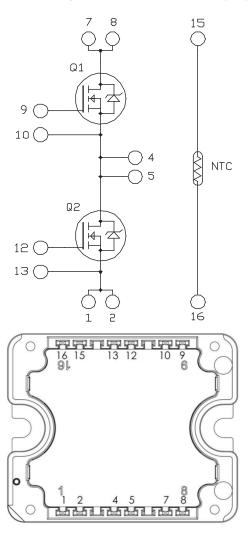
# MSCSM120AM31T1AG

# **Phase Leg SiC MOSFET Power Module**

# **Product Overview**

The MSCSM120AM31T1AG device is a phase leg 1200V, 89A silicon carbide (SiC) MOSFET power module.



#### Notes:

- Pins 1/2, 4/5, and 7/8 must be shorted together.
- All ratings at T<sub>J</sub> = 25 °C, unless otherwise specified.

**⚠** CAUTION

These devices are sensitive to electrostatic discharge. Proper handling procedures must be followed.

### **Features**

The following are key features of the MSCSM120AM31T1AG device:

- SiC Power MOSFET
  - Low R<sub>DS(on)</sub>
  - High temperature performance
- Kelvin source for easy drive
- Very low stray inductance
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AIN) substrate for improved thermal performance

### **Benefits**

The following are the benefits of MSCSM120AM31T1AG device:

- · High power and efficiency converters and inverters
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS compliant

# **Application**

The MSCSM120AM31T1AG device is designed for the following applications:

- · Welding converters
- Switched mode power supplies
- Uninterruptible power supplies
- EV motor and traction drive

DS00004618A-page 2 **Data Sheet** 

# 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120AM31T1AG device.

# 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120AM31T1AG device.

**Table 1-1. Absolute Maximum Ratings** 

Symbol	Parameter		Maximum Ratings	Unit	
V <sub>DSS</sub>	Drain-Source voltage	Drain-Source voltage		V	
I <sub>D</sub>	10 20 0		89	Α	
			71		
I <sub>DM</sub>	Pulsed drain current		180		
V <sub>GS</sub>	Gate-Source voltage		-10/23	V	
R <sub>DS(on)</sub>	Drain-Source ON resistance		31	mΩ	
P <sub>D</sub>	Power dissipation	T <sub>C</sub> = 25 °C	395	W	

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120AM31T1AG device.

**Table 1-2. Electrical Characteristics** 

Symbol	Characteristic	Test Conditions		Min.	Тур.	Max.	Unit
I <sub>DSS</sub>	Zero gate voltage drain current	$V_{GS} = 0V$ $V_{DS} = 1200V$		_	10	100	μΑ
R <sub>DS(on)</sub>	Drain-Source on	V <sub>GS</sub> = 20V	T <sub>J</sub> = 25 °C	_	25	31	mΩ
	resistance	I <sub>D</sub> = 40A		_	40	_	
V <sub>GS(th)</sub>	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 3 \text{ mA}$		1.8	2.8	_	V
I <sub>GSS</sub>	Gate–Source leakage current	V <sub>GS</sub> = 20V; V <sub>DS</sub> = 0V		_	_	150	nA

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120AM31T1AG device.

**Table 1-3. Dynamic Characteristics** 

Symbol	Characteristic	Test Conditions		Min.	Тур.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>GS</sub> = 0V		_	3020	_	pF
C <sub>oss</sub>	Output capacitance	V <sub>DS</sub> = 1000V		_	270	_	
C <sub>rss</sub>	Reverse transfer capacitance	f = 1 MHz		_	25	_	
Qg	Total gate charge	V <sub>GS</sub> = -5V/20V		_	232	_	nC
Q <sub>gs</sub>	Gate-Source charge	V <sub>Bus</sub> = 800V		_	41	_	
$Q_{gd}$	Gate-Drain charge	I <sub>D</sub> = 40A		_	50	_	
T <sub>d(on)</sub>	Turn-on delay time	V <sub>GS</sub> = -5V/20V		_	30	_	ns
T <sub>r</sub>	Rise time	V <sub>Bus</sub> = 800V		_	30	_	
T <sub>d(off)</sub>	Turn-off delay time	I <sub>D</sub> = 50A		_	50	_	
T <sub>f</sub>	Fall time	$R_{G(on)} = 8\Omega$ $R_{G(off)} = 4.7\Omega$			25	_	
Eon	Turn-on energy	V <sub>GS</sub> = -5V/20V	T <sub>J</sub> = 150 °C	_	1.2	_	mJ
E <sub>off</sub>	Turn-off energy	$V_{Bus} = 600V$ $I_{D} = 50A$ $R_{G(on)} = 8\Omega$ $R_{G(off)} = 4.7\Omega$		_	0.66	_	
R <sub>Gint</sub>	Internal gate resistance			_	0.88	_	Ω
R <sub>thJC</sub>	Junction-to-case thermal res	sistance		_	_	0.38	°C/W

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120AM31T1AG device.

**Table 1-4. Body Diode Ratings and Characteristics** 

Symbol	Characteristic	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>SD</sub>	Diode forward voltage	$V_{GS} = 0V; I_{SD} = 40A$	_	4	_	V
		$V_{GS} = -5V; I_{SD} = 40A$	_	4.2	_	
t <sub>rr</sub>	Reverse recovery time	$I_{SD} = 40A; V_{GS} = -5V$	_	90	_	ns
Q <sub>rr</sub>	Reverse recovery charge	$V_R = 800V$ ; $di_F/dt = 1000 A/\mu s$	_	550	_	nC
I <sub>rr</sub>	Reverse recovery current		_	13.5	_	Α

### 1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120AM31T1AG device.

**Table 1-5. Thermal and Package Characteristics** 

Symbol	Characteristics	Characteristics				Unit
V <sub>ISOL</sub>	RMS isolation voltage, any termi	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz				
T <sub>J</sub>	Operating junction temperature	Operating junction temperature range			175	°C
T <sub>JOP</sub>	Recommended junction tempera	Recommended junction temperature under switching conditions			T <sub>Jmax</sub> –25	
T <sub>STG</sub>	Storage temperature range	Storage temperature range				
T <sub>C</sub>	Operating case temperature	Operating case temperature			125	
Torque	Mounting torque	Mounting torque To heatsink M4				N.m
Wt	Package weight			_	80	g

The following table lists the temperature sensor NTC of the MSCSM120AM31T1AG device.

**Table 1-6. Temperature Sensor NTC** 

Symbol	Characteristic		Min.	Тур.	Max.	Unit
R <sub>25</sub>	Resistance at 25 °C		_	50	_	kΩ
$\Delta R_{25}/R_{25}$	_	_	_	5	_	%
B <sub>25/85</sub>	T <sub>25</sub> = 298.15K	_	_	3952	_	K
ΔΒ/Β	_	T <sub>C</sub> = 100 °C	_	4	_	%

$$R_{T} = \frac{R_{25}}{\exp \left[ B_{25/85} \left( \frac{1}{T_{25}} - \frac{1}{T} \right) \right]}$$
 T: Thermistor temperature R<sub>T</sub>: Thermistor value at T

**Note:** See APT0406—Using NTC Temperature Sensor Integrated into Power Module for more information.

### 1.3 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120AM31T1AG device.

Figure 1-1. Maximum Thermal Impedance

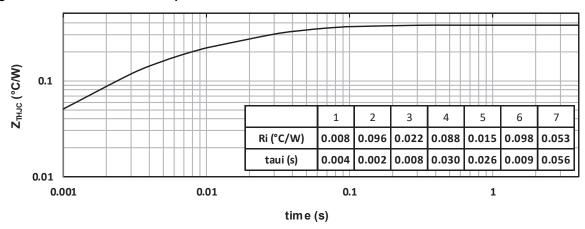


Figure 1-2. Output Characteristics,  $T_J = 25$  °C

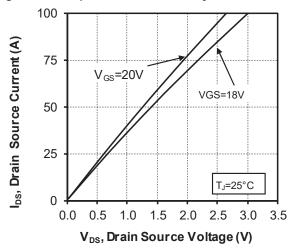


Figure 1-3. Output Characteristics,  $T_J = 175$  °C

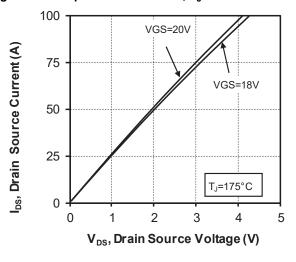


Figure 1-4. Normalized R<sub>DS(on)</sub> vs. Temperature

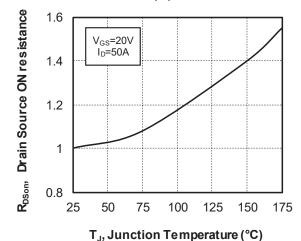


Figure 1-5. Transfer Characteristics

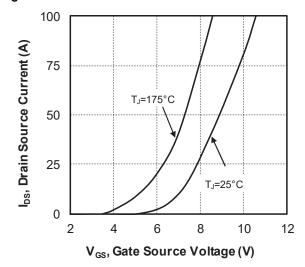


Figure 1-6. Switching Energy vs. Current

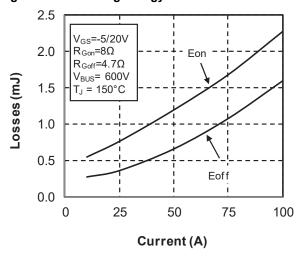


Figure 1-7. Switching Energy vs. Rg

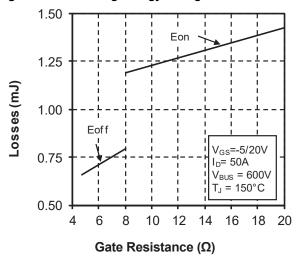


Figure 1-8. Capacitance vs. Drain Source Voltage

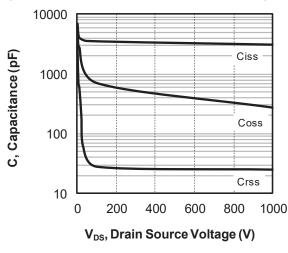


Figure 1-9. Gate Charge vs. Gate Source Voltage

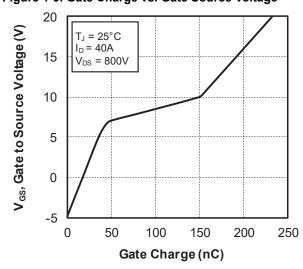


Figure 1-10. Body Diode Characteristics, T<sub>J</sub> = 25 °C

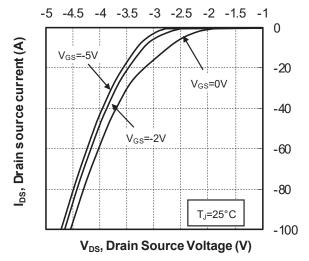


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics, T<sub>J</sub> = 25 °C

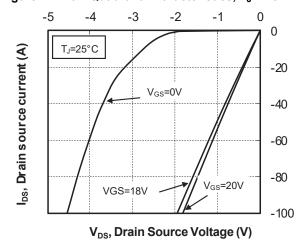
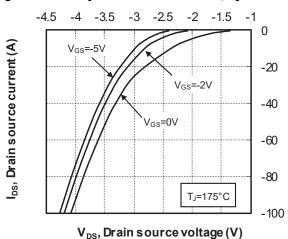
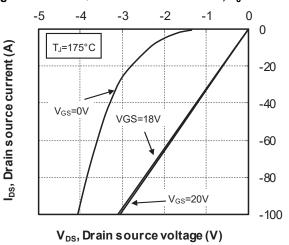
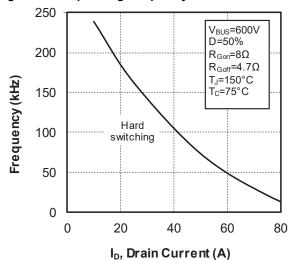


Figure 1-12. Body Diode Characteristics, T<sub>J</sub> = 175 °C Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics, T<sub>J</sub> = 175 °C







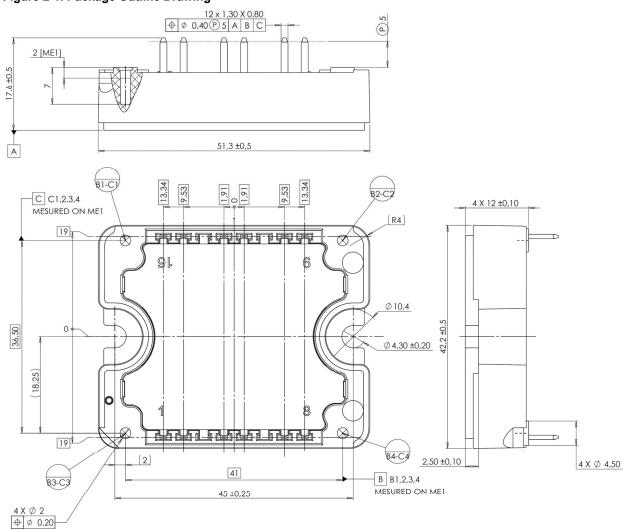
# 2. Package Specifications

The following section shows the package specification of the MSCSM120AM31T1AG device.

# 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120AM31T1AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See AN3500A—Mounting Instructions for SP1F and SP3F Power Modules for more information.

# MSCSM120AM31T1AG

**Revision History** 

# 3. Revision History

Revision	Date	Description
Α	06/2022	Initial Release

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Deston   Tel: 852-2943-5100   Tel: 863-3-7651-7906   Malaysia - Penang   Tel: 49-7131-72400   Tel: 62-58-8473-2460   Tel: 66-2-58473-2460   Tel: 66-2-58473-2460   Tel: 66-2-632-8502-7355   Tel: 60-4-2278-8870   Tel: 49-721-625370   Tel: 630-285-0071   Tel: 86-532-8502-7355   Tel: 632-634-9055   Germany - Munich   Tel: 49-721-625370   Tel: 630-285-0071   Tel: 86-21-3326-8000   Tel: 65-6334-8870   Fax: 49-89-627-144-0   Tel: 630-285-0075   China - Shenyang   Tel: 86-24-334-2829   Tel: 86-24-334-2829   Tel: 86-24-334-2829   Tel: 86-24-334-2829   Tel: 86-25-334-8870   Tel: 49-89-627-144-0   Tel: 97-28-18-7423   Tel: 86-24-334-2829   Tel: 86-35-866-2200   Tel: 866-37-8366   Tel: 49-8031-354-550   Tel: 97-28-18-7423   Tel: 86-55-8864-2200   Tel: 886-37-78-366   Tel: 98-39-331-46-500   Tel: 86-32-31-526   Tel: 86-2-598-8600   Tel: 39-0331-742611   Tel: 248-848-4000   Tel: 86-186-623-1526   Tel: 86-2-598-8600   Tel: 39-0331-742611   Tel: 248-848-84000   Tel: 86-27-5980-5300   Tel: 86-2-598-8630   Tel: 39-0331-742611   Tel: 281-894-5883   Tel: 86-27-5880-37252   Tel: 86-2-8833-7252   Tel: 86-2-8833-7252   Tel: 86-2-8833-7252   Tel: 86-2-8833-7252   Tel: 86-2-8833-7252   Tel: 86-39-2388138   Tel: 86-39-238138   Tel: 86-39-2388138   Tel: 86-39-338138	Austin, TX	Tel: 86-571-8792-8115	Tel: 82-2-554-7200	Germany - Haan
Westborough, MA	Tel: 512-257-3370	China - Hong Kong SAR	Malaysia - Kuala Lumpur	Tel: 49-2129-3766400
Tel: 774-760-0087	Boston	Tel: 852-2943-5100	Tel: 60-3-7651-7906	Germany - Heilbronn
Tel: 774-760-0087	Westborough, MA	China - Nanjing	Malaysia - Penang	Tel: 49-7131-72400
Tel: 86-532-8502-7355   Tel: 63-2-634-9065   Germany - Munich	<del>-</del>	Tel: 86-25-8473-2460	Tel: 60-4-227-8870	Germany - Karlsruhe
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Itasca,   I.   China - Shanghai   Tel: 49-80-627-144-0   Tel: 49-80-627-144-0   Tel: 630-285-0071   Tel: 86-21-3326-8000   Tel: 65-6334-8870   Fax: 49-98-627-144-44   Fax: 630-285-0075   China - Shenyang   Taiwan - Hsin Chu   Germany - Rosenheim   Tel: 86-24-2334-2829   Tel: 868-3-577-8366   Tel: 49-8031-354-560   Italy - Milan   Tel: 972-818-7423   Tel: 86-755-8864-2200   Tel: 886-3-577-8366   Tel: 49-8031-354-560   Italy - Milan   Tel: 972-918-2924   China - Suzhou   Taiwan - Kaohslung   Tel: 972-9-744-7705   Tel: 866-72-13-7830   Tel: 972-9-744-7705   Tel: 866-72-13-7830   Tel: 972-9-744-7705   Tel: 868-848-4000   Tel: 86-823-1526   Tel: 886-2-2508-8600   Tel: 39-0331-742611   Tel: 248-848-4000   Tel: 86-27-5880-5300   Tel: 68-27-5880-5300   Tel: 68-27-5880-5300   Tel: 68-27-5880-5300   Tel: 86-28-45811   taly - Padova   Tel: 86-829-8833-7252   Tel: 86-294-1351   taly - Padova   Tel: 39-049-7625286   Tel: 86-592-238138   Tel: 86-592-238138   Tel: 86-592-238138   Tel: 86-592-238138   Tel: 86-592-238138   Tel: 86-756-3210040   Tel: 86-592-2388138   Tel: 47-728-8333   Tel: 87-773-8033   Tel: 86-756-3210040   Tel: 86-756-3210040   Tel: 86-756-8008   Tel: 949-462-9623   Tel: 86-756-3210040   Tel: 86-756-8008   Tel: 86-756-8021040   Te	Chicago	Tel: 86-532-8502-7355	Tel: 63-2-634-9065	Germany - Munich
Fax: 630-285-0075	<u>-</u>	China - Shanghai	Singapore	
Dallas	Tel: 630-285-0071	Tel: 86-21-3326-8000		Fax: 49-89-627-144-44
Dallas	Fax: 630-285-0075	China - Shenyang	Taiwan - Hsin Chu	Germany - Rosenheim
Tel: 972-818-7423 Tel: 96-755-8864-2200 Tel: 86-755-8864-2200 Tel: 86-86-2694-1351 Tel: 39-0331-4266781 Tel: 248-848-4000 Tel: 86-27-5980-5300 Tel: 66-2-694-1351 Tel: 66-2-694-1351 Tel: 39-0331-466781 Tel: 39-0331-466781 Tel: 39-0331-466781 Tel: 39-0331-466781 Tel: 86-289833-7252 Tel: 86-29-8833-7252 Tel: 86-29-8833-7252 Tel: 86-598-238138 Tel: 317-773-8323 China - Xiamen Noblesville, IN Tel: 36-592-2388138 Tel: 317-773-8323 China - Zhuhai Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 98-756-3210040 Tel: 98-756-3210040 Tel: 98-756-3210040 Tel: 98-757-7800 Raleigh, NC Tel: 99-844-7510 New York, NY Tel: 63-1-356-6000 San Jose, CA Tel: 408-735-9110 Tel: 408-735-9110 Tel: 408-735-9110 Tel: 408-735-9110 Tel: 905-695-1980	Dallas		Tel: 886-3-577-8366	
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Detroit	Tel: 972-818-7423	Tel: 86-755-8864-2200		Tel: 972-9-744-7705
Detroit	Fax: 972-818-2924	China - Suzhou	Taiwan - Taipei	Italy - Milan
Tel: 248-848-4000 Houston, TX Tel: 281-894-5983 Tel: 86-27-5980-5300 China - Xian Tel: 281-894-5983 Tel: 86-29-8833-7252 Indianapolis China - Xiamen Noblesville, IN Tel: 34-690340 Tel: 86-592-2388138 Tel: 86-592-2388138 Tel: 86-592-2388138 Tel: 86-756-3210040 Tel: 317-773-8423 Tel: 86-756-3210040 Tel: 317-73-8423 Tel: 86-756-3210040 Tel: 86-756	Detroit	Tel: 86-186-6233-1526	Tel: 886-2-2508-8600	Tel: 39-0331-742611
Houston, TX	Novi, MI	China - Wuhan		Fax: 39-0331-466781
Houston, TX	Tel: 248-848-4000	Tel: 86-27-5980-5300	Tel: 66-2-694-1351	Italy - Padova
Indianapolis	Houston, TX	China - Xian	Vietnam - Ho Chi Minh	Tel: 39-049-7625286
Noblesville, IN Tel: 86-592-2388138 China - Zhuhai Tel: 317-773-8323 Tel: 317-773-5453 Tel: 86-756-3210040 Tel: 47-72884388 Tel: 47-72884388 Poland - Warsaw Tel: 48-22-3325737 Romania - Bucharest Tel: 40-21-407-87-50 Spain - Madrid Tel: 34-91-708-08-90 Raleigh, NC Tel: 919-844-7510 New York, NY Tel: 631-435-6000 San Jose, CA Tel: 408-436-4270 Canada - Toronto Tel: 905-695-1980  Tel: 905-695-1980  Tel: 86-756-3210040 Tel: 86-756-3210040 Tel: 46-31-704-60-40 Tel: 46-8-5090-4654 UK - Wokingham Tel: 44-118-921-5820	Tel: 281-894-5983	Tel: 86-29-8833-7252	Tel: 84-28-5448-2100	Netherlands - Drunen
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Fax: 317-773-5453 Tel: 317-536-2380 Los Angeles Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800 Raleigh, NC Tel: 919-844-7510 New York, NY Tel: 631-435-6000 San Jose, CA Tel: 40-8-735-9110 Tel: 408-436-4270 Canada - Toronto Tel: 905-695-1980  Tel: 86-756-3210040  Tel: 86-756-3210040  Tel: 86-756-3210040  Tel: 86-756-3210040  Tel: 48-22-3325737 Romania - Bucharest Tel: 40-21-407-87-50 Spain - Madrid Tel: 40-21-407-87-50 Spain - Madrid Tel: 34-91-708-08-90 Fax: 34-91-708-08-91 Sweden - Gothenberg Tel: 46-31-704-60-40 Sweden - Stockholm Tel: 408-735-9110 Tel: 408-436-4270 Fax: 44-118-921-5820	Noblesville, IN	Tel: 86-592-2388138		Fax: 31-416-690340
Fax: 317-773-5453       Tel: 86-756-3210040       Tel: 47-72884388         Tel: 317-536-2380       Poland - Warsaw         Los Angeles       Tel: 48-22-3325737         Mission Viejo, CA       Romania - Bucharest         Tel: 949-462-9523       Tel: 40-21-407-87-50         Fax: 949-462-9608       Spain - Madrid         Tel: 951-273-7800       Tel: 34-91-708-08-90         Raleigh, NC       Fax: 34-91-708-08-91         Tel: 919-844-7510       Sweden - Gothenberg         New York, NY       Tel: 46-31-704-60-40         Tel: 631-435-6000       Sweden - Stockholm         Tel: 408-735-9110       Tel: 408-436-4270         Canada - Toronto       Fax: 44-118-921-5800         Tel: 905-695-1980       Fax: 44-118-921-5820		China - Zhuhai		Norway - Trondheim
Los Angeles       Tel: 48-22-3325737         Mission Viejo, CA       Romania - Bucharest         Tel: 949-462-9523       Tel: 40-21-407-87-50         Fax: 949-462-9608       Spain - Madrid         Tel: 951-273-7800       Tel: 34-91-708-08-90         Raleigh, NC       Fax: 34-91-708-08-91         Tel: 919-844-7510       Sweden - Gothenberg         New York, NY       Tel: 46-31-704-60-40         Tel: 631-435-6000       Sweden - Stockholm         San Jose, CA       Tel: 408-735-9110         Tel: 408-436-4270       UK - Wokingham         Tel: 408-436-4270       Fax: 44-118-921-5800         Canada - Toronto       Fax: 44-118-921-5820	Fax: 317-773-5453	Tel: 86-756-3210040		_
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Tel: 951-273-7800  Raleigh, NC  Tel: 919-844-7510  New York, NY  Tel: 631-435-6000  San Jose, CA  Tel: 408-735-9110  Tel: 408-436-4270  Canada - Toronto  Tel: 905-695-1980  Tel: 34-91-708-08-90  Fax: 34-91-708-08-91  Sweden - Gothenberg  Tel: 46-31-704-60-40  Sweden - Stockholm  Tel: 46-8-5090-4654  UK - Wokingham  Tel: 44-118-921-5800	<u>-</u>			Tel: 40-21-407-87-50
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Raleigh, NC       Fax: 34-91-708-08-91         Tel: 919-844-7510       Sweden - Gothenberg         New York, NY       Tel: 46-31-704-60-40         Tel: 631-435-6000       Sweden - Stockholm         San Jose, CA       Tel: 46-8-5090-4654         Tel: 408-735-9110       UK - Wokingham         Tel: 408-436-4270       Tel: 44-118-921-5800         Canada - Toronto       Fax: 44-118-921-5820	Tel: 951-273-7800			·
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New York, NY       Tel: 46-31-704-60-40         Tel: 631-435-6000       Sweden - Stockholm         San Jose, CA       Tel: 46-8-5090-4654         Tel: 408-735-9110       UK - Wokingham         Tel: 408-436-4270       Tel: 44-118-921-5800         Canada - Toronto       Fax: 44-118-921-5820         Tel: 905-695-1980       Fax: 44-118-921-5820	Tel: 919-844-7510			Sweden - Gothenberg
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San Jose, CA       Tel: 46-8-5090-4654         Tel: 408-735-9110       UK - Wokingham         Tel: 408-436-4270       Tel: 44-118-921-5800         Canada - Toronto       Fax: 44-118-921-5820         Tel: 905-695-1980       Fax: 44-118-921-5820	•			
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Canada - Toronto         Fax: 44-118-921-5820           Tel: 905-695-1980         Fax: 44-118-921-5820				_
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