

CALIBRATING NI 4451/4452/4472/4551/4552 WITH CALIBRATION EXECUTIVE USER GUIDE

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Introduction

This document contains step-by-step instructions for calibrating NI 4451/4452/4472/4551/4552 dynamic signal acquisition and analysis (DSA) devices with Calibration Executive.

What Is Calibration?

Calibration determines the measurement accuracy of a device and corrects for any measurement error. Calibration consists of both verification and adjustment procedures. Verification measures the performance of a device and compares the results to the factory specifications of the device. National Instruments Calibration Executive automates the verification and adjustment of National Instruments measurement devices.

Why Should You Calibrate?

The accuracy of electronic components drifts with time and temperature, which can affect the measurement accuracy of a device. Calibration restores the specified accuracy of the device and ensures that it still meets National Instruments standards.

How Often Should You Calibrate?

The measurement accuracy requirements of your application determine how often you should calibrate DSA devices. National Instruments recommends that you perform a complete calibration at least once every year. You can shorten this interval to 90 days or six months based on the demands of your application.

Equipment and Other Test Requirements

This section describes the equipment, software, documentation, and test conditions required for calibration.

Test Equipment

Table 1 lists the required specifications and recommended test equipment to calibrate National Instruments DSA devices.

If you do not have the recommended instruments, use the accuracy requirements listed in Table 1 to select substitute calibration standards.

Table 1. Recommended Test Equipment Specifications

Instrument	Critical Specifications	Suggested Model	Use
Calibrator	Frequency Range: 20 Hz–95 kHz Voltage Range: 5 mV _{rms} –15 V _{rms} AC Accuracy: $\pm 0.1\%$ ¹ , 20 Hz–95 kHz DC Accuracy: $\pm 115 \text{ ppm}^2$ at 5 V	Fluke 5700A	Verification and adjustment
Function Generator	Frequency range: 20 Hz–95 kHz Frequency accuracy: $\pm 6 \text{ ppm}^3$ Voltage range: 3 V _{rms}	Agilent 3324A	Verification
Digital Multimeter (DMM)— required for 4451/4551 only	Voltage range: 5 mV _{rms} –5 V _{rms} AC accuracy: $\pm 0.2\%$ ¹ , 20 Hz–95 kHz DC accuracy: $\pm 500 \mu\text{V}^2$ at 0 V	Agilent 3458A	Verification
Frequency Counter— required for 4451/4551 only	Frequency Range: 20 Hz–5 MHz Frequency Accuracy: $\pm 6 \text{ ppm}^3$ 20 Hz–20 kHz Frequency Accuracy: $\pm 25 \text{ ppm}^3$ 20 Hz–5 MHz Input Voltage: 3 V _{rms}	Agilent 53131A	Verification
¹ AC accuracy is the sum of all errors including percent of reading error and temperature error but excluding percent of range error. ² DC accuracy is the sum of all errors including percent of reading error, percent of range error, and temperature error. ³ Frequency accuracy is the sum of all errors including initial accuracy and stability errors.			

Connectors

The Calibration Executive procedure for NI 445X and NI 455X devices requires the following connectors:

- BNC-2140 connector assembly
- SHC-68-C68-A1 cable
- SCB-68 shielded I/O connector block
- SHC-50-68 cable
- 50 Ω BNC terminator

- BNC T-connectors:
 - For NI 4451 and NI 4551 devices—one T-connector
 - For NI 4452 and NI 4552 devices—three T-connectors



Note Use the BNC-2140 for analog input and output calibration and the SCB-68 for counter verification.

The Calibration Executive procedure for NI 4472 devices requires the following connectors:

- Eight T-connectors
- Eight SMB-to-BNC cables

Software and Documentation

This section describes the software and documentation you need to calibrate NI 4451/4452/4472/4551/4552 devices.

Software

The DSA calibration procedure requires Calibration Executive software and the latest version of the National Instruments NI-DAQ driver to be loaded on the calibration system. You can download the latest version of the NI-DAQ driver from ni.com/downloads.

Documentation

The following documents contain information on using Calibration Executive and NI 4451/4452/4472/4551/4552 devices:

- *Calibration Executive Software User Manual*
- *PCI 4451/4452/4453/4454 User Manual, NI 4551/4552 User Manual, or NI 4472 User Manual*

The following documents contain information on using the NI-DAQ driver:

- *NI-DAQ Function Reference Online Help*
- *NI-DAQ User Manual for PC Compatibles*

You can download these documents from ni.com/manuals.

The function reference online help file includes detailed information on the driver functions. You can access the online help by selecting **Start»Programs»National Instruments DAQ»NI-DAQ Help**.

Test Conditions

Follow these guidelines to optimize the connections and the environment during calibration:

- Keep connections to the NI 4451/4452/4472/4551/4552 device as short as possible. Long cables and wires can act as antennae, which could pick up extra noise and affect measurements.
- Use shielded copper wire for all cable connections to the device. Use twisted-pair wire to eliminate noise and thermal offsets.
- Maintain a temperature between 18–28 °C.
- Keep relative humidity below 80%.
- Allow a warm-up time of at least 15 minutes to ensure that the measurement circuitry is at a stable operating temperature.

Calibration Procedures

This section explains how to set up and run the DSA calibration procedure. In automated mode, the calibration procedure takes approximately one hour. In manual mode, the calibration procedure can take as long as two hours.



Note The calibration procedure runs in automated mode if you use NI-IVI-supported DMMs and calibrators.

Setting Up NI 4472 Devices

To set up and configure NI 4472 devices for calibration, complete the following steps:

1. Install the NI 4472 in the host computer.
2. Configure the NI 4472 with Measurement & Automation Explorer (MAX).
3. Connect the eight SMB to BNC cables to channels 0–7.
4. Using the eight BNC T-connectors, tie all analog input channels together and connect them to the 50 Ω terminator.
5. Skip to the [Loading and Running the Calibration Procedure](#) section.

Setting Up NI 445X and NI 455X Devices

To set up and configure NI 445X and NI 455X devices for calibration, complete the following steps:

1. Install the device in the host computer.
2. Configure the device with MAX.

3. Connect the NI 445X or 455X device to the BNC-2140 using the SHC-68-C68-A1 cable. For the connector pin assignments, refer to Figure 1 for the BNC-2140, Figure 2 for NI 445X devices, and Figure 3 for 455X devices.

-ACH0	1	35	+ACH0
AIGND [†]	2	36	AIGND
-ACH1	3	37	+ACH1
AIGND [†]	4	38	AIGND
-ACH2	5	39	+ACH2
AIGND [†]	6	40	AIGND
-ACH3	7	41	+ACH3
AIGND [†]	8	42	AIGND
NC	9	43	NC
NC	10	44	NC
NC	11	45	NC
NC	12	46	NC
NC	13	47	NC
NC	14	48	NC
NC	15	49	NC
NC	16	50	NC
NC	17	51	NC
NC	18	52	NC
NC	19	53	NC
NC	20	54	NC
NC	21	55	NC
NC	22	56	NC
NC	23	57	NC
NC	24	58	NC
-DAC0OUT	25	59	+DAC0OUT
AOGND [†]	26	60	AOGND
-DAC1OUT	27	61	+DAC1OUT
AOGND [†]	28	62	AOGND
NC	29	63	NC
NC	30	64	NC
NC	31	65	NC
NC	32	66	NC
+5 V	33	67	+5 V
DGND	34	68	DGND

[†]These AIGND and AOGND pins are not connected in the SHC6868-A1 cable.

Figure 1. BNC-2140 External 68-Pin Analog Connector

-ACH0	1	35	+ACH0
AIGND [†]	2	36	AIGND
-ACH1	3	37	+ACH1
AIGND [†]	4	38	AIGND
-ACH2 ²	5	39	+ACH2 ²
AIGND [†]	6	40	AIGND
-ACH3 ²	7	41	+ACH3 ²
AIGND [†]	8	42	AIGND
NC	9	43	NC
AIGND [†]	10	44	AIGND [†]
NC	11	45	NC
AIGND [†]	12	46	AIGND [†]
NC	13	47	NC
AIGND [†]	14	48	AIGND [†]
NC	15	49	NC
AIGND [†]	16	50	AIGND [†]
NC	17	51	NC
AIGND [†]	18	52	AIGND [†]
NC	19	53	NC
AIGND [†]	20	54	AIGND [†]
NC	21	55	NC
AIGND [†]	22	56	AIGND [†]
NC	23	57	NC
AIGND [†]	24	58	AIGND [†]
-DAC0OUT ¹	25	59	+DAC0OUT ¹
AOGND ^{1†}	26	60	AOGND ¹
-DAC1OUT ¹	27	61	+DAC1OUT ¹
AOGND ^{1†}	28	62	AOGND ¹
NC	29	63	NC
AOGND ^{1†}	30	64	AOGND ^{1†}
NC	31	65	NC
AOGND ^{1†}	32	66	AOGND ^{1†}
+5 V	33	67	+5 V
DGND	34	68	DGND

¹PCI-4451 only

²PCI-4452 only

[†]These AIGND and AOGND pins are not connected in the SHC68-C68-A1 cable.

Figure 2. NI 4451/4452 Analog Pin Assignments

-ACH0	1	35	+ACH0
AIGND [†]	2	36	AIGND
-ACH1	3	37	+ACH1
AIGND [†]	4	38	AIGND
-ACH2 ¹	5	39	+ACH2 ¹
AIGND [†]	6	40	AIGND
-ACH3 ¹	7	41	+ACH3 ¹
AIGND [†]	8	42	AIGND
NC	9	43	NC
AIGND [†]	10	44	AIGND [†]
NC	11	45	NC
AIGND [†]	12	46	AIGND [†]
NC	13	47	NC
AIGND [†]	14	48	AIGND [†]
NC	15	49	NC
AIGND [†]	16	50	AIGND [†]
NC	17	51	NC
AIGND [†]	18	52	AIGND [†]
NC	19	53	NC
AIGND [†]	20	54	AIGND [†]
NC	21	55	NC
AIGND [†]	22	56	AIGND [†]
NC	23	57	NC
AIGND [†]	24	58	AIGND [†]
-DAC0OUT ²	25	59	+DAC0OUT ²
AOGND [†]	26	60	AOGND
-DAC1OUT ²	27	61	+DAC1OUT ²
AOGND [†]	28	62	AOGND
NC	29	63	NC
AOGND [†]	30	64	AOGND [†]
NC	31	65	NC
AOGND [†]	32	66	AOGND [†]
+5 V	33	67	+5 V
DGND	34	68	DGND

¹Not available on NI 4551

²Not available on NI 4552

[†]These AIGND and AOGND pins are not connected in the SHC68-C68-A1 cable.

Figure 3. NI 4551/4552 Analog Pin Assignments

4. Using the BNC T-connectors, tie all analog input channels together and connect them to the 50 Ω terminator.
 - For NI 4451 and NI 4551 devices, connect analog input channels 0 and 1.
 - For NI 4452 and NI 4552 devices, connect analog input channels 0–3.
5. While the calibration procedure is running, you are prompted to make further connections to the analog outputs on the BNC-2140. Follow the onscreen instructions at each prompt.
6. Refer to Figure 4 to configure the switches on the BNC-2140.

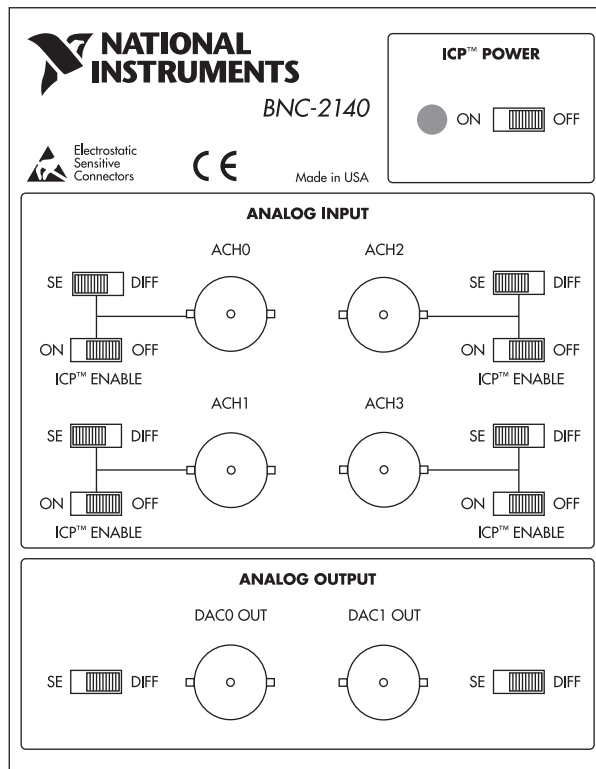
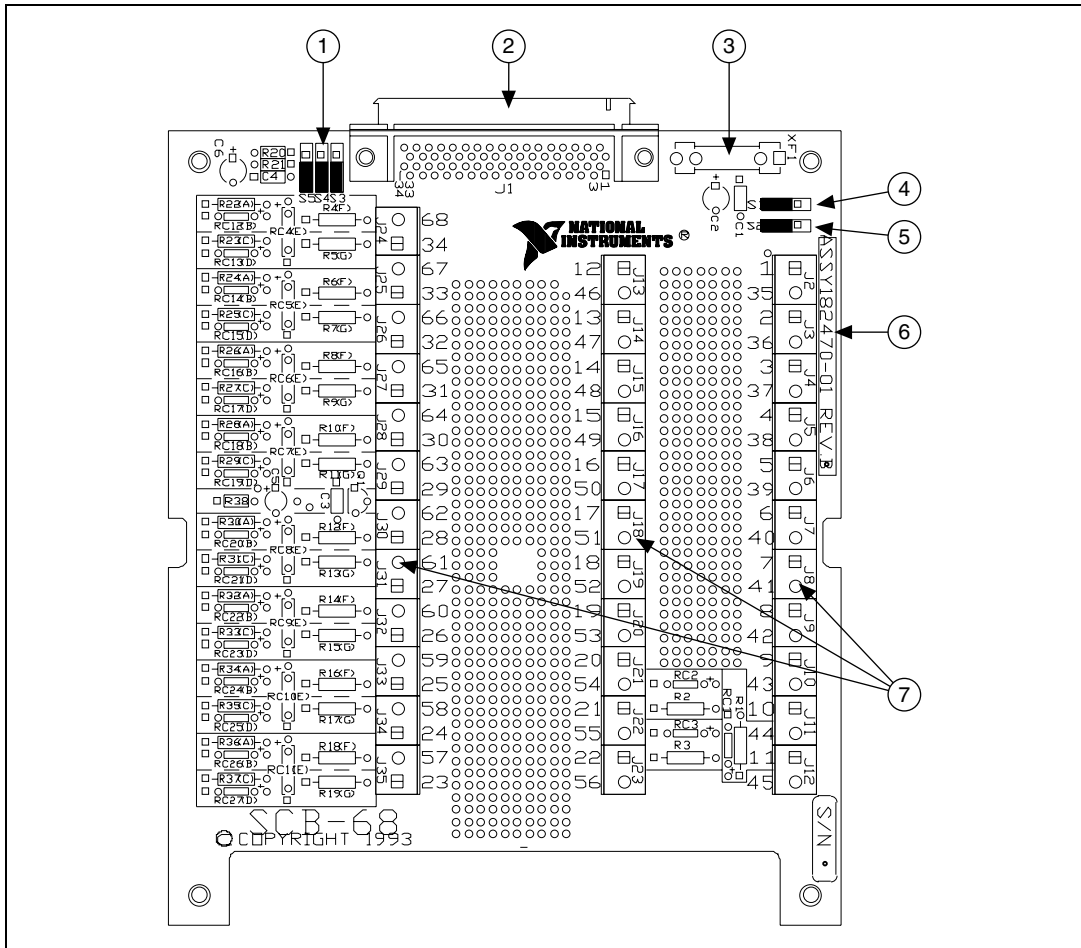


Figure 4. BNC-2140 Switch Settings

- a. Set the Integrated Circuit Piezoelectric (ICP[®]) Power switch and ICP Enable switches to OFF.
- b. Set the SE/DIFF switches in the analog input area to SE. If you use a function generator other than the Agilent 3324, verify that the negative output of the function generator is floating. If the negative output is tied to earth ground, set the SE/DIFF switches in the analog input area to DIFF.

- c. Set the SE/DIFF switches in the analog output area to DIFF. If you use a frequency counter other than the Agilent 53131A, verify that the negative input of the counter is tied to earth ground. If the negative input is floating, set the SE/DIFF switches in the analog output area to SE.

7. Locate switches S4 and S5 on the device. Refer to Figure 5 for the location of these switches on the SCB-68.



- | | |
|---------------------------|--------------------------------|
| 1 Switches S3, S4, and S5 | 5 Switch S2 |
| 2 68-Pin I/O Connector | 6 Assembly Number and Revision |
| 3 Fuse (0.8 A) | 7 Screw Terminals |
| 4 Switch S1 | |

Figure 5. SCB-68 Parts Locator Diagram

8. Disable the temperature sensor on the SCB-68 by setting switches S4 and S5 in the down position, as shown in Figure 6.

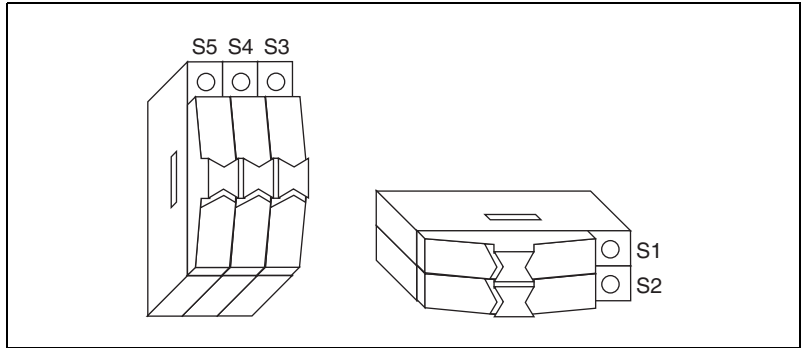


Figure 6. SCB-68 Switches Diagram

9. Connect the NI 4451/4452/4551/4552 device to the SCB-68 using the SHC-50-68 cable. Refer to Figure 5 to locate the parts on the SCB-68.
10. If you are calibrating an NI 455X device, connect inputs as follows:
 - a. Connect the positive input of the frequency counter to pin 30 of the SCB-68.
 - b. Connect the negative input of the frequency counter to pin 63 of the SCB-68.

Use only the pin number designations to locate the correct pins—disregard the descriptive labels on the pins of the SCB-68. Refer to Figure 5 to determine the correct pin numbers. Calibration Executive prompts you when to make the connections.

11. If you are calibrating an NI 445X device, connect the inputs as follows:
 - a. Connect the positive input of the frequency counter to pin 3 of the SCB-68.
 - b. Connect the negative input of the frequency counter to pin 35 of the SCB-68.

Use only the pin number designations to locate the correct pins—disregard the descriptive labels on the pins of the SCB-68. Calibration Executive prompts you when to make the connections.

The calibration procedure steps you through the connections between the BNC-2140, the SCB-68, the calibrator, the DMM, the function generator, and the counter.



Note Refer to the *PCI 4451/4452/4453/4454 User Manual*, the *NI 4551/4552 User Manual*, or the *NI 4472 User Manual* if you need additional configuration information.

Loading and Running the Calibration Procedure

Launch Calibration Executive and follow the steps described in the Calibration Configuration Wizard to load the DSA calibration procedure. Refer to Chapter 1, *Introduction to Calibration Executive*, of the *Calibration Executive Software User Manual* if you need more information on loading a calibration procedure.

When the procedure is loaded, click **Run Procedure** to begin. The calibration procedure prompts you to enter information about the specific device you are calibrating. Follow any additional instructions you receive from Calibration Executive. After the procedure finishes, complete the following steps:

1. Click **View»Reports**.
2. Select **View** to launch your browser and view the report. The calibration report appears as a printable HTML file.

If you need more information on running a Calibration Executive procedure, refer to the *Calibration Executive Software User Manual*.

You have completed calibrating the NI 4451/4452/4472/4551/4552 with Calibration Executive. If the device fails after calibration, further warm-up time may be required. If the device fails after further warm-up time, return it to National Instruments for repair.

Troubleshooting Guidelines

This section describes common problems you might encounter when calibrating a DSA device and explains how to correct the problem.

If the NI 4451/4452/4472/4551/4552 device is not recognized in MAX, verify that you followed the configuration guidelines. Additional configuration information is available at ni.com/support/daq. If MAX fails to recognize the device after you reconfigure and refresh (<F5>), contact NI technical support.

If the device fails after calibration, try the following steps:

1. Check the connections and run the Calibration Executive procedure again.
2. If the calibration still fails after trying step 1, try inputting or outputting the failed test points using the Test Panel in MAX. For example, if the analog input (AI) failed at 0.98 V, input that value from the calibrator.
 - a. Launch the test panel in MAX.
 - b. Click the **Analog Input** tab.

- c. Set the **High Limit** to 1.00 V and set the **Low Limit** to -1.00 V for bipolar readings.
- d. Check the Average Reading indicator.

If the Average Reading still fails after you complete steps 1–3, contact NI for repair or replacement. If the Average Reading passes, you can change the calibration report to indicate the passing value.



Note If you have Microsoft Access 2000 or later, you can also modify the database containing the test results. By default, this database is located in `\Calibration Executive\Databases\Calibration Reports.mdb`.

NI-DAQ Errors and Other Errors

This section describes some of the common errors that can occur when calibrating a DSA device.

The error **Could not find ividmm.dll** is caused by a problem with the original installation of Calibration Executive. If you see this error when you launch the calibration procedure, complete the following steps:

1. Navigate to `\Program Files\National Instruments\Calibration Executive\TestStand\Cfg`.
2. Using a text editor, look at the `testexec.ini` file. The entry under the `config.searchdirectories` should be as listed in Table 2.

Table 2. Navigation Paths to `testexec.ini` File

Operating System	Path
Windows Me/9x	[Config.SearchDirectories[11]] Path= c:\\VXIpn\\Win95\\Bin
Windows 2000/NT/XP	[Config.SearchDirectories[11]] Path= c:\\VXIpn\\WinNT\\Bin

If the search path contains more than two backslashes between folders, the extra backslashes can cause the error. Remove the extra backslashes so that the search path matches the correct path from Table 2, save `testexec.ini`, and then relaunch Calibration Executive.

Error code **-10005** indicates that the device number you selected is not configured or recognized in MAX. Configure the device in MAX and restart Calibration Executive.

Error code **-10842** during the internal calibration step indicates that the hardware is not responding correctly and the DSA device needs repair. When you contact NI for repair, explicitly indicate that the DSA Calibration function returns error **-10842** during internal calibration.

Error code **-15** at the beginning of the calibration procedure indicates that the computer may be configured to use commas as decimal places. Calibration Executive only supports using periods (.) for decimal places. To change this configuration on the computer, complete the following steps:

1. Select **Start»Settings»Control Panel**.
2. If you are using Windows Me/9x, click **Regional Settings**. If you are using Windows 2000/NT/XP, click **Regional Options**.
3. Click the **Numbers** tab and change the Decimal Symbol from a comma (,) to a period (.). Change the Digit Grouping Symbol from (.) to (,).



Note If you change the **Regional Settings** or **Regional Options** on the computer, remember to change them back to the default setting after running the Calibration Executive procedure.

You can find more information on other error codes in the *Status Codes* topic of the *NI-DAQ Function Reference Help* file. To launch this file, select **Start»Programs»National Instruments»NI-Daq»NI-DAQ Help**.

Technical Support Resources

NI Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of ni.com.

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of ni.com. Branch office Web sites provide up-to-date contact information, support phone numbers, email addresses, and current events.

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China (Shanghai) 021 6555 7838, China (ShenZhen) 0755 3904939,
Czech Republic 02 2423 5774, Denmark 45 76 26 00,
Finland 09 725 725 11, France 01 48 14 24 24, Germany 089 741 31 30,
Greece 30 1 42 96 427, Hong Kong 2645 3186, India 91 80 4190000,
Israel 03 6393737, Italy 02 413091, Japan 03 5472 2970,
Korea 02 3451 3400, Malaysia 603 9596711, Mexico 001 800 010 0793,
Netherlands 0348 433466, New Zealand 09 914 0488,
Norway 32 27 73 00, Poland 0 22 3390 150, Portugal 351 210 311 210,
Russia 095 238 7139, Singapore 6 2265886, Slovenia 386 3 425 4200,
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