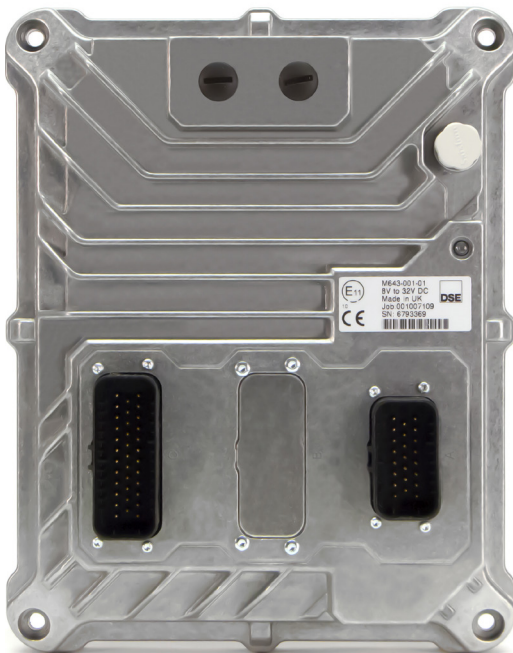




# DSEM643

PROGRAMMABLE CONTROLLER FOR USE IN VEHICLES AND OFF-HIGHWAY MACHINERY



## KEY FEATURES / SUMMARY

- Controller specifically designed for mobile applications
- Powerful 32 bit processor with 220 MHz clock speed
- 4 MB application memory
- 16 configurable inputs, digital and analogue capability
- 18 configurable outputs with digital, PWM and PWMi
- 4 independent CAN interfaces, J1939, CAN Open and Raw CAN
- Ethernet interface for communication
- Flexible user programming via CODESYS 3.5
- Ruggedised die cast aluminium housing for IP67 protection

## ADDITIONAL HARDWARE

M643 Connector Set x2  
 M643 Connector Harness Set x2  
 M12 to Ethernet Cable  
 M12 to USB Data Cable

## DSE PART

007-1020  
 016-174  
 016-160  
 016-161

## OVERVIEW

**DC SUPPLY**  
 8 V DC to 36 V DC

**CURRENT CONSUMPTION**  
**OPERATING CURRENT**  
 < 300 mA at 24 V without external loads

**TOTAL INPUTS/OUTPUTS**  
 34 (16 inputs / 18 outputs)

**INPUTS**  
 Configurable  
 Digital inputs (positive / negative)  
 Analogue inputs voltage 0 V to 5 V, 0 V to 10 V, 0 V to 32 V current 4 mA to 20 mA, Ratiometric, Resistive, Frequency, Phase, Fast Counter, Encoder

**OUTPUTS**  
 Configurable  
 2 A / 4 A  
 Digital Output High-Sided, Low-Sided  
 PWM, PWMi

**INTERFACES**  
**CAN 1.4**  
 CAN Interfaces 2.0 A/B, ISO11898  
 50 kbits/s... 1 Mbit/s  
 J1939, CAN Open and Raw CAN

**ETHERNET**  
 10 Mbit/s / 100 Mbit/s, Duplex

**USB**  
 USB Host 2.0 (12 Mbit/s)

**DIMENSIONS**  
 49 mm x 240 mm x 190 mm (H x W x D)  
 1.46 " x 9.45 " x 7.48 " (H x W x D)

**WEIGHT**  
 1.5 kg

**STORAGE TEMPERATURE RANGE**  
 -40 °C to +85 °C  
 -40 °F to +185 °F

**OPERATING TEMPERATURE RANGE**  
 -40 °C to +85 °C  
 -40 °F to +185 °F  
 (at full load)

**PROTECTION RATING**  
 IP67 (with mating connectors)

**MOUNTING**  
 4 x M6 bolts

## RELATED MATERIALS

| TITLE                               | PART NO. |
|-------------------------------------|----------|
| M640/M643 Installation Instructions | 053-186  |
| M640/M643 Operator Manual           | 057-244  |



## Technical Data

### DSEM643

| Supply   |                                      | Connector A                      |
|--|--------------------------------------|----------------------------------|
| Operating voltage  | 8 V DC to 36 V DC                    | Pin 4                            |
| Unit power supply maximum current consumption (no external loads)  | < 300 mA at 24 V                     |                                  |
| Unit power supply current consumption after controlled shutdown has occurred due to the ignition being turned off  | < 5 mA at 24 V                       |                                  |
| Fusing   |                                      | Connector A                      |
| Unit power supply external protection fuse rating  | 3 A                                  | Pin 4                            |
| Maximum total current of the device is 16 A. This includes the device current consumption plus the current supplied to the outputs. Each output supply is rated max 16 A.<br>Output supply 3 + Output supply 4 must not exceed 16 A. | 16 A                                 | Pin 16, 23                       |
| Program Enable Pin   |                                      | Connector A                      |
| Program enable high (program enabled)  | > 6 V                                | Pin 6                            |
| Program enable low (program disabled)  | < 2 V                                | When not used must put to GND    |
| Program enable pin pull-down resistance  | 33 kΩ                                |                                  |
| Housing  |                                      |                                  |
| Diecast aluminium  |                                      |                                  |
| Dimensions   |                                      |                                  |
| 49 mm x 240 mm x 190 mm (H x W x D) / 1.46 " x 9.45 " x 7.48 " (H x W x D)   |                                      |                                  |
| Weight   |                                      |                                  |
| 1.5 kg   |                                      |                                  |
| Temperature  |                                      |                                  |
| Operating temperature  | -40 °C to +85 °C / -40 °F to +185 °F |                                  |
| Storage temperature  | -40 °C to +85 °C / -40 °F to +185 °F |                                  |
| Protection Rating  |                                      |                                  |
|  |                                      | IP67 (with mating connector)     |
| Connectors   |                                      |                                  |
| Mating Connector A - 23 pin TE connectivity 1-770680-1   |                                      |                                  |
| Connector C - 35 pin TE connectivity 1-776164-1  |                                      |                                  |
| M12, D-coded 4 pole socket   |                                      |                                  |
| M12, A-coded 5 pole socket   |                                      |                                  |
| Digital Inputs   |                                      | Connector C                      |
| Digital inputs active high/active low  |                                      | Pin 6, 9, 14, 15, 16, 22, 28, 31 |
| High level voltage threshold for active high   | > 6 V                                |                                  |
| Low level voltage threshold for active high  | < 2 V                                |                                  |
| Analogue Voltage Inputs  |                                      | Connector C                      |
| 0 V to 5 V programmable voltage range  | 0 V to 5 V                           | Pin 7, 8, 17, 18, 19, 20, 29, 30 |
| 0 V to 10 V programmable voltage range   | 0 V to 10 V                          |                                  |
| 0 V to 32 V programmable voltage range   | 0 V to 32 V                          |                                  |
| Voltage measurement resolution   | 12 bits                              |                                  |
| Voltage measurement accuracy   | ±1% FSD                              |                                  |
| Voltage measurement input resistance   | ≥ 30 kΩ                              |                                  |
| Voltage measurement sampling rate  | 1 kHz                                |                                  |
| <i>FSD = Full Scale Deflection</i>   |                                      |                                  |



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| Analogue Current Inputs                       |                                      | Connector C                      |
|---|--------------------------------------|----------------------------------|
| Current measurement direction                 | Current sink only                    | Pin 7, 8, 17, 18, 19, 20, 29, 30 |
| Current measurement ranges                    | 0 mA to 20 mA<br>4 mA to 20 mA       |                                  |
| Current measurement resolution                | 12 bits                              |                                  |
| Current measurement accuracy                  | ±1% FSD                              |                                  |
| Current measurement input sink resistance     | 100 Ω ±1%                            |                                  |
| Current measurement sampling rate             | 1 kHz                                |                                  |
| <i>FSD = Full Scale Deflection</i>            |                                      |                                  |
| Analogue Resistive Inputs                     |                                      | Connector C                      |
| Resistance measurement range                  | 0 Ω to 3400 Ω                        | Pin 7, 8, 17, 18, 19, 20, 29, 30 |
| Resistance measurement source voltage         | 12 V maximum                         |                                  |
| Resistance measurement current                | 1 mA                                 |                                  |
| Resistance measurement resolution             | 12 bits                              |                                  |
| Resistance measurement accuracy               | ±1% FSD                              |                                  |
| Resistance measurement sampling rate          | 1 kHz                                |                                  |
| <i>FSD = Full Scale Deflection</i>            |                                      |                                  |
| Analogue Ratiometric Inputs                   |                                      | Connector C                      |
| Voltage ratiometric measurement voltage range |                                      | Pin 7, 8, 17, 18, 19, 20, 29, 30 |
| Voltage ratiometric measurement Vref          | Supply / Vref                        |                                  |
| Voltage ratiometric measurement               | Ratio of input pin to supply voltage |                                  |
| Voltage ratiometric measurement accuracy      | ±1% FSD                              |                                  |
| <i>FSD = Full Scale Deflection</i>            |                                      |                                  |
| Frequency Inputs                              |                                      | Connector C                      |
| Frequency range                               | 5 Hz to 30 kHz                       | Pin 6, 9, 14, 15, 16, 22, 28, 31 |
| Resolution                                    | 100 Hz at maximum frequency          |                                  |
| Accuracy                                      | 400 Hz at Maximum frequency          |                                  |
| Maximum space voltage                         | < 2 V                                |                                  |
| Minimum mark voltage                          | > 6 V                                |                                  |
| Phase Inputs                                  |                                      | Connector C                      |
| Frequency range                               | 5 Hz to 30 kHz                       | Pin 6, 9, 14, 15, 16, 22, 28, 31 |
| Resolution                                    | 1 degree                             |                                  |
| Accuracy                                      | 1 degree                             |                                  |
| Maximum space voltage                         | < 2 V                                |                                  |
| Minimum mark voltage                          | > 6 V                                |                                  |
| Pulse Counter Inputs                          |                                      | Connector C                      |
| Frequency range                               | 5 Hz to 30 kHz                       | Pin 6, 9, 14, 15, 16, 22, 28, 31 |
| Resolution                                    | 1 count                              |                                  |
| Maximum count                                 | 2 <sup>24</sup> (15777215)           |                                  |
| Direction                                     | Up / down                            |                                  |



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| Encoder Inputs   |   | Connector C  |
|--|---|--|
| Frequency range  | 5 Hz to 30 kHz  | Pin 6, 9, 14, 15, 16, 22, 28, 31                   |
| Resolution   | 1 count   |  |
| Maximum count  | 2 <sup>24</sup> (15777215)  |  |
| Direction  | Up / down   |  |
| Digital Outputs High Side  |   | Connector C  |
| Switching current  | 2 A   | Pin 1,2,3,5,11,12,13, 23,24,26,32,34,35            |
|  | 4 A   | Pin 2,4,10,12,13,23,25, 27,35                      |
| Digital output active high 'ON' state internal voltage drop at rated current | < 2 V   |  |
| Digital output active high 'OFF' state leakage current                       | < 10 mA at 24 V   |  |
| Digital Outputs Low Side   |   | Connector C  |
| Switching current  | 2 A   | Pin 1,12,13,23,24                                  |
|  | 4 A   | Pin 12,13,25                                       |
| Digital output active low 'ON' state maximum voltage at rated current        | < 2 V   |  |
| Digital output active low 'OFF' state leakage current                        | < 10 mA at 24 V   |  |
| PWM/PWMI Outputs   |   | Connector C  |
| Peak current rating (software will stop output if > rating detected)         | 5 A   | Pin 1, 2, 3, 12, 13, 23, 34, 35                    |
| Minimum PWM frequency  | 20 Hz   |  |
| Maximum PWM frequency  | 250 Hz  |  |
| PWM frequency resolution   | 0.1 Hz steps  |  |
| PWM minimum pulse ratio  | 0 Hz  |  |
| PWM maximum pulse ratio  | 100%  |  |
| PWM pulse resolution   | 1%  |  |
| Current measurement resolution (0 A to 2 A range)                            | 1 mA  |  |
| Current measurement resolution (0 A to 4 A range)                            | 2 mA  |  |
| Current measurement accuracy   | ±1% FSD   |  |
| Min. load impedance (12 V supply voltage to 4 A output)                      | 3 Ω   |  |
| Min. load impedance (24 V supply voltage to 4 A output)                      | 6 Ω   |  |
| Reference Voltage  |   | Connector A  |
| Reference voltage output   | Programmable 5 V or 10 V, 500 mA accuracy ±5%                       | 5  |
|  |   | VRef GND on B21/C21                                |
| CAN Interfaces   |   | Connector A  |
| Number of CAN interfaces   | 4   | Pin 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22 |
| Supported protocols  | J1939   |  |
|  | CAN open  |  |
|  | Raw CAN   |  |
| Supported programmable baud rates  | 50 kbit/s, 125 kbit/s, 250 kbit/s, 500 Kbit/s, 800 Kbit/s, 1 Mbit/s |  |



## DSEM643

| Ethernet Interface              |   | M12, 4 pole            |                            |
|---------------------------------|---|------------------------|----------------------------|
| Number of Ethernet ports        | 1   | D-coded 4 pole socket  |                            |
| Supported data rates            | 10 Mbit/s / 100 Mbit/s, duplex  |                        |                            |
| Supported protocols             | MODBUS TCP  |                        |                            |
|                                 | CODESYS 3.5   |                        |                            |
| USB Interface                   |   | M12, 5 pole            |                            |
| Number of USB host ports        | 1   | B-coded, 5 pole socket |                            |
| Supported USB version           | 2   |                        |                            |
| Speeds supported                | Full speed (12 Mbit/s)  |                        |                            |
| Device class supported          | 08 (Mass Storage)   |                        |                            |
| Supported filing system         | FAT32   |                        |                            |
| Processor                       |   |                        |                            |
| Ti Hercules™ RM microcontroller | 32 bit ARM cortex - R4FCPU  |                        |                            |
|                                 | 220 MHz   |                        |                            |
| Memory                          |   |                        |                            |
| Internal flash                  | 3 MB  |                        |                            |
| External flash                  | 8 MB  |                        |                            |
| Internal RAM                    | 256 kB  |                        |                            |
| External RAM                    | 8 MB  |                        |                            |
| FRAM                            | 512 kB  |                        |                            |
| LED Status                      |   |                        |                            |
| Colour                          | Description   | Operation              | State                      |
| None                            | Device not powered  | N/A                    | Off                        |
| Green                           | Unit powered up, application program loaded but not running   | Static                 | Application stopped        |
|                                 | Unit powered up, application program loaded and running   | 1 Hz flash             | Application running        |
|                                 | Unit powered up, but no application program loaded  | 5 Hz flash             | No application             |
| Amber                           | Bootloader functioning normally, firmware present   | Static                 | Bootloader mode            |
|                                 | Firmware is at start-up   | Static                 | Firmware start-up          |
|                                 | Unit stopped due to a serious fault   | Static                 | Application exception      |
|                                 | Bootloader is decrypting the downloaded image   | 1 Hz flash             | Decrypting image           |
|                                 | Bootloader is reading an image from the USB   | 5 Hz flash             | Reading image from USB     |
| Red                             | Fatal system/hardware fault - LED may be driven directly by microcontroller error pin or firmware is in a fault condition | Static                 | Fatal error                |
|                                 | Unit running with a fault, see CODESYS error flags or web tool.   | 1 Hz flash             | Faulty application running |

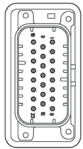
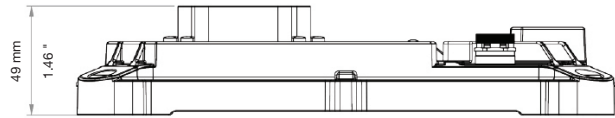
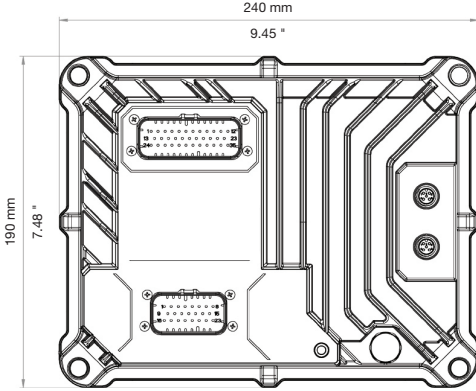


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| Environmental and Testing |   |   |
|---------------------------|---|---|
| CE marking (Industrial)   | Electromagnetic compatibility (EMC) noise immunity<br>Electromagnetic compatibility (EMC) emission standard   | EN 61000-6-2<br>EN 61000-6-4                        |
| CE marking (Off-highway)  | Electromagnetic compatibility (EMC)   | EN ISO 13766-1:2008                                 |
| E11                       | Electromagnetic compatibility (EMC) for vehicles  | UN/ECE-R10.05                                       |
| Electrical tests          | Pulse 1, severity level: III; function state C<br>Pulse 2a, severity level: III; function state A<br>Pulse 2b, severity level: III; function state C<br>Pulse 3a, severity level: III; function state A<br>Pulse 3b, severity level: III; function state A<br>Pulse 4, severity level: III; function state A<br>Pulse 5a, severity level: III; function state C | ISO 7637-2 (2004)                                   |
| Climatic tests            | Damp heat, cyclic upper temperature 55 °C<br>Damp heat, steady state test temperature 40 °C / 93% RH<br>Test duration: 21 days<br>Salt spray test severity level 3 (vehicle)  | EN 60068-2-30<br>EN 60068-2-78<br><br>EN 60068-2-52 |
| Mechanical tests          | Test VII; vibration, random mounting location: vehicle body. Vibration, sinusoidal<br>10...500 Hz; 0.73 mm / 10 g: 10 cycles / axis.<br>bumps 30 g / 6 ms; 24,000 shocks  | ISO 16750-3<br>EN 60068-2-6<br>ISO 16750-3          |

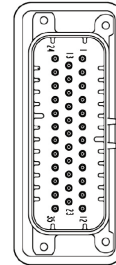
# DSEM643

PROGRAMMABLE CONTROLLER FOR USE IN VEHICLES AND OFF-HIGHWAY MACHINERY



### Connector A

| PIN | DESCRIPTION             |
|-----|-------------------------|
| 1   | Not Connected           |
| 2   | Vref +VE                |
| 3   | Ignition +VE (15)       |
| 4   | ECU Supply +VE          |
| 5   | ECU Supply GND          |
| 6   | PRG Enable              |
| 7   | Not Connected           |
| 8   | Not Connected           |
| 9   | Output Supply 3 & 4 GND |
| 10  | CAN1 H                  |
| 11  | CAN1 H                  |
| 12  | CAN1 L                  |
| 13  | CAN1 L                  |
| 14  | CAN4 H                  |
| 15  | CAN 4 L                 |
| 16  | Output Supply 3 +VE     |
| 17  | CAN2 H                  |
| 18  | CAN2 H                  |
| 19  | CAN2 L                  |
| 20  | CAN2 L                  |
| 21  | CAN3 H                  |
| 22  | CAN3 L                  |
| 23  | Output Supply 4 +VE     |



### Connector C

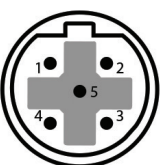
| PIN | DESCRIPTION                | REF   |
|-----|----------------------------|-------|
| 1   | OUT H, L, PWM (2 A)        | QC005 |
| 2   | OUT H, PWM (2 A or 4 A)    | QC001 |
| 3   | OUT H, PWM (2 A)           | QC007 |
| 4   | OUT H (4 A)                | QC010 |
| 5   | OUT H (2 A)                | QC014 |
| 6   | DIN, H, L, FREQ            | IC009 |
| 7   | AIN                        | IC001 |
| 8   | AIN                        | IC002 |
| 9   | DIN, H, L, FREQ            | IC014 |
| 10  | OUT H (4 A)                | QC011 |
| 11  | OUT H (2 A)                | QC015 |
| 12  | OUT H, L, PWM (2 A or 4 A) | QC004 |
| 13  | OUT H, L, PWM (2 A or 4 A) | QC003 |
| 14  | DIN, H, L, FREQ            | IC010 |
| 15  | DIN, H, L, FREQ            | IC011 |
| 16  | DIN H, L, FREQ             | IC012 |
| 17  | AIN                        | IC003 |
| 18  | AIN                        | IC004 |
| 19  | AIN                        | IC005 |
| 20  | AIN                        | IC006 |
| 21  | VREF GND                   | -     |
| 22  | DIN, H, L, FREQ            | IC015 |
| 23  | OUT H, L, PWM (2 A)        | QC006 |
| 24  | OUT H, L (2 A)             | QC018 |
| 25  | OUT H, L (4 A)             | QC017 |
| 26  | OUT H (2 A)                | QC013 |
| 27  | OUT H (4 A)                | QC009 |
| 28  | DIN, H, L, FREQ            | IC013 |
| 29  | AIN                        | IC007 |
| 30  | AIN                        | IC008 |
| 31  | DIN, H, L, FREQ            | IC016 |
| 32  | OUT H (2 A)                | QC016 |
| 33  | OUT H (4 A)                | QC012 |
| 34  | OUT H, PWM (2 A)           | QC008 |
| 35  | OUT H, PWM (2 A or 4 A)    | QC002 |



### Ethernet

M12 'D' coded - 4 Pin Female

|          |      |
|----------|------|
| Pin - 01 | TX + |
| Pin - 02 | RX + |
| Pin - 03 | TX - |
| Pin - 04 | RX - |



### USB Host

M12 'B' coded - 5 Pin Female

|          |         |
|----------|---------|
| Pin - 01 | +5 V DC |
| Pin - 02 | Data -  |
| Pin - 03 | Data +  |
| Pin - 04 | ID      |
| Pin - 05 | GND     |

#### Abbreviations

OUT PWM, H, L  
OUT H  
OUT H, L  
AIN  
DIN, H, L, FREQ

Output can be configured as a PWM, PWMi, digital high-side or digital low-side.

Output is digital high.

Output can be configured as a digital high-side or digital low side.

Input can be configured to accept signals from positive digital, negative digital, 0 V to 5 V, 0 V to 10 V, 0 V to 32 V, 4 mA to 20 mA, ratiometric or resistive.

Input can be configured to accept signals from positive digital, negative digital or frequency.