

FP-AI-110 AND cFP-AI-110

8-Channel, 16-Bit Analog Input Modules

These operating instructions describe how to install and use the FP-AI-110 and cFP-AI-110 analog input modules (referred to inclusively as the [c]FP-AI-110). For information about configuring and accessing the [c]FP-AI-110 over a network, refer to the user manual for the FieldPoint network module you are using.

Features

The [c]FP-AI-110 is a FieldPoint analog input module with the following features:

- Eight analog voltage or current input channels
- Eight voltage input ranges: 0–1 V, 0–5 V, 0–10 V, ± 60 mV, ± 300 mV, ± 1 V, ± 5 V, and ± 10 V
- Three current input ranges: 0–20, 4–20, and ± 20 mA
- 16-bit resolution
- Three filter settings: 50, 60, and 500 Hz
- $2,300 V_{\text{rms}}$ transient overvoltage protection between the inter-module communication bus and the I/O channels
- $250 V_{\text{rms}}$ isolation voltage rating
- -40 to 70 °C operation
- Hot plug-and-play

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Installing the FP-AI-110

The FP-AI-110 mounts on a FieldPoint terminal base (FP-TB-*x*). Hot plug-and-play enables you to install the FP-AI-110 onto a powered terminal base without disturbing the operation of other modules or terminal bases. The FP-AI-110 receives operating power from the terminal base.

To install the FP-AI-110, refer to Figure 1 and follow these steps:

1. Slide the terminal base key to either position X (used for any module) or position 1 (used for the FP-AI-110 module).
2. Align the FP-AI-110 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-AI-110 on the terminal base. When the FP-AI-110 is firmly seated, the latch on the terminal base locks it into place.

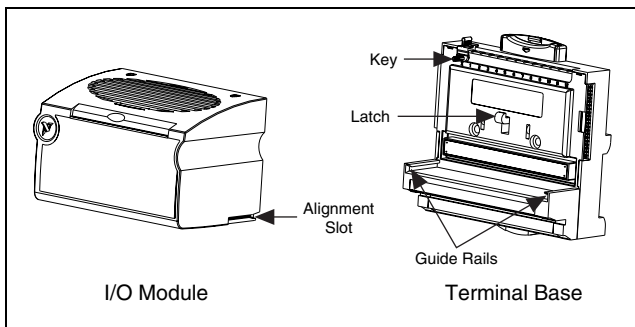


Figure 1. Installing the FP-AI-110

Installing the cFP-AI-110

The cFP-AI-110 mounts on a Compact FieldPoint backplane (cFP-BP-*x*). Hot plug-and-play enables you to install the cFP-AI-110 onto a powered backplane without disturbing the operation of other modules or connector blocks. The cFP-AI-110 receives operating power from the backplane.

To install the cFP-AI-110, refer to Figure 2 and follow these steps:

1. Align the captive screws on the cFP-AI-110 with the holes on the backplane. The alignment keys on the cFP-AI-110 prevent backward insertion.

2. Press firmly to seat the cFP-AI-110 on the backplane.
3. Using a number 2 Phillips screwdriver with a shank of at least 64 mm (2.5 in.) length, tighten the captive screws to 1.1 N · m (10 lb · in.) of torque. The nylon coating on the screws prevents them from loosening.

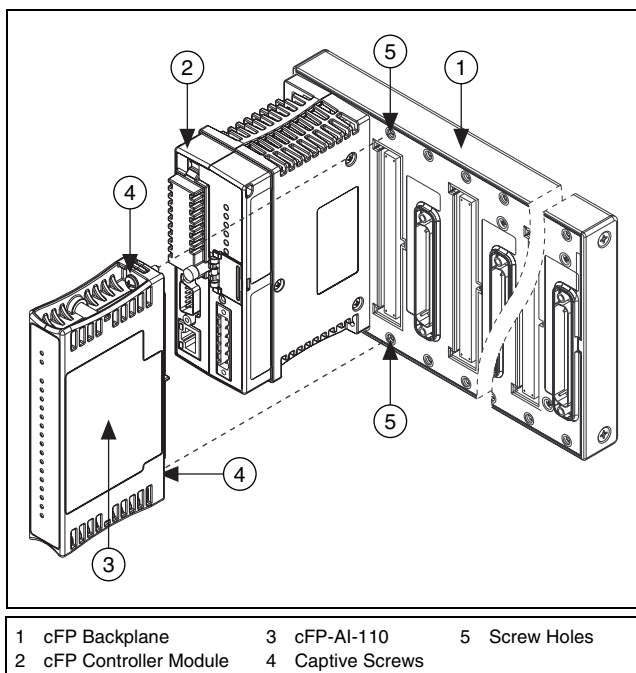


Figure 2. Installing the cFP-AI-110

Wiring the [c]FP-AI-110

The FP-TB-*x* terminal bases have connections for each of the eight input channels on the FP-AI-110 and for an external supply to power field devices. The cFP-CB-*x* connector blocks provide the same connections for the cFP-AI-110.

Table 1 lists the terminal assignments for the signals associated with each channel. The terminal assignments are the same for the FP-TB-*x* terminal bases and the cFP-CB-*x* connector blocks.

Table 1. Terminal Assignments

Channel	Terminal Numbers			
	V_{in}	I_{in}	V_{sup}	COM
0	1	2	17	18
1	3	4	19	20
2	5	6	21	22
3	7	8	23	24
4	9	10	25	26
5	11	12	27	28
6	13	14	29	30
7	15	16	31	32

Each channel has separate input terminals for voltage (V_{in}) and current (I_{in}) input. Voltage and current inputs are referenced to the COM terminals. If you are using an external supply to power field devices, connect the power supply to the V and C terminals of the terminal base or connector block. Refer to the sections that follow for detailed wiring diagrams.



Caution Do not connect both current and voltage inputs to the same channel.



Caution Cascading power between two modules defeats isolation between those modules. Cascading power from the network module defeats all isolation between modules in the FieldPoint bank.

Taking Measurements with the [c]FP-AI-110

The [c]FP-AI-110 has eight single-ended input channels. All eight channels share a common ground reference that is isolated from other modules in the FieldPoint system. Figure 3 shows the analog input circuitry on one channel.

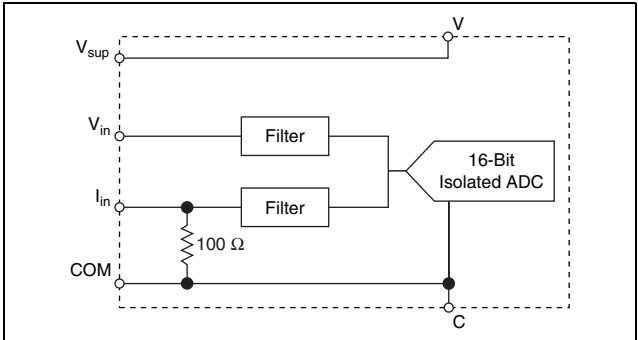


Figure 3. FP-AI-110 Analog Input Circuit

Measuring Voltage with the [c]FP-AI-110

The input ranges for voltage signals are 0–1 V, 0–5 V, 0–10 V, ± 60 mV, ± 300 mV, ± 1 V, ± 5 V, and ± 10 V.

Figure 4 shows how to connect a voltage source without an external power supply to one channel of the [c]FP-AI-110.

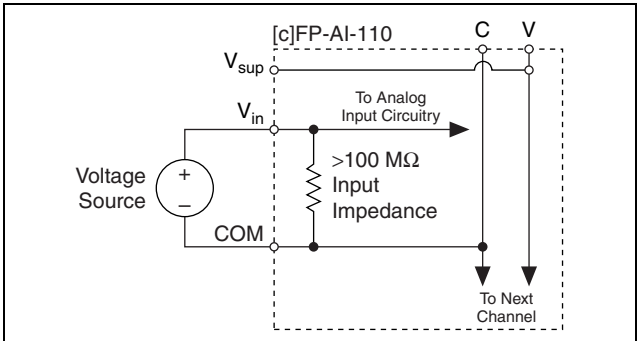


Figure 4. Voltage Source without External Power Supply

Figure 5 shows how to connect a voltage source with an external power supply to one channel of the [c]FP-AI-110.

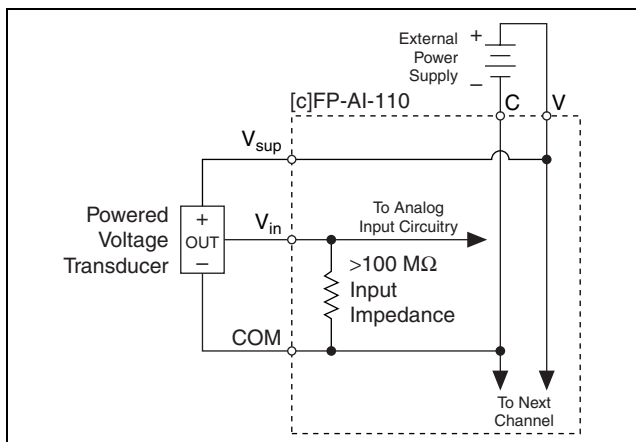


Figure 5. Voltage Source with External Power Supply

Measuring Current with the [c]FP-AI-110

The input ranges for current sources are 0–20, 4–20, and ± 20 mA. The module reads current flowing into the I_{in} terminal as positive and current flowing out of the terminal as negative. Current flows into the I_{in} terminal, goes through a $100\ \Omega$ resistor, and flows out from the COM or C terminal.

Figure 6 shows how to connect a current source without an external power supply to one channel of the [c]FP-AI-110.

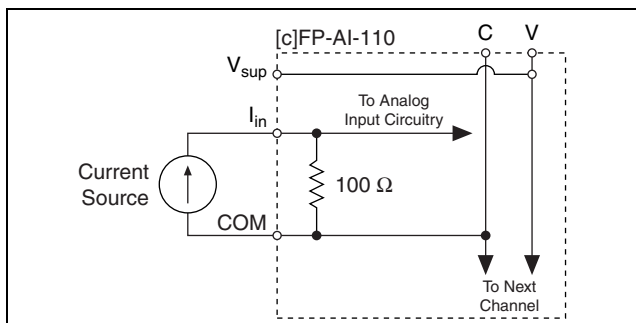


Figure 6. Current Source without External Power Supply

Figure 7 shows how to connect a current source with an external power supply to one channel of the [c]FP-AI-110.

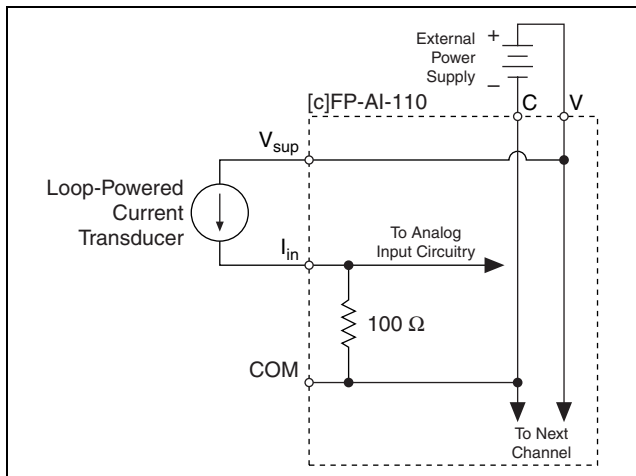


Figure 7. Current Source with External Power Supply

Input Ranges

To prevent inaccurate readings, choose an input range such that the signal you are measuring does not exceed either end of the range.

Overranging

The [c]FP-AI-110 has an overranging feature that measures a little beyond the nominal values of each range. For example, the actual measurement limit of the $\pm 10\text{ V}$ range is $\pm 10.4\text{ V}$. The overranging feature enables the [c]FP-AI-110 to compensate for field devices with span errors of up to +4% of full scale. Also, with the overranging feature, a noisy signal near full scale does not create rectification errors.

Filter Settings

Three filter settings are available for each channel. The filters on the [c]FP-AI-110 input channels are comb filters that provide notches of rejection at multiples, or harmonics, of a fundamental frequency. You can select a fundamental frequency of 50, 60, or 500 Hz. The [c]FP-AI-110 applies 95 dB of rejection at the fundamental frequency and at least 60 dB of rejection at each of the harmonics. In many cases, most of the noise components of input

signals are related to the local AC power line frequency, so a filter setting of either 50 or 60 Hz is best.

The filter setting determines the rate at which the [c]FP-AI-110 samples the inputs. The [c]FP-AI-110 resamples all of the channels at the same rate. If you set all of the channels to the 50 or 60 Hz filter, the [c]FP-AI-110 samples each channel every 1.470 s or every 1.230 s, respectively. If you set all of the channels to 500 Hz filters, the module samples each channel every 0.173 s. When you select different filter settings for different channels, use the following formula to determine the sampling rate.

$$\begin{aligned} & (\text{number of channels with 50 Hz filter}) \times 184 \text{ ms} + \\ & (\text{number of channels with 60 Hz filter}) \times 154 \text{ ms} + \\ & (\text{number of channels with 500 Hz filter}) \times 21.6 \text{ ms} = \\ & \text{Update Rate} \end{aligned}$$

If you are not using some of the [c]FP-AI-110 channels, set them to the 500 Hz filter setting to improve the response time of the module. For example, if one channel is set for a 60 Hz filter, and the other seven channels are set to 500 Hz, the module samples each channel every 0.3 s (four times faster than the case in which all eight channels are set to the 60 Hz setting).

The sampling rate does not affect the rate at which the network module reads the data. The [c]FP-AI-110 always has data available for the network module to read; the sampling rate is the rate at which this data is updated. Set up your application so that the sampling rate is faster than the rate at which the network module polls the [c]FP-AI-110 for data.

Status Indicators

The [c]FP-AI-110 has two green status LEDs, **POWER** and **READY**. After you insert the [c]FP-AI-110 into a terminal base or backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-AI-110 informs the network module of its presence. When the network module recognizes the [c]FP-AI-110, it sends initial configuration information to the [c]FP-AI-110. After the [c]FP-AI-110 receives this initial information, the green **READY** indicator lights and the module is in normal operating mode.

Upgrading the FieldPoint Firmware

You may need to upgrade the FieldPoint firmware when you add new I/O modules to the FieldPoint system. For information on determining which firmware you need and how to upgrade your firmware, go to ni.com/info and enter `fpmatrix`.

Isolation and Safety Guidelines



Caution Read the following information before attempting to connect the [c]FP-AI-110 to any circuits that may contain hazardous voltages.


This section describes the isolation of the [c]FP-AI-110 and its compliance with international safety standards. The field wiring connections are isolated from the backplane and the inter-module communication bus. The isolation is provided by the module, which has optical and galvanic isolation barriers designed and tested to protect against transient fault voltages of up to $2,300 V_{\text{rms}}$. The [c]FP-AI-110 provides *double insulation* (compliant with IEC 61010-1) for working voltages of $250 V_{\text{rms}}^1$. Safety standards (such as those published by UL and IEC) require the use of double insulation between hazardous voltages and any human-accessible parts or circuits.

Never try to use any isolation product between human-accessible parts (such as DIN rails or monitoring stations) and circuits that can be at hazardous potentials under normal conditions, unless the product is specifically designed for such an application, as is the [c]FP-AI-110.

Even though the [c]FP-AI-110 is designed to handle applications with hazardous potentials, follow these guidelines to ensure a safe total system:

- The [c]FP-AI-110 has a safety isolation barrier between the inter-module communication bus and the I/O channels. There is no isolation between channels unless otherwise noted. If any of the channels on a module are wired at a hazardous potential, make sure that all other devices or circuits connected to that module are properly insulated from human contact.

¹ *Working voltage* is defined as the signal voltage plus the common-mode voltage. *Common-mode voltage* is the voltage of the module with respect to ground.

- Do *not* share the external supply voltages (the V and C terminals) with other devices (including other FieldPoint devices), unless those devices are isolated from human contact.
- For Compact FieldPoint, you *must* connect the protective earth (PE) ground terminal on the cFP-BP-*x* backplane to the system safety ground. The backplane PE ground terminal has the following symbol stamped beside it: . Connect the backplane PE ground terminal to the system safety ground using 14 AWG (1.6 mm) wire with a ring lug. Use the 5/16 in. panhead screw shipped with the backplane to secure the ring lug to the backplane PE ground terminal.
- As with any hazardous voltage wiring, make sure that all wiring and connections meet applicable electrical codes and commonsense practices. Mount terminal bases and backplanes in an area, position, or cabinet that prevents accidental or unauthorized access to wiring that carries hazardous voltages.
- The isolation of the [c]FP-AI-110 is certified as double-insulated for working voltages of 250 V_{rms}. Do *not* use the [c]FP-AI-110 as the only isolating barrier between human contact and working voltages of more than 250 V_{rms}.
- Operate the [c]FP-AI-110 only at or below pollution degree 2. Pollution degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Do *not* operate FieldPoint products in an explosive atmosphere or where there may be flammable gases or fumes. If you need to operate FieldPoint products in such an environment, the FieldPoint products *must* be in a suitably rated enclosure.
- Operate the [c]FP-AI-110 at or below Installation Category II. Installation Category II is for measurements performed on circuits directly connected to the low-voltage installation. This category refers to local-level distribution, such as that provided by a standard wall outlet.

Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted. Gain errors are given as a percentage of input signal value.

Input Characteristics

Number of channels.....	8
ADC resolution.....	16 bits
Type of ADC.....	Delta-sigma
Input signal ranges (software selectable by channel)	

Nominal Input Range		With Overranging	Effective Resolution*
Voltage	± 60 mV	± 65 mV	3 μ V
	± 300 mV	± 325 mV	16 μ V
	± 1 V	± 1.04 V	40 μ V
	± 5 V	± 5.2 V	190 μ V
	± 10 V	± 10.4 V	380 μ V
	0–1 V	0–1.04 V	25 μ V
	0–5 V	0–5.2 V	90 μ V
	0–10 V	0–10.4 V	190 μ V
Current	0–20 mA	0–21 mA	0.5 μ A
	4–20 mA	3.5–21 mA	0.5 μ A
	± 20 mA	± 21 mA	0.7 μ A

*Includes quantization errors and rms noise with the filter set to 50 or 60 Hz.

Filter settings (software selectable by channel)

Characteristic	Filter Settings		
	50 Hz	60 Hz	500 Hz
Update rate*	1.470 s	1.230 s	0.173 s
Input bandwidth (-3 dB)	13 Hz	16 Hz	130 Hz

* Applies when all eight channels are set to the same filter setting.

Normal-mode rejection..... 95 dB (with 50/60 Hz filter)

Nonlinearity	0.0015% (monotonicity ¹ guaranteed over the operating temperature range)
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Voltage Inputs

Input impedance.....	>100 M Ω
Overtoltage protection	± 40 V
Input current	
25 °C.....	400 pA typ, 1 nA max
70 °C.....	3 nA typ, 15 nA max
Input noise (50 or 60 Hz filter)	
± 60 mV range.....	± 3 LSB ² peak-to-peak
± 300 mV range.....	± 2 LSB peak-to-peak
Other ranges	± 1 LSB peak-to-peak
Offset error	
25 °C.....	± 25 μ V + 2 LSB
-40 to 70 °C	± 450 μ V + 2 LSB
Offset error drift.....	± 6 μ V/°C
Gain error	
25 °C.....	$\pm 0.03\%$
-40 to 70 °C	$\pm 0.1\%$
Gain error drift.....	± 20 ppm/°C

Current Inputs

Input impedance.....	100 Ω
Overcurrent protection	± 30 mA
Input noise (50 or 60 Hz filter)	0.3 μ A rms
Offset error	
25 °C.....	1 μ A
-40 to 70 °C	10 μ A
Offset error drift.....	± 100 nA/°C

¹ A characteristic of an ADC in which the digital code output always increases as the value of the analog input to it increases.

² Least significant bit: the smallest voltage change detectable by the ADC.

Gain error	
25 °C.....	±0.04%
-40 to 70 °C.....	±0.2%
Gain error drift.....	±40 ppm/°C

Physical Characteristics

Indicators Green **POWER** and **READY** indicators

Weight

FP-AI-110.....	140 g (4.8 oz.)
cFP-AI-110.....	110 g (3.7 oz.)

Power Requirements

Power from network module 350 mW

Isolation Voltage

Isolation voltage rating 250 V_{rms}, Installation Category II

Channel-to-channel isolation..... No isolation between channels

Transient overvoltage..... 2,300 V_{rms}

Environmental

FieldPoint modules are intended for indoor use only. For outdoor use, they *must* be mounted inside a sealed enclosure.

Operating temperature -40 to 70 °C

Storage temperature -55 to 85 °C

Humidity 10 to 90% RH, noncondensing

Maximum altitude..... 2,000 m

Pollution degree 2

Shock and Vibration

Operating shock (IEC 68-2-27)

cFP-AI-110.....	50 g, 3 ms half sine, 3 shocks; 30 g, 11 ms half sine, 3 shocks
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Operating vibration, random (IEC 60068-2-34)

FP-AI-110..... 10–500 Hz, 2.2 g_{rms}

cFP-AI-110..... 10–500 Hz, 5 g_{rms}

Operating vibration, sinusoidal (IEC 60068-2-6)

[c]FP-AI-110 10–500 Hz, 5 g

Safety

The [c]FP-AI-110 meets the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use:

- EN 61010-1, IEC 61010-1
- UL 3121-1
- CAN/CSA c22.2 no. 1010.1

Electromagnetic Compatibility

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Electrical emissions EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Electrical immunity Evaluated to EN 61326:
1997/A1: 1998, Table 1



Note For full EMC compliance, you must operate this device with shielded cabling. See the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declaration of Conformity** at ni.com/hardref.nsf/.

Mechanical Dimensions

Figure 8 shows the mechanical dimensions of the FP-AI-110 installed on a terminal base. Dimensions are given in millimeters [inches]. If you are using the cFP-AI-110, refer to the cFP controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

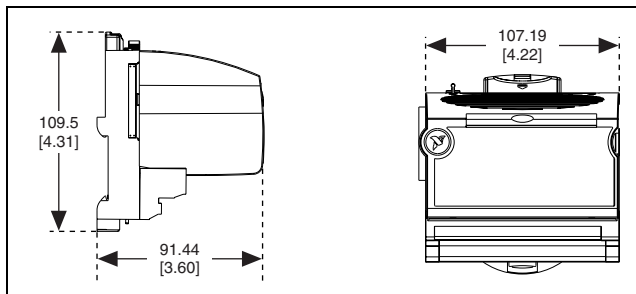


Figure 8. FP-AI-110 Mechanical Dimensions

Where to Go for Support

For more information about setting up the FieldPoint system, refer to these National Instruments documents:

- FieldPoint network module user manual
- Other FieldPoint I/O module operating instructions
- FieldPoint terminal base operating instructions

Go to ni.com/support for the most current manuals, examples, and troubleshooting information.

For telephone support in the United States, create your service request at ni.com/ask and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0,
Belgium 02 757 00 20, Brazil 55 11 3262 3599,
Canada (Calgary) 403 274 9391, Canada (Montreal) 514 288 5722,
Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521,
Canada (Toronto) 905 785 0085, China 86 21 6555 7838,
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 01 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 22 3390 150,
Portugal 210 311 210, Russia 095 238 7139,
Singapore 65 6 226 5886, Slovenia 3 425 4200,
South Africa 11 805 8197, Spain 91 640 0085,
Sweden 08 587 895 00, Switzerland 056 200 51 51,
Taiwan 02 2528 7227, United Kingdom 01635 523545



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