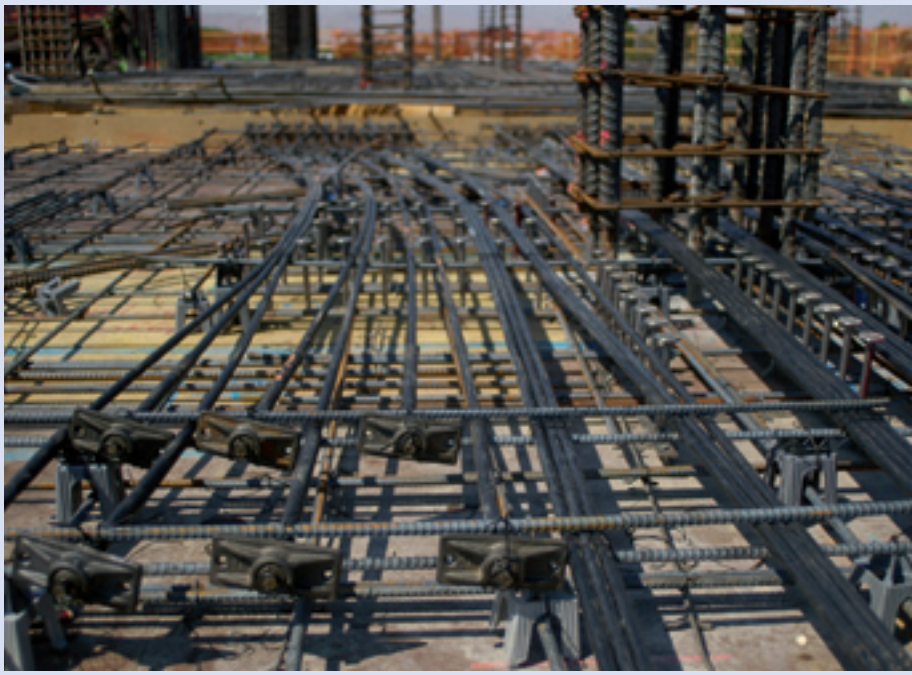
DYWIDAG-SYSTEMS INTERNATIONAL

DYWIDAG Unbonded Monostrand Post-Tensioning Systems

Contents



Structures built using unbonded post-tensioning systems have many advantages as compared to conventionally reinforced concrete structures. Reductions in reinforcing steel and concrete quantities are only two of these advantages that directly impact overall construction costs.

The commercial building segment, including: hotels, office towers and condominiums, benefit from a weight reduction from thinner slabs. Furthermore, post-tensioning allows earlier stripping of formwork, shortening overall construction time.

For cast-in-place parking structures, it is the improved ride and architectural lighting advantages that are the main benefits over precast designs. Tendons for slabs-on-ground provide a virtually crack-free slab for high durability with direct exposure to expansive soils, ground water and contaminated run-off water. Post-tensioned slabs also offer increased seismic resistance.

For tanks and silos the main benefits in using post-tensioning come from the permanent compressive stress level eliminating cracks and leakage.

DSI will supply the most suitable system to provide a durable solution meeting the design objectives.
We have been supplying engineered, unbonded post-tensioning systems for the construction industry since 1986. DSI offers the latest corrosion protection technology using proven methods and equipment.

Corrosion Protection

Durability over the lifetime of the structure has become a principal quality objective. Many factors play a determining role in assessing the adequate level of corrosion protection. Corrosion is an electrochemical process that degenerates the prestressing steel. The primary and secondary barrier against corrosion is the grease and tendon sheathing. The main objective of corrosion protection is to keep water away from the prestressing steel, especially when the water is contaminated with corrosive elements such as chlorides.

There are four main considerations in order to select the appropriate corrosion protection system. First the environment needs to be considered: geographical latitude, coastal areas versus central regions, salt spray zone, altitude, precipitation, salt contamination. Second, the exposure should be considered. Is the structure directly exposed to the elements (parking garages, balconies) or is it enclosed in a protective shell (apartment building)? Third consideration is design service life of the structure and fourth is safety.

DSI offers a variety of systems in order to allow an unbiased assessment of corrosion protection requirements. Consider all tradeoffs with respect to life-cycle cost in order to achieve consistent durability results on every project.

Concept to Delivery

DSI recognizes that only a start-to-finish approach ensures full customer satisfaction. During the design phase, experienced DSI sales engineers are available to meet with Design Consultants and General Contractors to discuss options and system selection. Once the project is awarded, DSI CAD detailers produce installation drawings that include tendon layouts and supports, details of stressing pockets, local zone reinforcement as well as friction and long-term loss calculations. Upon approval of installation drawings, tendons are fabricated and shipped for just-in-time delivery in order to minimize job-site handling and storage. Each of DSI's six fabrication plants only uses calibrated equipment traceable to NIST[2] standards. All strand material is shipped with heat number identification and the QC records are centrally stored for reference. Wedges for fixed end anchorages are hydraulically seated at 80% of ultimate strength in the plant for a positive grip. Fabricated tendons are usually color coded or tagged to ensure easy identification during installation on the job-site. Intermediate anchorages are typically positioned along the tendon by DSI. Stressing anchorages are shipped separately to be assembled in the field.

Some important safety notes about the safe handling of high-strength steel:

1. Do not damage surface of steel.
2. Do not weld or burn so that hot sparks or slag will touch any particle of steel that will be under stress.
3. Do not use any part of steel as ground connection for welding.
4. Do not use steel that has been kinked or contains a sharp bend. Disregarding these instructions may cause failure during stressing.

Strand Properties

High density Polyethylene (HDPE) sheathing is available black or colored. DSI uses only certified HDPE material. The outer diameter in the table below are approximate values. PTI[3] recommends 40 mils for slab-on-ground and 50 mils for all other applications.

The use of carbon or UV inhibitors (available on request) will allow the sheathing to resist UV exposure for up to 6 months. Furthermore the sheathing material is designed for a temperature range of -20°F to +120°F [-28°C to +48°C].

Sheathing	40 mils [in] / [mm]	50 mils [in] / [mm]	60 mils [in] / [mm]
	0.040 / 1.02	0.050 / 1.27	0.060 / 1.52
OD for 0.5“	0.600 / 15.2	0.620 / 15.7	0.640 / 16.2
OD for 0.6“	0.724 / 18.4	0.744 / 18.9	0.764 / 19.4

DYWIDAG monostrand tendons are typically made from cold-drawn, low relaxation 7-wire strand conforming to ASTM A416, gr270 [1860MPa].

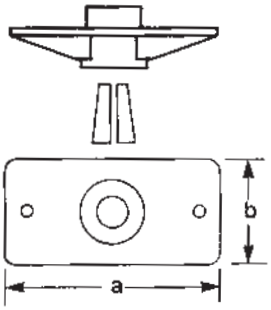
Galvanized strand, other strand sizes, such as 0.52“ [12.9mm], or strands conforming to different standards may also be available.

Strand [in] / [mm]	Steel Area [in^2] / [mm^2]	Yield Strength F_y [kips] / [kN]	Ultimate Strength Fu [kips] / [kN]	Nominal Weight [lbs/ft] / [kg/m]
0.5 / 12.7	0.153 / 98,71	37.2 / 165.3	41.3 / 183.7	0.52 / 0.775
0.6 / 15.2	0.217 / 140	52.7 / 234.5	58.6 / 260.7	0.74 / 1.10

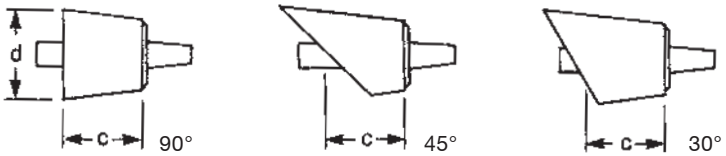
[2] National Institute of Standards and Technology
[3] Post-Tensioning Institute

Component Dimensions

DYWIDAG's small anchorage dimensions meet edge distance requirements for slabs as thin as 4.5" [114 mm], 4" [102 mm] for slabs-on-ground. The DYWIDAG wedge-anchor system meets ACI-318 code and ICC requirements developing 95% of specified Fu. DSI also offers a complete line of support chairs.



DYWIDAG Anchor



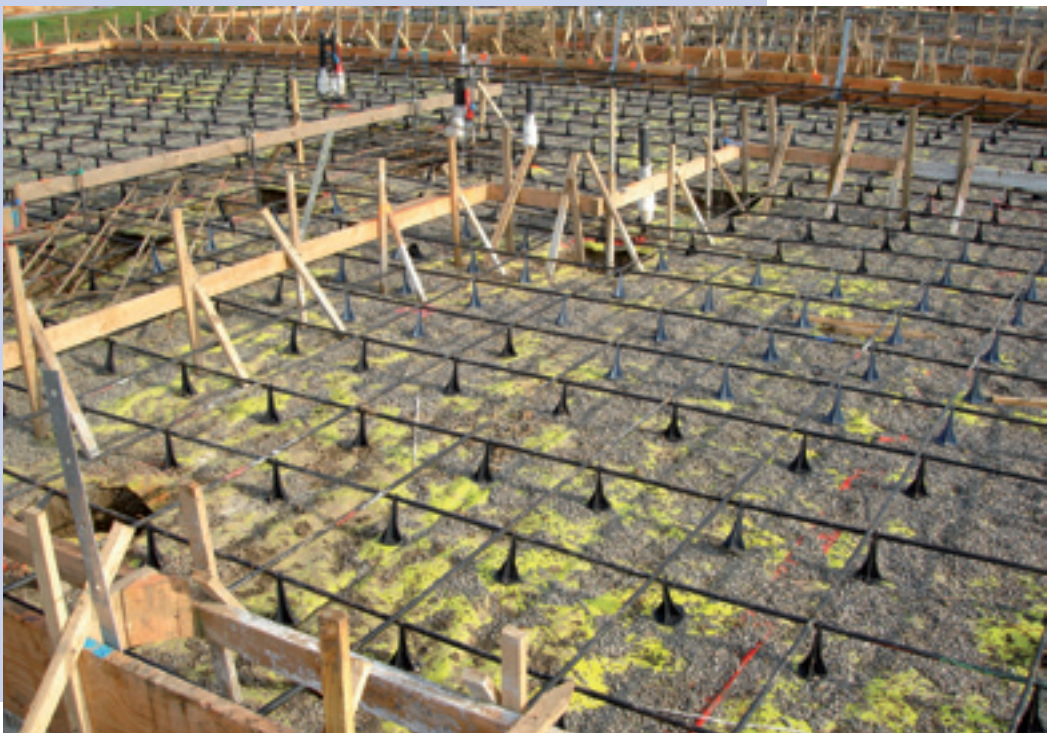
DYWIDAG Pocket Formers

Strand [in] / [mm]	a	b [in] / [mm]	c [in] / [mm]	d [in] / [mm]	[in] / [mm]
0.5 / 12.7	Standard system	5 / 127	2.25 / 57.2	1.5 or 2 / 38.1 or 50.8	2.25 / 57.1
0.5 / 12.7	Encapsulated	5.18 / 131.6	2.47 / 62.7	2 / 50.8	2.50 / 63.5
0.6 / 15.2	Encapsulated	6.03 / 153.2	3.2 / 81.3	2 / 50.8	3.25 / 82.6

Slab-on-Ground, Texas

Typical Texas residential “waffle” slab

Slab-on-Ground, California



Typical California residential “flat” slab

Installation

To avoid damage to the tendons, only smooth or padded forks or nylon slings may be used to unload tendons. When tendons are to be moved, they should be lifted and not dragged. Storage of tendons on the job-site shall be in a well drained and enclosed place. Maximum support spacing for the tendons is 4 ft [1.2 m]. Pocket formers should be installed without release agents that may reduce bond of the grout plugs to the concrete. In order to avoid problems during stressing and seating, any tendon curvature should not begin within 12 inches [30 cm] of the stressing end. In highly aggressive environments, any stressing tails can draw in water if left exposed for a longer period of time. A temporary end cap may be used to avoid water ingress.

Stressing / Equipment / Elongation

Stressing

Once the concrete has reached a minimum cylinder strength of 3000psi [25N/mm^2 cube] stressing may proceed. Where required, strands are stressed to the maximum jacking levels shown in the table. This jacking force (also called overstress force) is designed to overcome friction losses. Maximum jacking forces must not be exceeded. After the wedges are seated, the stresses at the anchorage shall not exceed “Anchorage” forces shown. The effective force takes into account all losses for typical installations including long-term losses such as steel relaxation, creep and shrinkage of the concrete. The effective force can be estimated at 65% of Fu. For each project, DSI calculates all short- and long-term losses using proprietary software considering local factors such as humidity.

Strand	Max Jacking Force 80% Fu	Anchorage Force 70% Fu	Effective Force 65% Fu
[in] / [mm]	[kips] / [kN]	[kips] / [kN]	[kips] / [kN]
0.5 / 12.7	33.0 / 146.8	28.9 / 128.6	26.8 / 119.2
0.6 / 15.2	46.9 / 208.6	41.0 / 182.5	38.1 / 169.4

Equipment

All DSI equipment is regularly maintained and calibrated by trained technicians to ensure consistent quality. An open throat, twin ram jack for 0.5“ or 0.6“ monostrand is suitable for tensioning both at the stressing end and at the intermediate anchorage. When anticipated elongation exceeds the stroke of the jack, the wedges are temporarily seated after partial stressing and the jack is recycled. The jacks are powered by a hydraulic pump, typically 115 V single phase 30 amp with 19,000psi hydraulic hoses and 10,000psi pressure gages.

Strand	Jacking Capacity	Jack Stroke	Jack Weight
[in] / [mm]	[kips] / [tons]	[in] / [mm]	[lbs] / [kgs]
0.5 / 12.7	40 / 20	8.00 / 202.3	38 / 17.3
0.6 / 15.2	60 / 30	8.25 / 209.6	87 / 39.5

Detailed operating and safety instructions are provided with all stressing units.
Read and understand these instructions before operating the equipment.

Elongation

The following are the DSI standard values used for calculating the steel elongation: E-modulus of the strand is 28,500ksi [195,000N/mm^2], the friction coefficient is 0.07/rad, wobble factor is 0.0012/ft [0.004/m]. The observed elongation should be within code tolerance. Elongations should be measured with an accuracy of 1/8“ [3 mm].

Cutting Stressing Tails

Today we have other choices available to go along with the traditional proven method of using an oxy-acetylene torch. A plasma cutter cuts with less heat build up and reduces sparks without inducing an electrical current in the tendon. Cold shear cut methods reduce the need for fire protection and result in more precise cuts. If caps are part of the system, a protective end cap is installed and sealed to the anchorage. The stressing pockets should always be filled with non-shrink grout.

Cold shear cut

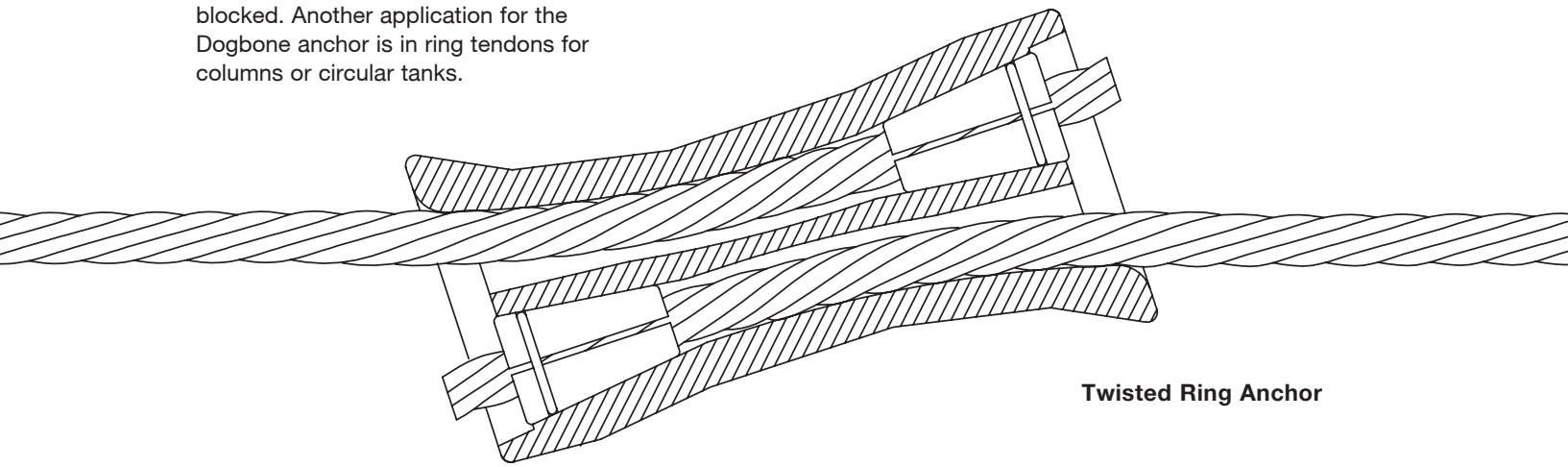
Detensioning/Repair

DSI offers a full line of repair systems installed by experienced repair crews. This specialty work often involves concrete chipping, controlled detensioning, placing of new anchorages and inserting new strands. DSI has successfully executed such unbonded repair work after fires, accidents that damaged the structure or after tendon failure due to corrosion in older structures. Full or partial detensioning is a very sensitive operation with high injury risk. Detensioning should only be performed by experienced personnel.

Oxy-acetylene cut

Center Stressing (Twisted Ring Anchor)

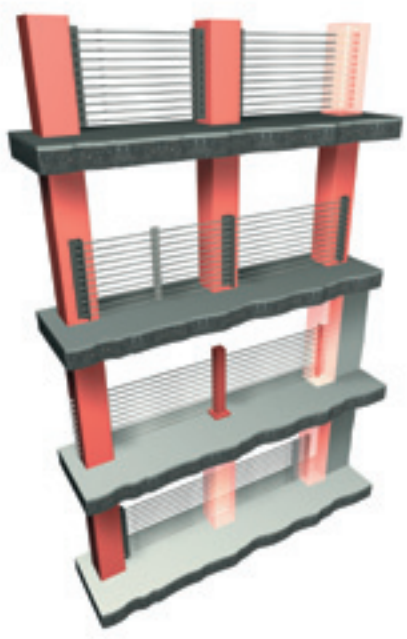
The “Dogbone” ring anchor allows stressing a tendon from the center by creating a pocket in the free length and overlapping the strands as shown. The anchor is suitable for 0.5“ [12.7 mm] and 0.6“ [15.2 mm] strand. This labor saving method is often used in repair situations as well as new construction when access to the anchorages is blocked. Another application for the Dogbone anchor is in ring tendons for columns or circular tanks.



Twisted Ring Anchor

Additional Products

Barrier Cables



Pre-stressing strands are an increasingly popular option in the selection of vehicular and pedestrian barrier systems. The DYWIDAG Barrier Cable System provides an economical and high impact resistance solution.

DSI offers various embedded and external connection components to meet a wide variety of architectural and structural conditions.

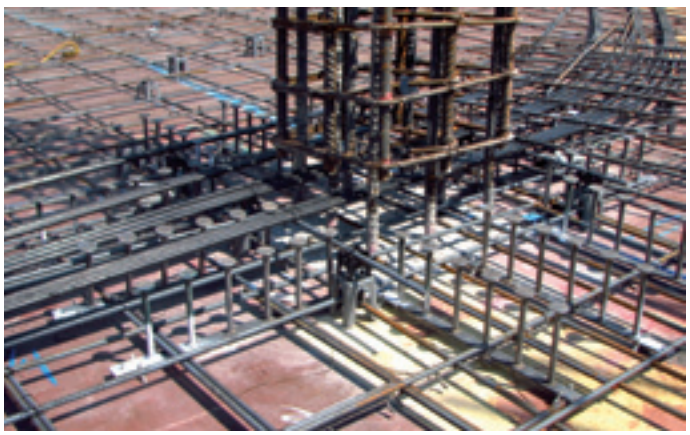
Refer to the DYWIDAG Barrier Cable System Brochure for more details.

DYWIDAG Shear System (DSS)

The DYWIDAG Shear System (DSS) is a system used to provide punching shear strength reinforcement to flat concrete slabs and provides an effective and cost efficient alternative to the use of ties, drop panels or column capitals. The DSS is comprised of specially engineered studs welded to a flat rectangular steel base plate placed on DSS support chairs.

In post-tensioned flat plate construction, thinner slabs are able to span further distances. This results in greater punching shear stresses in the slab.

Refer to the DYWIDAG Shear System (DSS) Brochure for more details.



Team up with DSI

Striving for complete customer satisfaction, DSI is a full service organization prepared to supply engineering, detailing and installation drawings as well as practical field assistance for installation and equipment maintenance. The wide range of corrosion protection systems offered by DSI allows the selection of the most suitable system to meet specific project requirements.

Our regional warehouse and PTI certified fabrication plants strategically located throughout North America, coupled with an extensive network of local sales/service centers, provide prompt, reliable response to customer needs. Most orders can be supplied from inventory with short lead time.

Shop prefabrication is continuously monitored in order to maintain a consistent high level of quality and to minimize site labor. Our customers can count on DSI for quality from start to finish, from engineering to delivery to installation. Make our dedication to quality and service part of your next successful project.

Long Beach, California Plant

Arlington, Texas Plant

Dallas - Ft. Worth, Texas Plant

Fort Lauderdale, Florida Plant

Santa Monica Civic Center P/S, Santa Monica, CA

Owner City of Santa Monica +++ **Architect** International Parking Design +++ **Engineer** Frame Design Group +++ **General Contractor** ARB Incorporated +++ **Installer** Pacific Coast Steel

DSI Unit DSI USA, BU Monostrand, CA, USA
DSI Scope Supply of 320,000 lineal feet of DYWIDAG Monostrand Tendons incl. accessories, 11 strand ½“ galvanized barrier cables for 6 levels of ramps

Use of DYWIDAG Monostrand Tendons in the Venice of America, W Hotel, Fort Lauderdale, FL

Owner Colonia Development Group, LLC, Fort Lauderdale, FL, USA +++ **General Contractor** Hunt Construction Group, Tampa, FL, USA +++ **Sub-Contractor** Baker Concrete, Medley, FL, USA +++ **Engineer** Jenkins & Charland, Inc., FL, USA

DSI Unit DSI USA, BU Monostrand, FL, USA
DSI Scope Supply of 800 km of DYWIDAG Monostrand Tendons incl. accessories

Marina Blue Apartment and Hotel High-Rise Building, Miami, FL

Owner Hyperion Development Group, LLC, Miami, FL, USA +++ **General Contractor** Soares Da Costa, Miami, FL, USA +++ **Engineer** Donnell Duquesne & Albaisa P.A., Miami, FL, USA

DSI Unit DSI USA, BU Monostrand, FL, USA
DSI Scope Supply of 670 km of DYWIDAG Monostrand Tendons incl. accessories

One West Ocean, Long Beach, CA

Owner Intracorp Los Angeles LLC/ Citigroup +++ **Construction Manager** LandCor Companies, Maple Grove, MN, USA +++ **Installer** Century Steel Inc.

DSI Unit DSI USA, BU Monostrand, CA, USA
DSI Scope Supply of 995,000 lineal feet of DYWIDAG Monostrand Tendons incl. accessories

DYWIDAG-Systems International USA Inc.

320 Marmon Drive
Bolingbrook, IL 60440 USA
Phone (630) 739 1100
Fax (630) 739 1405
E-Mail dsiamerica@dsiamerica.com

1263 Newark Road
Toughkenamon, PA 19374
Phone (724) 869 0155
Fax (724) 869 2775
E-Mail dsiamerica@dsiamerica.com

1591 E. Atlantic Blvd #200
Pompano Beach, FL 33060
Phone (954) 532 1326
Fax (954) 532 1330
E-Mail dsiamerica@dsiamerica.com

5139 South Royal Atlanta Drive
Tucker, GA 30084
Phone (770) 491 3790
Fax (770) 491 3777
E-Mail dsiamerica@dsiamerica.com

2154 South Street
Long Beach, CA 90805
Phone (562) 531 6161
Fax (562) 529 2225
E-Mail dsiamerica@dsiamerica.com

2400 Hwy 287 N, Suite 106
Mansfield, TX 76063
Phone (817) 473 6161
Fax (817) 473 1453
E-Mail dsiamerica@dsiamerica.com

DYWIDAG-Systems International CANADA Ltd.

Eastern Division
37 Cardico Drive
Gormley, ON L0H-1G0
Phone (905) 888 8988
Fax (905) 888 8987
E-Mail ecd@dsiamerica.com

Quebec Office
C.P. 412
St. Bruno
Quebec, QC, J3V 5G8
Phone (450) 653 0935
Fax (450) 653 0977
E-Mail ecd@dsiamerica.com

Western Division
19433 - 96th Avenue, Suite 103
Surrey, BC V4N 4C4
Phone (604) 888 8818
Fax (604) 888 5008
E-Mail wcd@dsiamerica.com

Calgary Office
2816-21st Street N.E., #204
Calgary, Alberta T2E 6 Z2
Phone (403) 291 4414
Fax (403) 250 5221
E-Mail wcd@dsiamerica.com

ARGENTINA
AUSTRALIA
AUSTRIA
BELGIUM
BOSNIA AND HERZEGOVINA
BRAZIL
CANADA
CHILE
CHINA
COLOMBIA
COSTA RICA
CROATIA
CZECH REPUBLIC
DENMARK
EGYPT
ESTONIA
FINLAND
FRANCE
GERMANY
GREECE
GUATEMALA
HONDURAS
HONG KONG
INDONESIA
ITALY
JAPAN
KOREA
LEBANON
LUXEMBOURG
MALAYSIA
MEXICO
NETHERLANDS
NORWAY
OMAN
PANAMA
PARAGUAY
PERU
POLAND
PORTUGAL
QATAR
RUSSIA
SAUDI ARABIA
SINGAPORE
SOUTH AFRICA
SPAIN
SWEDEN
SWITZERLAND
TAIWAN
THAILAND
TURKEY
UNITED ARAB EMIRATES
UNITED KINGDOM
URUGUAY
USA
VENEZUELA

Please note:
This brochure serves basic information purposes only. Technical data and information provided herein shall be considered non-binding and may be subject to change without notice. We do not assume any liability For losses or damages attributed to the use of this technical data and any improper use of our products. Should you require further information on particular products, please do not hesitate to contact us.

www.dsiamerica.com
www.dsicanada.ca

04323-1/07.11-web cb