DENISON CALZONI
Radial Piston Motor
Type MRT, MRTE, MRTF
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</table>

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GENERAL CHARACTERISTICS

CONSTRUCTION
Fixed displacement radial piston motor

TYPE
MRT, MRTE, MRTF

MOUNTING
Front flange mounting

CONNECTION
Connection flange

MOUNTING POSITION
Any (please note the installation notes on page 22)

DIRECTION OF ROTATION
Clockwise, anti-clockwise - reversible

FLUID
HLP mineral oils to DIN 51 524 part 2; Fluid type HFB, HFC and Bio-fluids on enquiry. FPM seals are required with phosphorous acid-Ester (HFD)

FLUID TEMPERATURE RANGE
\[ t \text{ °F} - 22° a + 176° (-30° a +80° C) \]

VISCOSITY RANGE 1)
\[ \nu = 85 \text{ to } 4635 \text{ SUS (18 to 1000 mm}^2/\text{s})\]: Recommended operating range 141 to 230 SUS (30 to 50 mm\(^2\)/s) (see fluid selection on page 6)

FLUID CLEANLINESS
Maximum permissible degree of contamination of fluid NAS 1638 Class 9. We therefore recommend a filter with a minimum retention rate of \( \beta_{10} \geq 75 \). To ensure a long life we recommend class 8 to NAS 1638. This can be achieved with a filter, with a minimum retention rate of \( \beta_{5} \geq 100 \).

1) For different valves of viscosity please contact DENISON Calzoni
FUNCTIONAL DESCRIPTION

The outstanding performance, which is already known in our MR - MRE series motors, is the result of an original and patented design. The principle is to transmit the effort from the stator to the rotating shaft (1) by means of a pressurized column of oil (A) instead of the more common connecting rods, pistons, pads and pins. This oil column is contained by a telescopic cylinder (2) with a mechanical connection at the lips at each end which seal against the spherical surfaces (3) of the cylinder-heads (4) and the spherical surface of the rotating shaft (1). These lips retain their circular cross section when stressed by the pressure so there is no alteration in the sealing geometry. The particular selection of materials and optimisation of design has minimized both the friction and the leakage. Another advantage of this design stems from the elimination of any connecting rods, the cylinder can only expand and retract linearly so there are no transverse components of the thrust. This means no oval wear on the moving parts and no side forces on the cylinder joints. A consequence of this novel design as a 10 piston motor is the significant reduction in dimensions. Especially the diameter is limited to a value of motors with half of its capacity. Performances reached by this motor type are improved with reference to other motors of same diplacement. Another advantage stems from the geometrical arrangement of the 10 - 14 pistons, that results in a static balance of the motor shaft and in a great reduction of the reaction forces on the bearings with consequent large extension of their life time.

TIMING SYSTEM

The timing system is realized by means of a rotary valve (5) driven by the rotary valve driving shaft (8) that it is connected to the rotating shaft. The rotary valve rotates between the rotary valve plate (6) and the reaction ring (7) which are fixed with the motor's housing. This timing system is also of a patented design being pressure balanced and self compensating for thermal expansion. The motor sizes from MRTE 16500 to MRTE 23000 are available with large timing system option that allows higher motor power performances as well as the possibility to have a throughhollow shaft (see pages 5, 18-19).

EFFICIENCY

The advantages of this type of valve coupled with a revolutionary cylinder arrangement produce a motor with extremely high values of mechanical and volumetric efficiency. The torque output is smooth even at very low speed and the motor gives a high performance starting under load.
### STANDARD TIMING TECHINICAL DATA

<table>
<thead>
<tr>
<th>Size Motor version</th>
<th>Displacement</th>
<th>Moment inertia of rotating parts</th>
<th>Theoretical specific torque</th>
<th>Min. start. torque % Theoretical torque</th>
<th>Maximum Pressure</th>
<th>Speed range</th>
<th>Maximum output power</th>
<th>Weight</th>
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<tr>
<td><strong>V</strong></td>
<td><strong>J</strong></td>
<td><strong>%</strong></td>
<td><strong>p</strong></td>
<td></td>
<td><strong>n</strong></td>
<td><strong>m</strong></td>
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<td>lb. ft/psi</td>
<td>psi</td>
<td>psi</td>
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### SPECIAL TIMING TECHINICAL DATA (please contact DENISON Calzioni)

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<th>Displacement</th>
<th>Moment inertia of rotating parts</th>
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(*) Please contact DENISON Calzioni

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EXAMPLE: At a certain ambient temperature, the operating temperature in the circuit is 122°F (50°C). In the optimum operating viscosity range ($\nu_{\text{rec}}$; shaded section), this corresponds to viscosity grades VG 46 or VG 68; VG 68 should be selected.

IMPORTANT: The drain oil temperature is influenced by pressure and speed and is usually higher than the circuit temperature or the tank temperature. At no point in the system, however, may the temperature be higher than 176°F (80°C).

If the optimum conditions cannot be met due to the extreme operating parameters or high ambient temperature, we always recommend flushing the motor case in order to operate within the viscosity limits. Should it be absolutely necessary to use a viscosity beyond the recommended range, you should first contact DENISON Calzoni for confirmation.

GENERAL NOTES

More detailed information regarding the choice of the fluid can be requested to DENISON Calzoni. Further notes on installation and commissioning can be found on page 22 of this data sheet. When operating with HF pressure fluids or bio-degradable pressure fluids possible limitations of the technical data must be taken into consideration, please see information sheet TCS 85, or consult DENISON Calzoni.

OPERATING VISCOSITY RANGE

The viscosity, quality and cleanliness of operating fluids are decisive factors in determining the reliability, performance and life-time of an hydraulic component. The maximum life-time and performance are achieved within the recommended viscosity range. For applications that go beyond this range, we recommend to contact DENISON Calzoni.

$\nu_{\text{rec}} = \text{recommended operating viscosity 141...230 SUS (30...50 mm}^2/\text{s})$

This viscosity refers to the temperature of the fluid entering the motor, and at the same time to the temperature inside the motor housing (case temperature). We recommend to select the viscosity of the fluid based on the maximum operating temperature, to remain within the recommended viscosity range. To reach the value of maximum continuous power the operating viscosity should be within the recommended viscosity range of 30 - 50 cSt.

LIMITS OF VISCOSITY RANGE

For limit conditions the following is valid:

$\nu_{\text{min.abs.}} = 45 \text{ SUS (10 mm}^2/\text{s)} \text{ in emergency, short term}$

$\nu_{\text{min.}} = 85 \text{ SUS (18 mm}^2/\text{s)} \text{ for continuous operation at reduced performances}$

$\nu_{\text{max.}} = 4635 \text{ SUS (1000 mm}^2/\text{s)} \text{ short term upon cold start}$

CHOOSING THE TYPE OF FLUID ACCORDING TO THE OPERATING TEMPERATURE

The operating temperature of the motor is defined as the greater temperature between that of the incoming fluid and that of the fluid inside the motor housing (case temperature). We recommend that you choose the viscosity of the fluid based on the maximum operating temperature, to remain within the recommended viscosity range (see diagram). We recommend that the higher viscosity grade must be selected in each case.

FILTRATION

The motor life also depends on the fluid filtration. At least it must correspond to one of the following cleanliness.

- class 9 according to NAS 1638
- class 6 according to SAE, ASTM, AIA
- class 18/15 according to ISO/DIS 4406

In order to assure a longer life a cleanliness class 8 to NAS 1638 is recommended, achieved with a filter of $\beta_2=100$. In case the above mentioned classes can not be achieved, please consult us.

CASE DRAIN PRESSURE

The lower the speed and the case drain pressure, the longer the life of the shaft seal. The maximum permissible housing pressure is

$p_{\text{max}} = 72.5 \text{ psi}$

If the case drain pressure is higher than 72.5 psi it is possible to use a special 218 psi shaft seal (see page 23, Seals, Code "F1").

"FPM" SEALS

In case of operating conditions with high oil temperature or high ambient temperature, we recommend to use "FPM" seals (see page 23, Seals, Code "V1"). These "FPM" seals should be used with HFD fluids.
FLUSHING PROCEDURE

In order to achieve the maximum continuous performance values the flushing of the housing is necessary (see diagrams pages 8 to 12).

Under special conditions, in order to achieve the recommended operating viscosity of 141-230 SUS (30 - 50 mm²/s) in the motor housing, the flushing of the motor may be necessary also in the "operating area without flushing" see page 6 and the "operating diagram" page 7 to 12.

NOTE1:
The oil temperature inside the motor housing is obtainable by adding 5°F (3°C) to the motor housing surface temperature, measured between two cylinders \( t_A \), see figures.

FUNCTION:
The flushing valve takes the flushing flow always from the low pressure line of the motor. The diameter of the orifice has to be chosen in order to supply the recommended quantity of flushing flow of 6 gpm (23 l/min).

<table>
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<tr>
<th>BACK PRESSURE (psi)</th>
<th>ORIFICE DIAMETER (inch)</th>
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<td>87.0</td>
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<td>130.5</td>
<td>0.142</td>
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<tr>
<td>362.6</td>
<td>0.114</td>
</tr>
<tr>
<td>435.1</td>
<td>0.110</td>
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</tbody>
</table>

NOTE2:
The flushing valve is delivered with a "closed" orifice.
Caution: Flushing does not work until the "closed" orifice is replaced by the proper one.
OPERATING DIAGRAM

(average values) measured at $V = 167$ SUS (36 mm$^3$/s); $t = 113^\circ$F (45$^\circ$C);

1 Output power  2 Intermittent operating area  3 Continuous operating area with flushing
4 Continuous operating area  5 Inlet pressure  \( \eta \) Total efficiency  \( \eta_v \) Volumeter efficiency

**MRT 7100**

- Torque in lb.ft
- Speed in rpm
- Output power: 25815, 22127, 18439, 14751, 11063, 7376, 3689
- Continuous operating area
- Intermittent operating area
- Inlet pressure $p_{out} = 0$ psi (0 bar)

**MRTF 7800**

- Torque in lb.ft
- Speed in rpm
- Output power: 24340, 22127, 17701, 13276, 8851, 4425
- Continuous operating area
- Intermittent operating area
- Inlet pressure $p_{out} = 0$ psi (0 bar)

**MRTE 8500**

- Torque in lb.ft
- Speed in rpm
- Output power: 26552, 22127, 17701, 13276, 8851, 4425
- Continuous operating area
- Intermittent operating area
- Inlet pressure $p_{out} = 0$ psi (0 bar)
OPERATING DIAGRAM (average values) measured at $V = 167$ SUS (36 mm³/s); $t = 113^\circ$F (45°C);

1. Output power
2. Intermittent operating area
3. Continuous operating area with flushing
4. Continuous operating area
5. Inlet pressure

$\eta_{\text{Total efficiency}}$
$\eta_{\text{Volumeter efficiency}}$

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OPERATING DIAGRAM

1 Output power
2 Intermittent operating area
3 Continuous operating area with flushing
4 Continuous operating area
5 Inlet pressure

η_T: Total efficiency
η_V: Volumeter efficiency

(average values) measured at \( V = 167 \text{ SUS (36 mm}^3/\text{s}) \); \( t = 113^\circ \text{F (45}^\circ \text{C)} \);
\( p_{\text{outlet}} = 0 \text{ psi (0 bar)} \)

MRT 14000

MRTF 15500

MRTE 16500

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OPERATING DIAGRAM - MOTOR TYPE MRT - MRTE - MRTF

(average values) measured at $V = 167$ SUS (36 mm$^3$/s); $t = 113^\circ$F (45$^\circ$ C); $p_{\text{out}} = 0$ psi (0 bar)

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<td>2</td>
<td>Intermittent operating area</td>
<td>3</td>
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<td>4</td>
<td>Continuous operating area</td>
<td>5</td>
<td>Inlet pressure</td>
<td>ηTotal efficiency</td>
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</table>

MRT 17000

MRT 18000

MRT 19500

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OPERATING DIAGRAM

(average values) measured at $V = 167$ SUS (36 mm²/s); $t = 113^\circ$F (45°C); $p_{\text{outlet}} = 0$ psi (0 bar)

1 Output power 2 Intermittent operating area 3 Continuous operating area with flushing
4 Continuous operating area 5 Inlet pressure

$\eta$ Total efficiency $\eta_v$ Volumetric efficiency

MRTE 20000

Speed in rpm

Torque in lbf ft

MRTE 21500

Speed in rpm

Torque in lbf ft

MRTE 23000

Speed in rpm

Torque in lbf ft

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OPERATING DIAGRAM (average values) measured at $V = 167$ SUS (36 mm²/s); $t = 113^\circ$F (45° C);
Min. required pressure difference $\Delta p$ with idling speed (shaft unloaded) $p_{out} = 0$ psi (0 bar)

MRT - MRTE - MRTF
7100 - 8500

MRT - MRTE - MRTF
9000 - 10800

MRT - MRTE - MRTF
14000 - 16500

MRT - MRTE - MRTF
17000 - 20000

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OPERATING DIAGRAM

(average values) measured at \( V = 167 \) SUS (36 mm\(^2\)/s); \( t = 113^\circ F (45^\circ C) \);

Min. required pressure difference \( \Delta p \) with idling speed (shaft unloaded) \( p_{\text{out}} = 0 \) psi (0 bar)

MRT - MRTE - MRTF
19500 - 23000

Minimum boost pressure during pump operation

MRT - MRTE - MRTF
7100 - 8500

MRT - MRTE - MRTF
9000 - 10800

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OPERATING DIAGRAM (average values) measured at $V = 167$ SUS ($36$ mm$^2$/s); $t = 113^\circ$F ($45^\circ$C); $p_{\text{outlet}} = 0$ psi (0 bar)

Minimum boost pressure during pump operation

**MRT - MRTE - MRTF**

14000 - 16500

**MRT - MRTE - MRTF**

17000 - 20000

**MRT - MRTE - MRTF**

19500 - 23000

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1 On request port flange can be rotated by 72°

*) These SAE ports are present only in the MRT 9000P, MRTF 9900P, MRTE 10800P, MRT 14000Q, MRTF 15500Q, MRTE 16500, MRT 17000Q, MRTF 18000Q, MRT 19500Q, MRTE 20000Q, MRTF 21500Q e MRTE 23000Q

2 Case drain port
BSP threads to ISO 228/1

3 See dimensions at page 17

4 Port 1/4" BSP threads to ISO 228/1 for pressure reading.

<table>
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<tr>
<th>Dir. of Rotation (Viewed on shaft end)</th>
<th>Port inlet</th>
<th>ordering code (see page23)</th>
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<tr>
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<td>anti-clockwise</td>
<td>B</td>
<td>&quot;S&quot;</td>
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The specified data are for product description purposes only and must not be interpreted as warranted characteristics in a legal sense.

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<th>Ø D4 (inch)</th>
<th>Ø D5 (inch)</th>
<th>D6 (mm)</th>
<th>T1 (inch)</th>
<th>D7</th>
<th>Ø D8 (inch)</th>
<th>Ø D9 (inch)</th>
<th>Ø D10 (inch)</th>
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**Code F 1 - DIN 5480**

**Code D 1 - DIN 5480**

**NOTE:** the threaded holes (D12/T10) for the shaft versions "D1" must be considered as service holes. In case the holes dimensions required by the application are different from the ones listed here above, please contact DENISON Calzoni.
1. On request port flange can be rotated by 72°.

2. These SAE ports are present only in the MRT 14000Q, MRTF 15500Q, MRT 16500Q, MRT 17000Q, MRTF 18000Q, MRT 19500Q, MRT 20000Q, MRTF 21500Q e MRTE 23000Q.

3. See dimensions at page 19.

4. Port 1/4" BSP threads to ISO 228/1 for pressure reading.

SPECIAL TIMING

Port inlet: A
Dif. of rotation (View from shaft end) clockwise: B
anti-clockwise: A

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</tbody>
</table>

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SPECIAL TIMING DIMENSIONS (please contact DENISON Calzoni)
COMPONENTS FOR SPEED CONTROL - MOTOR TYPE MRT - MRTE - MRTF

MECHANICAL
TACHOMETER DRIVE

TACHOGENERATOR
DRIVE

ENCODER
DRIVE

Dimensions in inch (threaded holes in mm)

Code "C1"

Code "T1"

Code "Q1"

Timing standard

INCREMENTAL ENCODER
DIMENSIONS

Dimensions in inch (threaded holes in mm)

encoder

encoder drive flange

protection

Female connector included in the supply

\[ \alpha = 45^\circ \]

Timing standard

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INCREMENTAL ENCODER

CONNECTION DIAGRAMS

**Monodirectional**

**Bidirectional**

<table>
<thead>
<tr>
<th>Color wires and function</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
<td>Brown</td>
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<tr>
<td>Power Supply (8 to 24 Vdc)</td>
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<tr>
<td>White</td>
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<tr>
<td>Output B phase (MAX 10 mA - 24 Vcc)</td>
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<tr>
<td>Blue</td>
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<tr>
<td>Power Supply (0 Vdc)</td>
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<tr>
<td>Black</td>
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<tr>
<td>Output A phase (MAX 10 mA - 24 Vcc)</td>
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**INCREMENTAL ENCODER TECHNICAL DATA**

- Encoder type: ELCIS mod. 478
- Supply voltage: 8 to 24 Vcc
- Current consumption: 120 mA max
- Current output: 10 mA max
- Output signal: A phase- MONODIRECTIONAL
- A and B phase BIDIRECTIONAL
- Response frequency: 100 KHz max
- Number of pulses: 500 (others on request - max 2540)
- Slew speed: Always compatible with maximum motor speed
- Operating temperature range: from 32 to 158 °F
- Storage temperature range: from -22 to +185 °F
- Ball bearing life: 1.5x10⁹ rpm
- Weigh: 0.220 lb
- Protection degree: IP 67 (with protection and connector assembled)

**Connectors:**

- MONODIRECTIONAL: RSF3/0.5 M (Lumberg) male, RKT3-06/5m (Lumberg) female
- BIDIRECTIONAL: RSF4/0.5 M (Lumberg) male, RKT4-07/5m (Lumberg) female

Note: Female connectors cable length equal to 16.4 foot (ft.).
Mounting

Any mounting position
- Note the position of the case drain port (see below)

Install the motor properly
- Mounting surface must be flat and resistant to bending

Min. tensile strength of mounting screws to DIN 267 Part 3 class 10.9
- Note the prescribed fastening torque

Pipes, pipe connections

Use suitable screws!
- Depending on type of motor use either threaded or flange connection

Choose pipes and hoses suitable for the installation
- Please note manufacturing data!

Before operation fill with hydraulic fluid
- Use the prescribed filter!

Note: Two of the mounting screws must be precisely located/fitted if operation is started and stopped frequently or if high reversible frequencies exist.

Coupling

Mounting with screws
- Use thread bore in the drive shaft

Take apart with extractor
- Curved tooth coupling hub

Screw to remove the coupling hub

DRAIN AND FLUSHING LINK INSTALLATION EXAMPLES

Note: Install leakage line in such a way that motor cannot run empty.

Low pressure case drain returns to tank

Choose drain port in order to allow the complete filling of the housing with hydraulic fluid.

*) Special designs for applications, where the equipment needs to be filled with oil (e.g. in a salty atmosphere)
Example: MRT 7100P - D1 M1 F1 S1 N **

<table>
<thead>
<tr>
<th>Code</th>
<th>MRT 7100 P</th>
<th>MRTF 7800 P</th>
<th>MRTE 8500 P</th>
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- **D1** spline DIN 5480 (see page 17)
- **F1** female spline DIN 5480 (see page 17-19)

- **N1** none
- **Q1** encoder drive (see page 20)
- **C1** mechanical tachometer drive (see page 20)
- **T1** tachogenerator drive (see page 20)
- **M1** incremental Elcis encoder (500 pulse/rev) (see page 20)  
  - Uni-directional
  - Bi-directional
- **B1**

- **N1** NBR mineral oil
- **F1** NBR, 218 psi shaft seal
- **V1** FPM seals
- **U1** no shaft seal (for brake)

- **S1** standard SAE metric (see page 16-19)
- **G1** SAE 6000 psi metric (see page 16-19)
- **M1** SAE 6000 psi metric special timing (see page 16-19)

- **N** standard rotation (CW: inlet in A, CCW: inlet in B)
- **S** reversed rotation (CW: inlet in B, CCW: inlet in A)

- **** space reserved to Denison Calzoni
SALES AND SERVICE LOCATIONS WORLDWIDE

**International Distributors**

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- Czech Republic
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- Jugosavia
- Norway
- Portugal
- Poland
- Romania
- Russia
- Slovakia
- Slovenia
- Switzerland
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- Turkey

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- Ivory Coast
- Jordan
- Lebanon
- Libya
- Morocco
- Nigeria
- Somalia
- South Africa
- Tunisia

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- Egypt
- Iraq
- Iran
- Kuwait
- Lebanon
- Pakistan
- Qatar
- Saudi Arabia
- Syria
- United Arab Emirates

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- Korea
- Malaysia
- New Zealand
- Philippines
- Thailand

**South America:**
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- Brazil
- Chile
- Colombia
- Ecuador
- Mexico
- Peru
- Venezuela

**Asia-Pacific**

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  - Fax: +852 2499 1522

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  - BP 539
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  - West Yorkshire, England
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  - Fax: +49 (02103) 940 558

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  - Fax: +1 (905) 829 5905

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