FP-SG-140 AND cFP-SG-140

Eight-Channel Strain-Gauge Input Modules

These operating instructions describe how to install and use the FP-SG-140 and cFP-SG-140 strain-gauge input modules (referred to inclusively as the [c]FP-SG-140). For information about configuring and accessing the [c]FP-SG-140 over a network, refer to the user manual for the FieldPoint network module you are using.

Features

The [c]FP-SG-140 is a FieldPoint strain-gauge input module with the following features:

- Internal support for full- and half-bridge configurations with programmable bridge completion
- Programmable excitation for each channel: 2.5, 5, or 10 V
- Four input ranges: ±3.5, ±7.5, ±30, and ±60 mV/V with overranging
- Three filter settings: 15, 60, and 240 Hz
- 16-bit resolution
- 2,300 V_{rms} transient overvoltage protection between the inter-module communication bus and the I/O channels
- –40 to 70 °C operation
- Hot plug-and-play

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NATIONAL INSTRUMENTS™

Installing the FP-SG-140

The FP-SG-140 mounts on a FieldPoint terminal base (FP-TB-*x*). Hot plug-and-play enables you to install the FP-SG-140 onto a powered terminal base without disturbing the operation of other modules or terminal bases. The FP-SG-140 receives operating power from the terminal base.

To install the FP-SG-140, refer to Figure 1 and complete the following steps:

1. Slide the terminal base key to either position X, used for any module, or position 1, used for the FP-SG-140.
2. Align the FP-SG-140 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-SG-140 on the terminal base. When the module is firmly seated, the terminal base latch locks it into place.

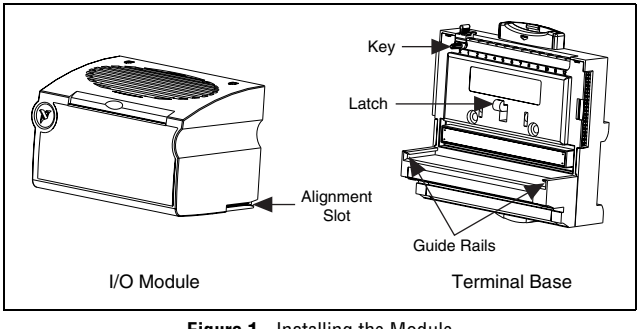


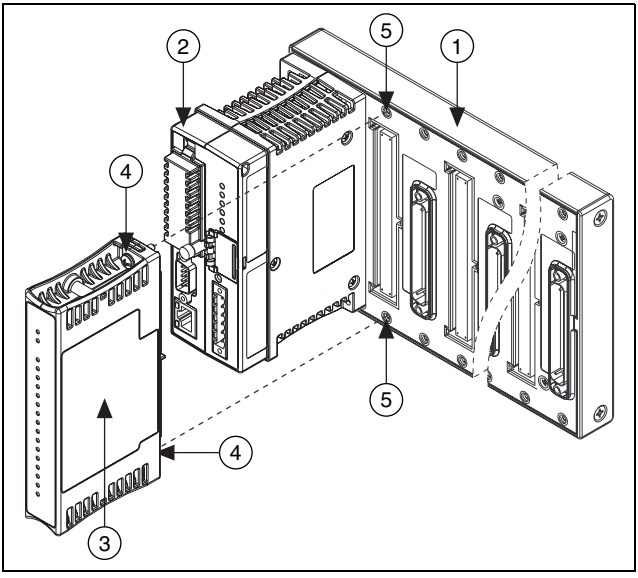
Figure 1. Installing the Module

Installing the cFP-SG-140

The cFP-SG-140 mounts on a Compact FieldPoint backplane (cFP-BP-*x*). Hot plug-and-play enables you to install the cFP-SG-140 onto a powered backplane without disturbing the operation of other modules or connector blocks. The cFP-SG-140 receives operating power from the backplane.

To install the cFP-SG-140, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-SG-140 with the holes on the backplane. The alignment keys on the cFP-SG-140 prevent backward insertion.
2. Press firmly to seat the cFP-SG-140 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.



1	cFP Backplane	3	cFP-SG-140	5	Screw Holes
2	cFP Controller Module	4	Captive Screws		

Figure 2. Installing the cFP-SG-140

Wiring the [c]FP-SG-140

The following sections show how to wire strain gauges to the [c]FP-SG-140 using the terminals on the FP-TB-*x* terminal base or cFP-CB-*x* connector block. The four terminals used for strain gauges are V_{exc}, COM, V_{in+}, and V_{in-}. Table 1 lists the terminal assignments for the signals associated with each channel.

Table 1. Terminal Assignments

Channel	V_{in+}	V_{in-}	V_{exc}	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

The eight input channels of the [c]FP-SG-140 share a common ground that is isolated from the other modules of the FieldPoint system. The COM terminals of all the channels and the C terminals are all connected together. If you are using shielded wiring, you can connect the shield to the COM terminal, but only if the shield is *not* connected to the strain-gauge circuit.

Connecting Sensors to the Input Channels

Each channel pulses a voltage between the V_{exc} and COM terminals. The V_{in+} and V_{in-} terminals measure the voltage generated across the output terminals of the strain-gauge bridge. Each channel is filtered, then sampled by an analog-to-digital converter. Figure 3 shows the input circuit for a single channel.

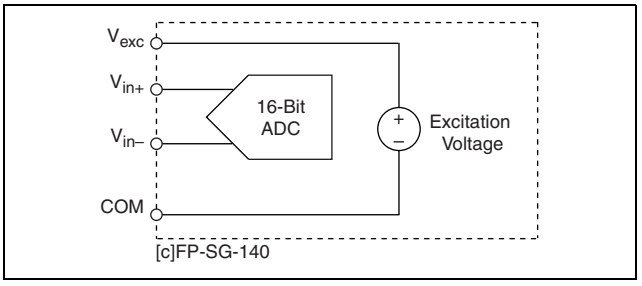


Figure 3. [c]FP-SG-140 Input Circuit

Connecting a Full-Bridge Strain Gauge

Connect the positive output to V_{in+} and the negative output to V_{in-}. Connect the positive excitation terminal to V_{exc} and the negative excitation terminal to COM. Refer to Figure 4.

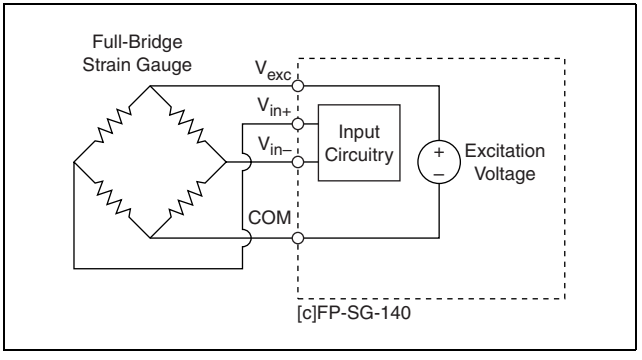


Figure 4. Connecting a Full-Bridge Strain Gauge to One Channel

Connecting a Half-Bridge Strain Gauge

Connect the positive output to the V_{in+} terminal and do not connect anything to the V_{in-} terminal. Connect the positive output to V_{in+} and the negative output to V_{in-}. Connect the positive excitation terminal to V_{exc} and the negative excitation terminal to COM. Refer to Figure 4.

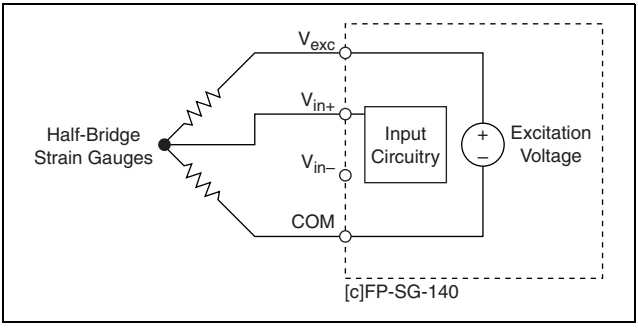


Figure 5. Connecting a Half-Bridge Strain Gauge to One Channel

For any channel connected to a half-bridge strain gauge, select **Half-Bridge Completion ON** in the Channel Configuration dialog box in the FieldPoint software.

Connecting a Quarter-Bridge Strain Gauge

For quarter-bridge sensors, you need an external resistor with the same resistance as the quarter-bridge strain gauge. The accuracy of your measurements depends on matching the value of this completion resistor to the nominal resistance value of the strain gauge.

Connect the positive output of the strain gauge to V_{in+}, connect the positive excitation terminal of the strain gauge to V_{exc}, and connect the completion resistor between V_{in+} and COM. In the FieldPoint software, select **Half-Bridge Completion ON**.

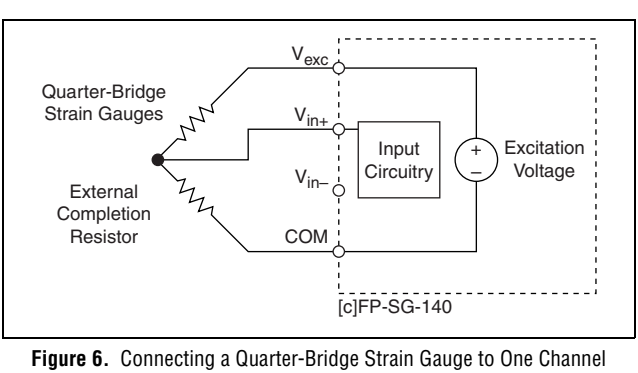


Figure 6. Connecting a Quarter-Bridge Strain Gauge to One Channel

Configuring Input Channels

After you connect the strain gauges, configure the input channels in the FieldPoint software.

Selecting an Input Range

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

Overranging allows the [c]FP-SG-140 to measure a little beyond the nominal value of each input range. For example, the actual measurement limit of the ±3.5 mV/V range is ±3.90625 mV/V. Overranging enables the [c]FP-SG-140 to compensate for field devices with span errors of up to 12%. Also, with the overranging feature, a noisy signal near full scale does not create rectification errors.

Channel Attributes

The Channel Attributes panel has an Attribute pulldown menu from which you choose the attribute you want to configure: **Noise Rejection**, **Excitation Voltage**, or **Half-Bridge Completion**.

Noise Rejection

Each analog input channel has a software-enabled comb filter that you can set to reject frequencies above 15, 60, or 240 Hz.

Excitation Voltage

You can choose 2.5, 5, or 10 V excitation for each channel. The current limit is 21 mA. Table 2 shows the minimum bridge resistance at each excitation voltage level.

Table 2. Minimum Bridge Resistance

Excitation Voltage	Minimum Bridge Resistance
2.5 V	120 Ω
5 V	240 Ω
10 V	477 Ω

If the bridge resistance is lower than the minimum value for the excitation voltage level, the readings are not valid and the red LED for the channel lights, indicating an overcurrent error.

Half-Bridge Completion

You can enable or disable half-bridge completion for each channel. Enable half-bridge completion for half-bridge and quarter-bridge sensors. When a channel is configured with the **Half-Bridge Completion ON** attribute value, the V_{in-} input is internally disconnected from the screw terminal and connected to a completion circuit.

Using Measured Values

The [c]FP-SG-140 reports measurements in units of mV/V (millivolts per volt of excitation), allowing the [c]FP-SG-140 to take measurements from a wide variety of transducers, such as load cells and pressure sensors. To convert measurements from mV/V to the physical units of a particular transducer, multiply by a constant as shown in the following sections.

Converting to Microstrain

Strain is measured in units of microstrain (με). The constant you use to convert readings from mV/V to με depends on whether you are using a full-, half-, or quarter-bridge strain-gauge circuit.

If you are using a full-bridge circuit similar to the one in Figure 4, you can convert readings from mV/V to με by multiplying the readings by the following constant:

$$constant = 1000 \times \frac{-1}{GF}$$

where GF is the gauge factor of the strain gauges. The gauge factor is listed in the strain gauge data sheet.

For example, assume a full-bridge circuit has strain gauges with a gauge factor of 2.03. Using the previous constant equation, the constant is –492.6108, as shown in the following calculation:

$$1000 \times \frac{-1}{(2.03)} = -492.6108$$

If the [c]FP-SG-140 reads 0.75 mV/V, the strain in units of microstrain is –369.5 με, as shown in the following calculations:

$$reading\ in\ mV/V \times constant = reading\ in\ microstrain$$

$$(0.75) \times (-492.6108) = -369.5\ \mu\varepsilon$$

If you are using a half-bridge circuit similar to the one in Figure 5, you can convert readings from mV/V to με by multiplying the readings by the following constant:

$$constant = 1000 \times \frac{-2}{GF}$$

If you are using a quarter-bridge circuit similar to the one in Figure 6, you can convert readings from mV/V to με by multiplying the readings by the following constant:

$$constant = 1000 \times \frac{-4}{GF}$$

For more information about strain gauges and how the equations in this section are derived, refer to NI Application Note 078, *Strain Gauge Measurement – A Tutorial*, available at `ni.com`.

Converting to Other Physical Units

If you use the [c]FP-SG-140 to measure the output of other transducers, such as load cells or pressure transducers, you can convert measurements from mV/V to other physical units such as force or pressure.

Load cells are specified by maximum voltage output at maximum load capacity. To convert load cell readings from the [c]FP-SG-140 to units of force or pressure, multiply the readings by the following constant:

$$constant = \frac{FullScaleCapacity}{FullScaleOutput}$$

where *FullScaleOutput* is the maximum voltage output of the load cell in mV/V, and *FullScaleCapacity* is the maximum capacity of the load cell in units of force or pressure.

For example, if you are using a load cell with a maximum capacity of 1,000 lb and a maximum output of 2 mV/V, the constant is 500, as shown in the following calculation:

$$\frac{1000}{2} = 500$$

This means the transducer outputs 1 mV/V per 500 lb of force applied to it. To convert readings to lb, multiply the output of the [c]FP-SG-140 by 500. If the [c]FP-SG-140 has a reading of

0.75 mV/V, the force in pounds that is applied to the load cell is 375 lb, as shown in the following calculation:

$$0.75 \times 500 \ = \ 375 \text{ lb}$$

Status Indicators

Figure 7 shows the [c]FP-SG-140 status indicators.

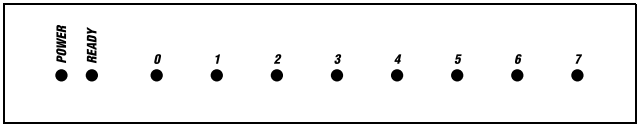


Figure 7. Status Indicators

The [c]FP-SG-140 has two green status LEDs, **POWER** and **READY**. After you insert the [c]FP-SG-140 into a terminal base or backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-SG-140 informs the network module of its presence. When the network module recognizes the [c]FP-SG-140, it sends initial configuration information to the [c]FP-SG-140. After receiving this initial information, the green **READY** indicator lights and the [c]FP-SG-140 is in normal operating mode.

In addition to the green **POWER** and **READY** indicators, each channel has a numbered, red LED that indicates overcurrent conditions. When a transducer draws more than 21 mA from the excitation terminal, the red LED for that channel lights and an overcurrent error is reported to the network module. This also occurs if the V_{exc} output is shorted to ground.

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, go to `ni.com/info` and enter `fpmatrix`.

Isolation and Safety Guidelines

Caution Read the following information before attempting to connect the [c]FP-SG-140 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-SG-140 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_{rms}.

Follow these guidelines to ensure a safe total system:

- The [c]FP-SG-140 has a safety isolation barrier between the I/O channels and the inter-module communication bus. 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.
- 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.
- Operate the [c]FP-SG-140 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.
- Refer to the FieldPoint product label for regulatory certification under hazardous location standards. If the FieldPoint product is not certified for operation in hazardous locations, do not operate it in an explosive atmosphere or where there may be flammable gases or fumes.

Specifications

These specifications are typical for the range –40 to 70 °C unless otherwise noted.

Input Characteristics

Number of channels 8

ADC resolution ..... 16 bits

Type of ADC ..... Delta-sigma

Input signal ranges (software-selectable per channel)

Nominal	With Overranging
±3.5 mV/V	±3.90625 mV/V
±7.5 mV/V	±7.8125 mV/V
±30 mV/V	±31.25 mV/V
±60 mV/V	±62.5 mV/V

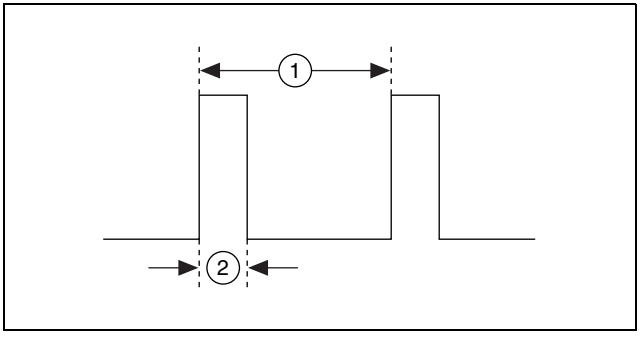
Filter settings ..... 15, 60, 240 Hz

Excitation voltage ..... 2.5, 5, 10 V, current is limited to 21 mA per channel

Pulse frequency and width

Filter Setting (Hz)	Pulse Width (ms)	Pulse Frequency (s)
15	324	1.15
60	116	0.95
240	70	0.90

Figure 8 shows how the pulse frequency and width are defined.



1 Pulse Frequency 2 Pulse Width

Figure 8. Pulse Width and Pulse Frequency

All-channel update rate

Filter Setting (Hz)	Update Rate (s)
15	1.15
60	0.95
240	0.90

Input impedance..... 20 MΩ

Offset error

15 to 35 °C ..... 7.6 µV typ, 28 µV max

–40 to 70 °C ..... 50 µV typ, 140 µV max

Gain error

15 to 35 °C ..... 0.06% of full scale (fs)

–40 to 70 °C ..... 0.4% fs

Input noise (60 Hz filter)

±3.5 mV/V..... ±3 LSB peak-to-peak

±7.5 mV/V..... ±2 LSB peak-to-peak

Other ranges ..... ±1 LSB peak-to-peak

Physical Characteristics

Indicators ..... Green **POWER** and **READY** indicators; eight red overcurrent indicators

Weight

FP-SG-140 ..... 140 g (4.8 oz)

cFP-SG-140 ..... 110 g (3.7 oz)

Power Requirements

Power from network module ..... 1 W

Isolation Voltage

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-SG-140 ..... 50 g, 3 ms half sine, 3 shocks; 30 g, 11 ms half sine, 3 shocks

Operating vibration, random (IEC 60068-2-34)

FP-SG-140 ..... 10–500 Hz, 2.2 g_{rms}

cFP-SG-140 ..... 10–500 Hz, 5 g_{rms}

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

[c]FP-SG-140 ..... 10–500 Hz, 5 g

Safety

The [c]FP-SG-140 is designed to meet 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

For certifications under regulatory standards, including hazardous location standards, refer to the product label or to `ni.com`.

Electromagnetic Compatibility

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

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

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

Note For full EMC compliance, you must operate this device with shielded cabling. Refer to 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/`. For FCC regulatory statements, refer to the *Read Me First* document that accompanies this product.

Mechanical Dimensions

Figure 9 shows the mechanical dimensions of the FP-SG-140 installed on a terminal base. Dimensions are given in millimeters [inches]. If you are using the cFP-SG-140, refer to the Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

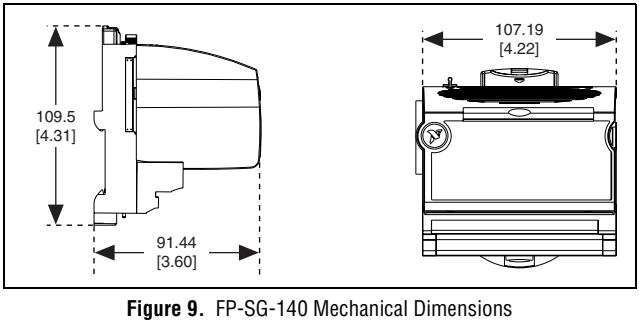


Figure 9. FP-SG-140 Mechanical Dimensions

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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