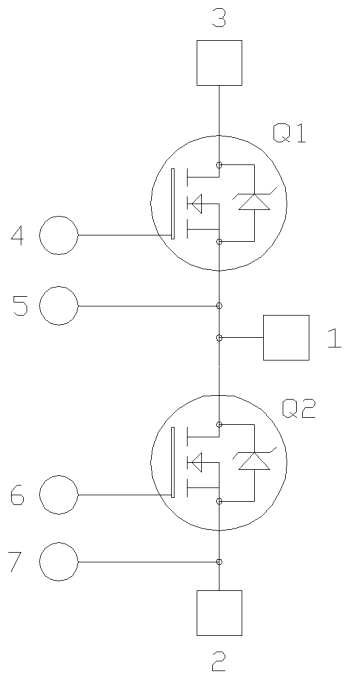
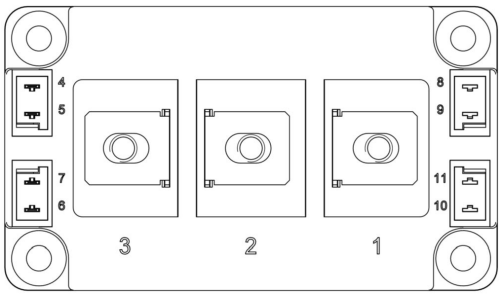
MSCSM70AM025D3AG

Phase Leg SiC Power Module

Product Overview

The MSCSM70AM025D3AG device is a 700V/689A phase leg silicon carbide (SiC) power module.





Note: All ratings at T_J = 25 °C, unless otherwise specified.

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

Features

The following are the key features of the MSCSM70AM025D3AG device:

- SiC Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- Kelvin source for easy drive
- High level of integration
- Aluminum Nitride (AlN) substrate for improved thermal performance
- M6 power connectors

Benefits

The following are the benefits of the MSCSM70AM025D3AG device:

- High efficiency converter
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- RoHS Compliant

Applications

The following are the applications of the MSCSM70AM025D3AG device:

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

1. Electrical Specifications

This section provides the electrical specifications of the MSCSM70AM025D3AG device.

1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings of the MSCSM70AM025D3AG device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-Source voltage		700	V
I_D	Continuous drain current	T_C = 25 °C	689[1]	A
		T_C = 80 °C	548[1]	
I_{DM}	Pulsed drain current		1380	
V_{GS}	Gate-Source voltage		–10/23	V
$R_{DS(on)}$	Drain-Source ON resistance		3.2	mΩ
P_D	Power dissipation	T_C = 25 °C	1882	W

Note:

1. Specification of SiC MOSFET device but output current must be limited due to size of power connectors.

The following table lists the electrical characteristics of the MSCSM70AM025D3AG device.

Table 1-2. Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0V V_{DS} = 700V		—	—	600	µA
$R_{DS(on)}$	Drain-Source on resistance	V_{GS} = 20V I_D = 240A	T_J = 25 °C	—	2.5	3.2	mΩ
			T_J = 175 °C	—	3.2	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS} I_D = 24 mA		1.9	2.4	—	V
I_{GSS}	Gate-Source leakage current	V_{GS} = 20V V_{DS} = 0V		—	—	600	nA

The following table lists the dynamic characteristics of the MSCSM70AM025D3AG device.

Table 1-3. Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	27	—	nF
C_{oss}	Output capacitance	V_{DS} = 700V		—	3	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.17	—	
Q_g	Total gate charge	V_{GS} = –5V/20V		—	1290	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 470V		—	348	—	
Q_{gd}	Gate-drain charge	I_D = 240A		—	210	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5V/20V		—	78	—	ns
T_r	Rise time	V_{Bus} = 400V		—	125	—	
$T_{d(off)}$	Turn-off delay time	I_D = 480A		—	214	—	
T_f	Fall time	T_J = 150 °C R_{GON} = 12Ω R_{GOFF} = 2.7Ω			92	—	
E_{on}	Turn-on energy	V_{GS} = –5V/20V	T_J = 150 °C	—	10	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 400V I_D = 480A R_{GON} = 12Ω R_{GOFF} = 2.7Ω		—	10.5	—	mJ
R_{Gint}	Internal gate resistance			—	0.95	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.08	°C/W

The following table lists the body diode ratings and characteristics of the MSCSM70AM025D3AG device.

Table 1-4. Body Diode Ratings and Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	V_{GS} = 0V I_{SD} = 240A	—	3.4	—	V
		V_{GS} = –5V I_{SD} = 240A	—	3.8	—	
t_{rr}	Reverse recovery time	I_{SD} = 240A	—	40	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = –5V	—	1.9	—	µC
I_{rr}	Reverse recovery current	V_R = 400V di_F/dt = 6000 A/µs	—	89	—	A

1.2 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM70AM025D3AG device.

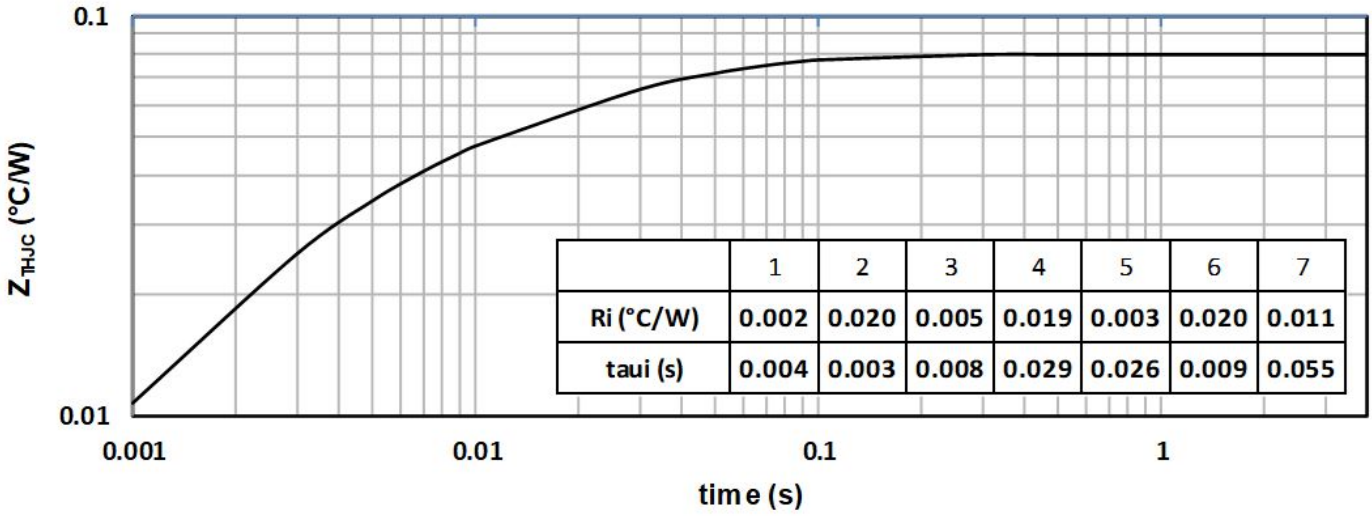
Table 1-5. Thermal and Package Characteristics

Symbol	Characteristic			Min.	Max.	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz			4000	—	V
T_J	Operating junction temperature range			–40	175	°C
T_{JOP}	Recommended junction temperature under switching conditions			–40	T_{Jmax}–25	
T_{STG}	Storage temperature range			–40	125	
T_C	Operating case temperature			–40	125	
Torque	Mounting torque	To Heatsink	M6	3	5	N.m
		For terminals	M5	2	3.5	
Wt	Package weight			—	300	g

1.3 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM70AM025D3AG device.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.020	0.005	0.019	0.003	0.020	0.011
taui (s)	0.004	0.003	0.008	0.029	0.026	0.009	0.055

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

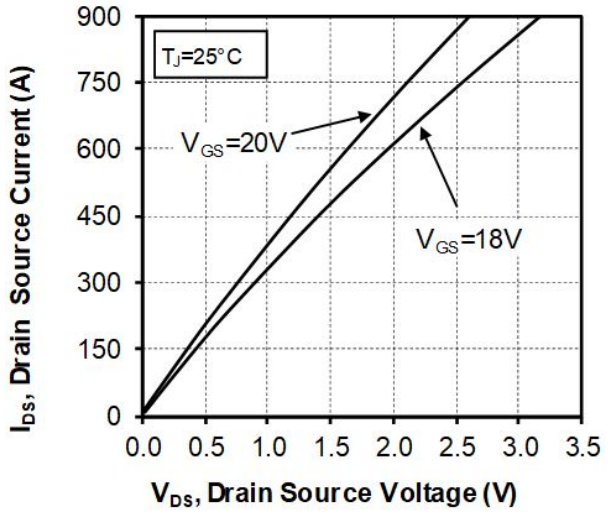


Figure 1-3. Output Characteristics, T_J = 175 °C

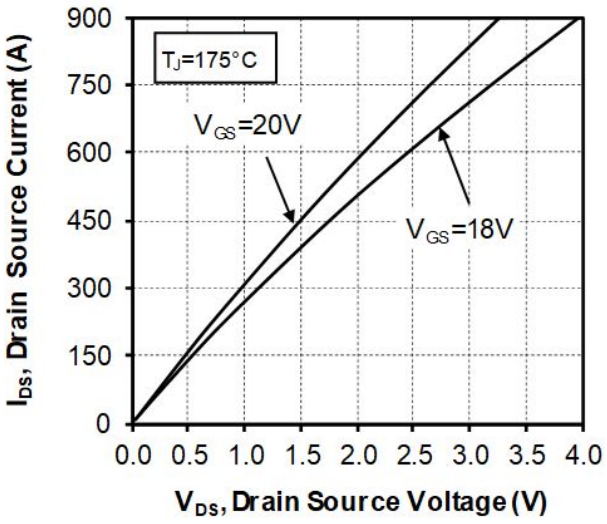


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

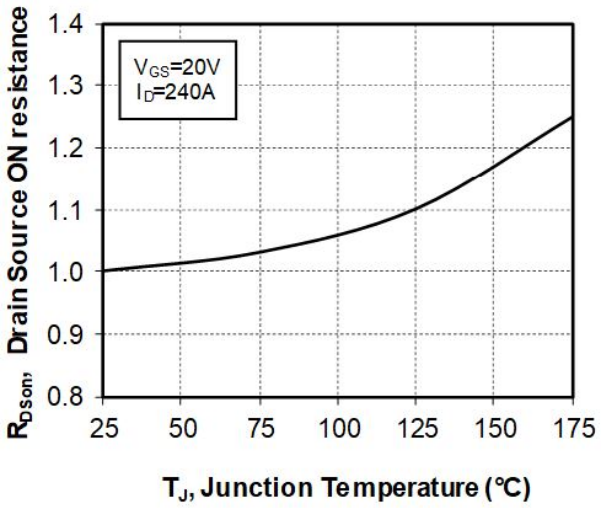


Figure 1-5. Transfer Characteristics

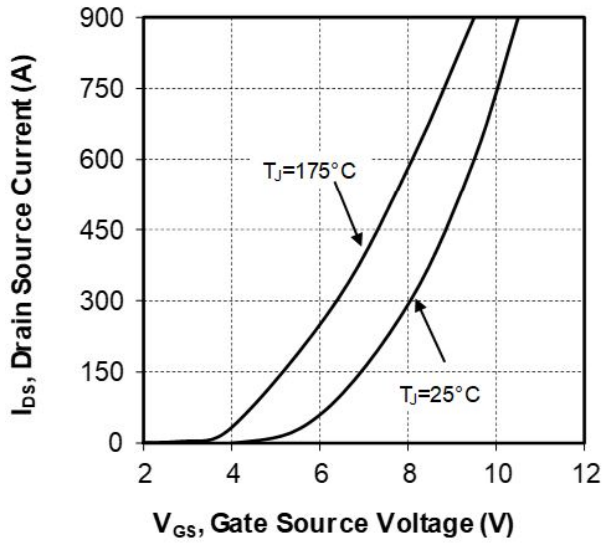


Figure 1-6. Turn On Energy vs Rg

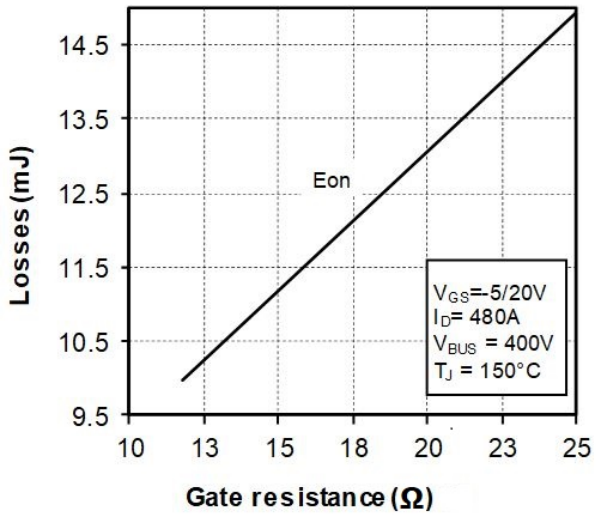


Figure 1-7. Switching Energy vs. Current

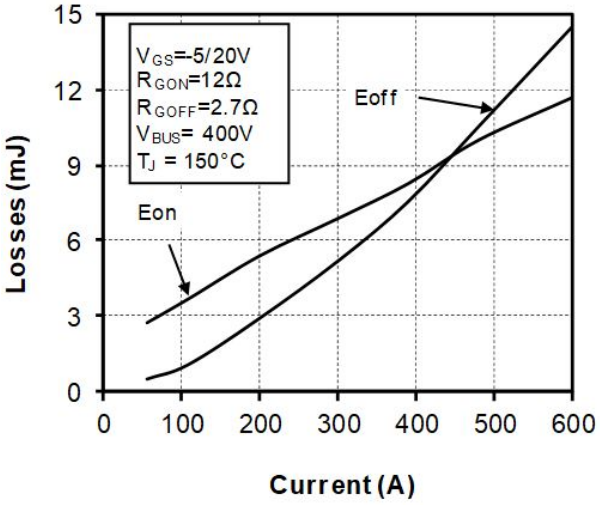


Figure 1-8. Capacitance vs. Drain Source Voltage

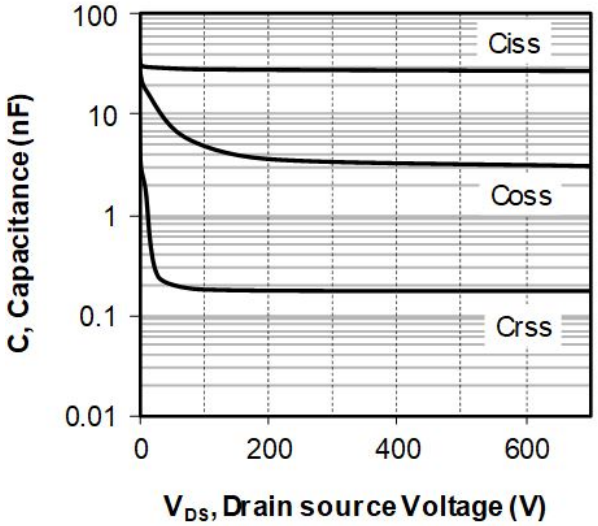


Figure 1-9. Gate Charge vs. Gate Source Voltage

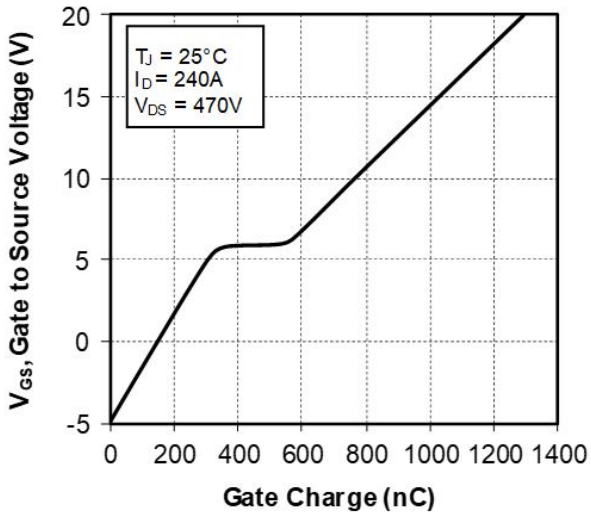


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

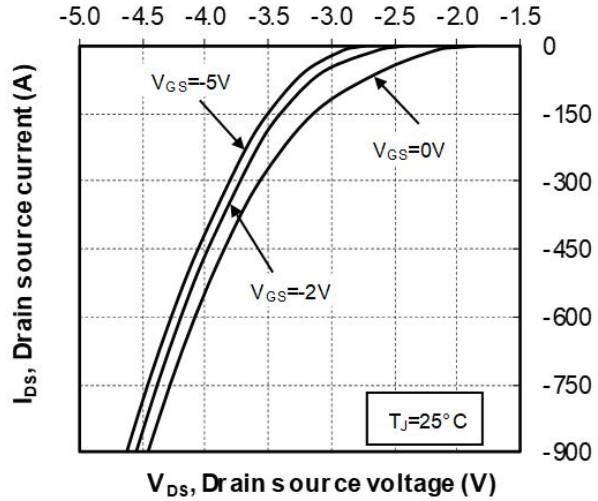


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

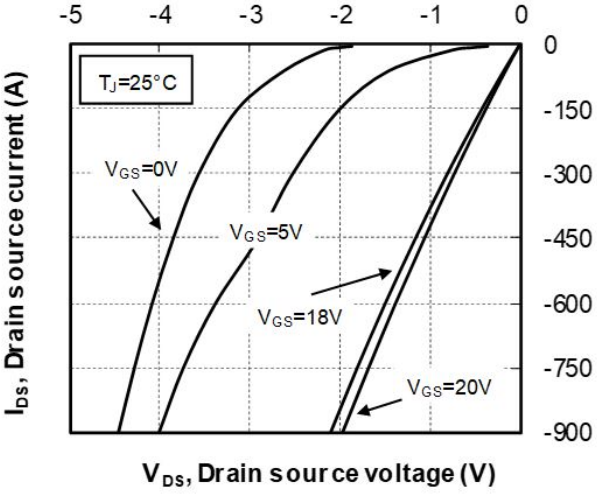


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

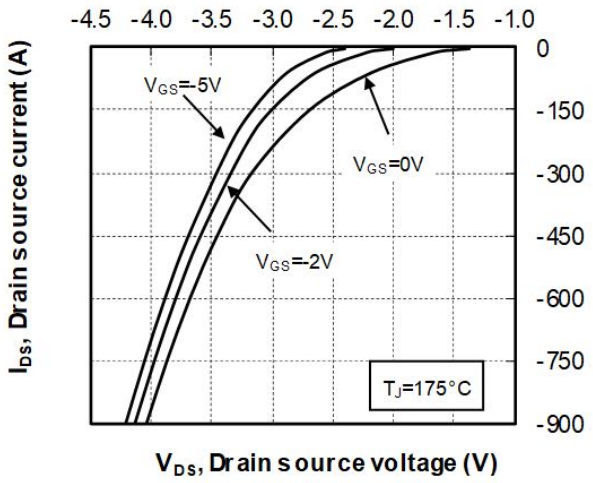


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

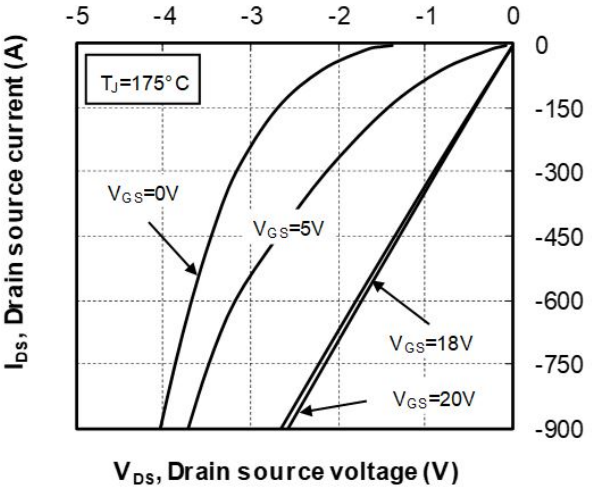


Figure 1-14. Operating Frequency vs. Drain Current

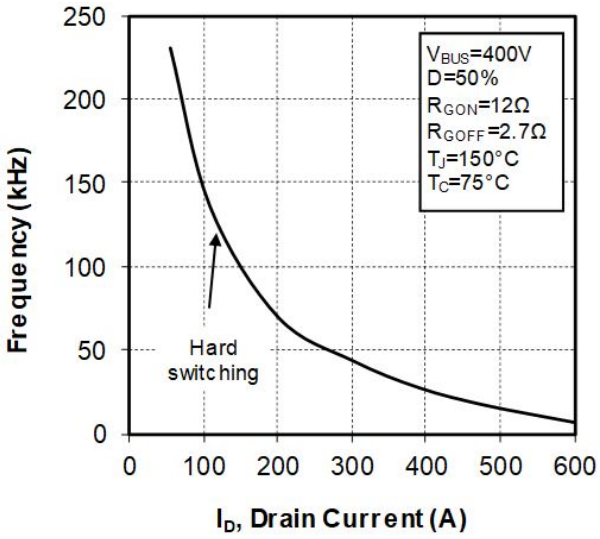
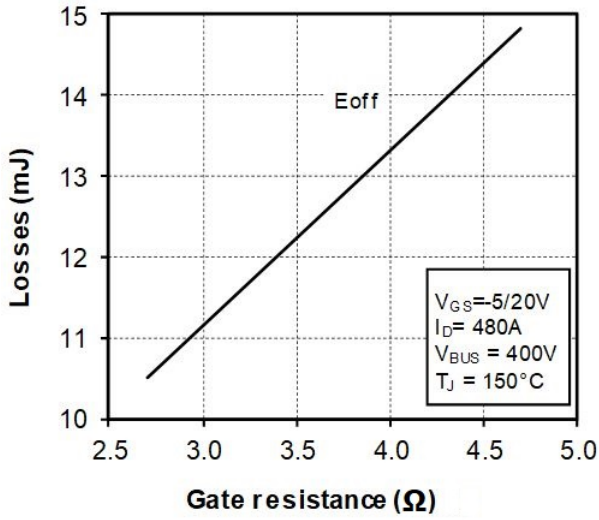


Figure 1-15. Turn Off Energy vs. Rg



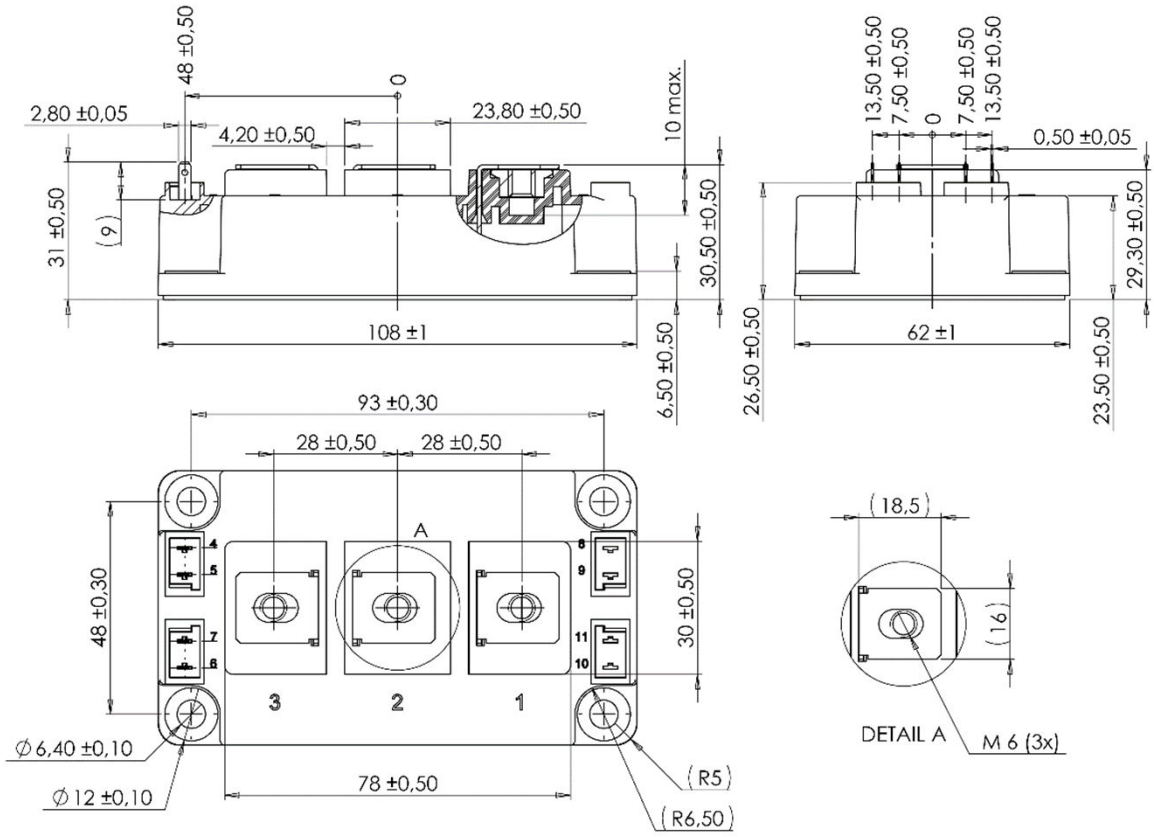
2. Package Specifications

The following section shows the package specification of the MSCSM70AM025D3AG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM70AM025D3AG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



Note: See Application note 1908—Mounting instructions for D3 and D4 power modules for more information.

3. Revision History

Revision	Date	Description
A	06/2022	Initial Revision

Microchip Information

The Microchip Website

Microchip provides online support via our website at www.microchip.com/. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Product Change Notification Service

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to www.microchip.com/pcn and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: www.microchip.com/support

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable". Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded

by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet- Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, TrueTime, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, GridTime, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntelliMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, KoD, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

ISBN: 978-1-6683-0746-5

Quality Management System

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.