPI Flash memory

Quad SPI Flash Memory

- QSPI_D0
- QSPI_D1
- QSPI_D2
- QSPI_D3
- QSPI_CLK
- QSPI_CS

Pinout:
- PE10
- PE11
- PE12
- PE13
- PE14
- PE15

Components:
- R74: 10K_1%_0402
- C61: 100nF_X7R_10%_0402
- U16: N25Q128A13EF840E
Figure 19. Gyroscope, accelerometer, magnetometer MEMS
Appendix A  Power consumption measurements

The power consumption measurements of the STM32L476 Discovery board are reflected in Figure 20. Note the GPIO configuration of the STM32L476VGT6 in standby mode.

Figure 20. Power consumption tree

STM32L476VGT6 GPIOs are configured in ‘Analog input’ except:

PWR->PUCRA = 0; // no PU on GPIOA
PWR->PDCRA = 0x2F; // PD on GPIOA[0,1,2,3,5]
PWR->PUCRB = 0; // no PU on GPIOB
PWR->PDCRB = 0; // no PD on GPIOB
PWR->PUCRC = 0x1; // PU on GPIOC[0] MAG_CS
PWR->PDCRC = 0x800; // PD on GPIOC[11]
PWR->PUCRD = 0x80; // no PU on GPIOD[0] MEMS_SPI_CLK, MEMS_SPI_MOSI
PWR->PDCRD = 0x12; // no PD on GPIOD[1,4] MEMS_SPI_CLK, MEMS_SPI_MOSI
PWR->PUCRE = 0x0001; // PU on GPIOE[0] XL_CS
PWR->PDCRE = 0xF400; // PD on GPIOE[9] QuadSPI_CLK, D0,D1,D2,D3
PWR->PUCRF = 0; // no PU on GPIOF
PWR->PDCRF = 0; // no PD on GPIOF
PWR->PUCRG = 0; // no PU on GPIOG
PWR->PDCRG = 0; // no PD on GPIOG
PWR->PUCRH = 0; // no PU on GPIOH
PWR->PDCRH = 0; // no PD on GPIOH

V+ : ~10µA due to resistors bridge
V- : ~11µA due to resistors bridge
The total measured power consumption of the STM32L476 Discovery board is 287 µA, which is as expected.

*Table 9* gives for each peripheral the theoretical power consumption value. It is extracted from the vendor’s product datasheet. The typical values are given under the same conditions as used for the power consumption measurement (see *Figure 20: Power consumption tree*). Refer to those product datasheets for more details about the conditions.

The theoretical total power consumption of the STM32L476 Discovery board is ~295 µA.

**Table 9. Typical power consumption of the STM32L476 Discovery board**

<table>
<thead>
<tr>
<th>MB1184-C01 component</th>
<th>Typical theoretical consumption (µA)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD3985M25R_U12</td>
<td>85</td>
<td>On mode: VINH = 1.2 V</td>
</tr>
<tr>
<td>TSZ122ISt_U10</td>
<td>58</td>
<td>-</td>
</tr>
<tr>
<td>Differential +</td>
<td>11</td>
<td>Current in R40 + R42</td>
</tr>
<tr>
<td>Differential -</td>
<td>11</td>
<td>Current in R47 + R50</td>
</tr>
<tr>
<td>CS43L22_U13</td>
<td>0</td>
<td>Reset pin 32 and all clocks and lines are hold Low</td>
</tr>
<tr>
<td>MP34DT01_U17</td>
<td>33</td>
<td>IddPdn, input clock in static mode</td>
</tr>
<tr>
<td>N25Q128A13EF840E_U16</td>
<td>14</td>
<td>Standby current</td>
</tr>
<tr>
<td>L3GD20_U7</td>
<td>5</td>
<td>IddPdn, Supply current in power-down mode</td>
</tr>
<tr>
<td>LSM303CTR_U6</td>
<td>10</td>
<td>IddPdn, current consumption in power-down mode</td>
</tr>
<tr>
<td>TSZ122ISt_U11</td>
<td>58</td>
<td>-</td>
</tr>
<tr>
<td>Bridge Op Amp</td>
<td>10</td>
<td>Current in R48 + R49</td>
</tr>
<tr>
<td>MFX_U8</td>
<td>0.3</td>
<td>Standby mode. All GPIOs in ‘Analog Input’ except WAKEUP input with external PD (R34)</td>
</tr>
<tr>
<td>STM32L476VGT6_U9</td>
<td>0.3</td>
<td>Standby mode, GPIOs configuration described above</td>
</tr>
<tr>
<td>TOTAL STM32L476</td>
<td>295.6</td>
<td>-</td>
</tr>
<tr>
<td>Discovery board</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B  Mechanical drawing

Figure 21. STM32L476 Discovery board mechanical drawing
Appendix C  Compliance statements

C.1  FCC Compliance Statement

C.1.1  Part 15.19
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.

C.1.2  Part 15.105
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 the receiver.
- Connect the equipment into an outlet on circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

C.1.3  Part 15.21
Any changes or modifications to this equipment not expressly approved by STMicroelectronics may cause harmful interference and void the user’s authority to operate this equipment.

C.2  IC Compliance Statement
This device complies with FCC and Industry Canada RF radiation exposure limits set forth for general population for mobile application (uncontrolled exposure). This device must not be collocated or operating in conjunction with any other antenna or transmitter.

C.2.1  Compliance Statement
Notice: This device complies with Industry Canada licence-exempt RSS standard(s). 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.

Industry Canada ICES-003 Compliance Label: CAN ICES-3 (B) / NMB-3 (B)
C.2.2 Déclaration de conformité

Avis: 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.

Etiquette de conformité à la NMB-003 d'Industrie Canada: CAN ICES-3 (B) / NMB-3 (B).
# Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-Jul-2015</td>
<td>1</td>
<td>Initial release.</td>
</tr>
<tr>
<td>04-Aug-2015</td>
<td>2</td>
<td>Added Section 6: Bootloader limitations.</td>
</tr>
<tr>
<td>24-Mar-2016</td>
<td>3</td>
<td>Added Section Appendix C: Compliance statements.</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2018 STMicroelectronics – All rights reserved