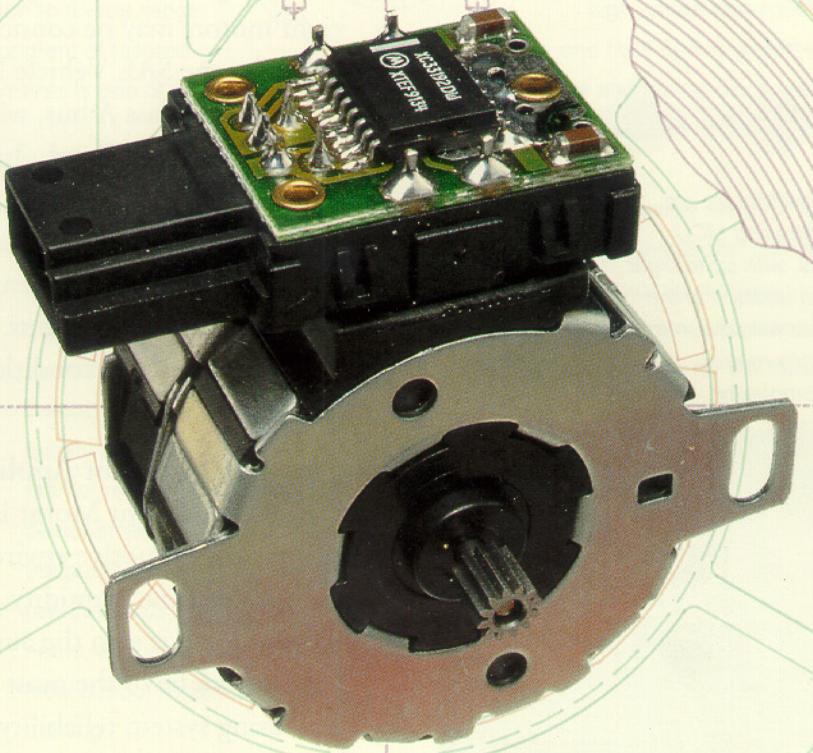
BR477/D

SMART MOVER

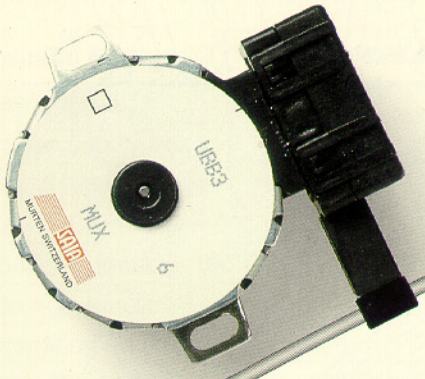


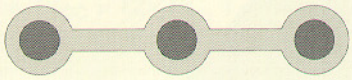
Stepper Motors with Integrated Serial Bus Controller

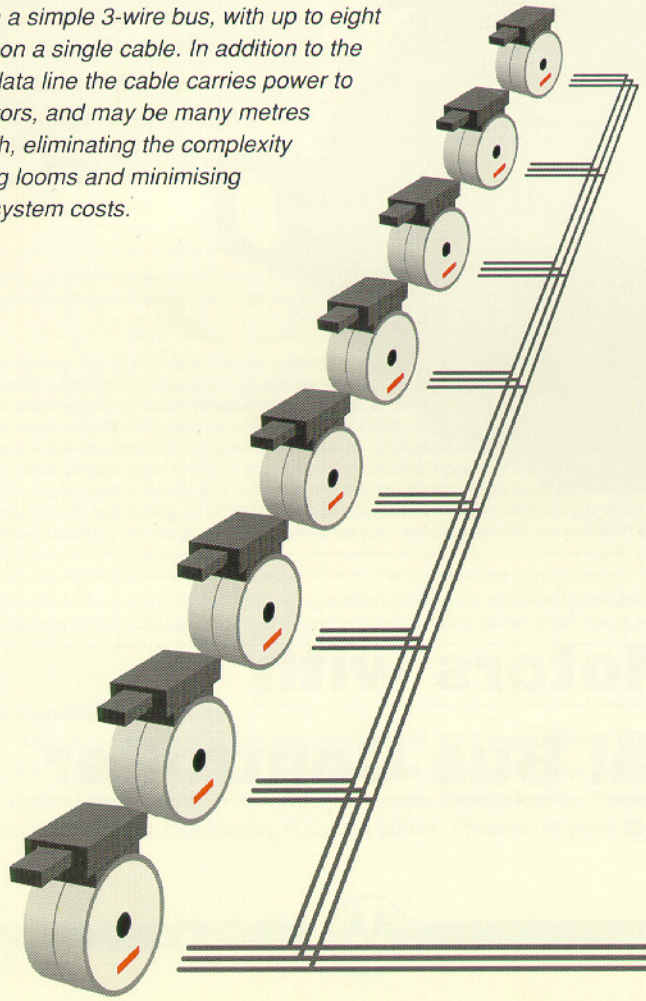
MOTOROLA

Smart Mover...

Stepper motors have long been the optimum choice in a broad variety of applications that need defined rotary motion over a wide range of speeds. Now SAIA takes their sophistication a giant step forward with the introduction of the Intelligent Stepper Motor.







SAIA's Intelligent Motors are connected to their controlling MCU through a simple 3-wire bus, with up to eight motors on a single cable. In addition to the single data line the cable carries power to the motors, and may be many metres in length, eliminating the complexity of wiring looms and minimising wiring system costs.

The permanent magnet stepper motor provides precise control without the need for positional feedback – an open loop system. It offers simple interfacing to digital control systems, and its simple, compact design provides a reliable but low cost solution even under harsh environmental conditions.

But in common with other motor types, the stepper motor has required its control circuits to be housed in a separate module. In applications using several motors this has lead to the need for bulky and expensive wiring looms and the possibility of electrical interference.

SAIA's 'smart motor' revolutionises stepper motor design by incorporating all the control electronics inside the motor itself. Communication with the system controller is via the MI Bus – a 3-wire bus with two wires carrying power to the motor and its electronics and a single wire carrying the control data. Up to eight motors may be connected to each bus.

Under the SAE Vehicle Network categories, the MI Bus is a Class A bus, with a typical operating frequency of 20 KBaud. In addition to being a cost-effective alternative to bulk wiring, it provides very high data integrity as a result of continuous two-way communication between the system controller and each motor on the bus. Data errors due to interference or fault conditions are detected, reported and corrected.

Intelligent Motor Applications

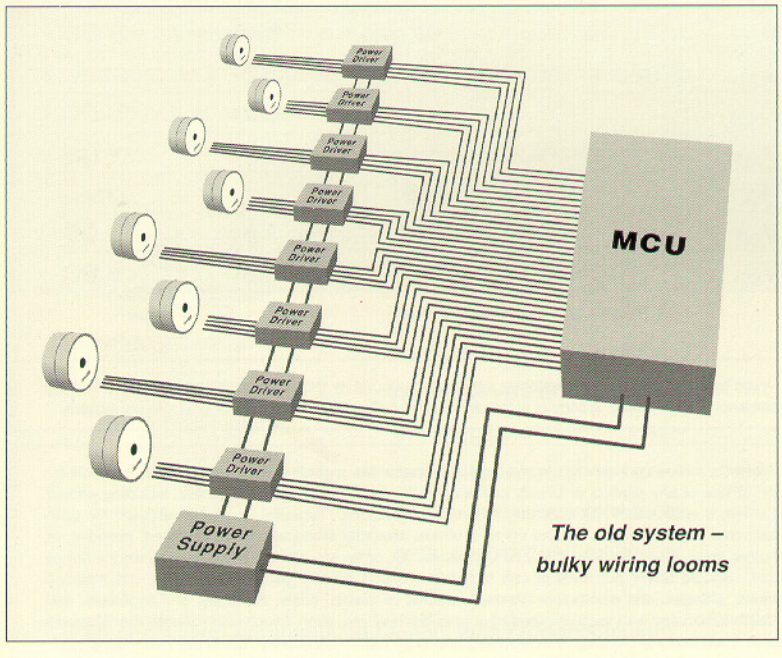
SAIA's Intelligent Motor is designed to operate in the harsh automotive environment, with extremes of temperature and humidity, and poor electrical conditions. And it is in the automotive industry that its features can be of the most immediate benefit, by increasing system reliability and reducing the high cost of complex wiring looms.

The Intelligent Motor eliminates bulky wiring looms and the need for a separate power module for each motor. All the phase drive circuits and their controlling electronics are incorporated in the motor. In addition, the electronic module is able to detect virtually every possible fault condition – including open and short circuit bus lines, half-bridge drivers and motor windings, and over temperature electronics – and to report them to the controlling microprocessor. Default settings can be programmed into the motor in case of complete data failure.

An air conditioning system in particular may use between 10 and 16 motors, and can be simplified and made more compact by the removal of traditional wiring. Other automotive applications include headlight levellers, electric windows, sensors, coil drivers, central locking systems, and so on; motors for different applications may be connected to the same bus. Safety considerations are addressed by installing one or more bus systems for each side of the vehicle, while built-in intelligence and two-way, fault reporting bus protocol can provide the system with diagnostic capability.

Environmental control systems in buildings will find similar benefits to their automotive counterparts. Existing applications such as computer and office equipment, and antennae systems, can offer their users lower costs and improved performance.

The first Intelligent Motor in the series is based on SAIA's popular 36mm UBB series, allowing direct mechanical replacement in many designs.



The old system – bulky wiring looms

The MI Bus – Technical Description

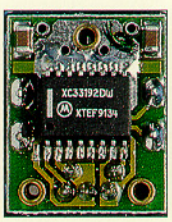
The MI Bus (Motorola Interconnect Bus) is a serial communications protocol which efficiently supports distributed real-time control. It operates with a fixed message format consisting of a series of data frames that provide two-way communication between the master controller – normally a microcomputer (MCU) – and the slave devices.

Data transmission is by means of a bi-phase Manchester code. The MCU can take control of the bus at any time by issuing a Start Bit, which violates the bi-phase encoding by holding a logic zero state for three consecutive time slots.

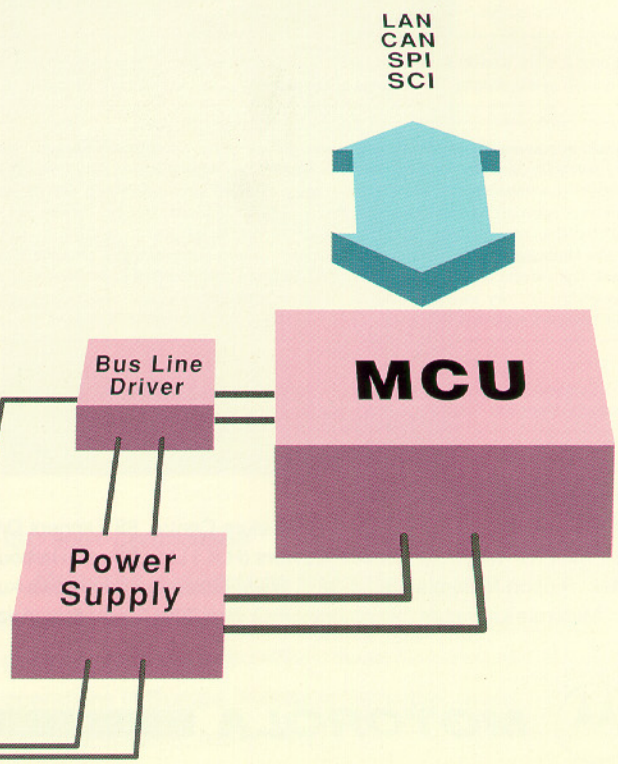
Each frame consists of two fields: the 'Push Field', in which data and addresses are transmitted by the MCU; and the 'Pull Field', in which serial data is read back from the selected device. The Push Field is a sequence of 8 data bits, 3 address bits and 5 control bits – the 3 address bits allow control of up to 8 devices on each bus. The Pull Field response from the remote device is initiated by a Pull Sync bit at the end of the Push Field.

In addition to high electrical noise immunity, the MI Bus achieves very high data integrity through an advanced error detection and reporting scheme – an error report is indicated by a code 1 1 1 followed by a permanent End of Frame pulse in the Pull Field. Error detection features include:

Noise Detection: the remote device samples the bi-phase code twice in each time slot to accommodate local clock variation and propagation delay. Line noise is indicated if the two samples do not agree.



The motor control board with the MC33192 Stepper Motor Controller



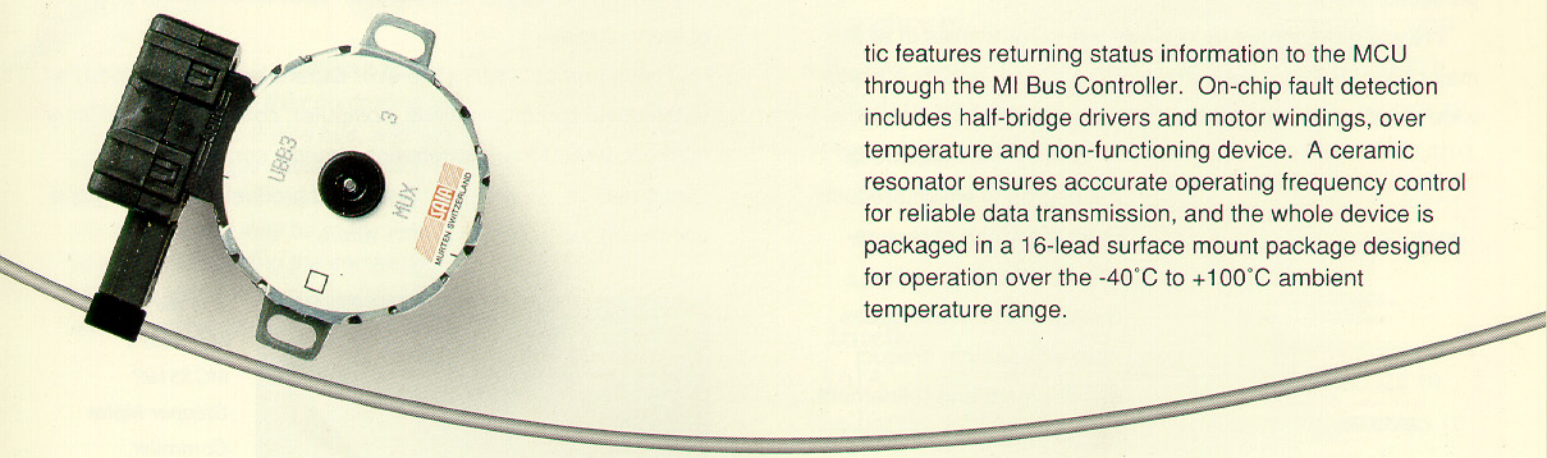
Each motor connects to the bus through a rugged 3-pin connector, fitted at any point on the cable without the need for cable preparation. Until now, multiple motor systems have required a separate power driver module for each motor – with bulky wiring looms from the central controller to each module, multiple multi-pole connectors, and high manufacturing and service costs. The Intelligent Motor offers a new way forward, with lower costs and excellent opportunities for compact designs and a new level of system reliability.

Bi-Phase Detector: an error is indicated by the remote device if consecutive time slots of the bi-phase code do not follow a logic exclusive-OR function. This is the case in the event of signal short circuit to ground or supply line.

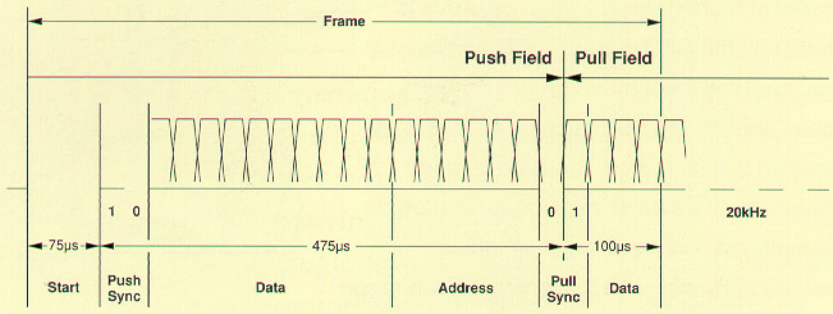
Field Check: a field error is indicated if the Pull Field contains an incorrect number of bits. The MCU can also monitor the bus at the same time as transmitting data, and can detect bit errors during the Push Field.

Stepper Motor Controller

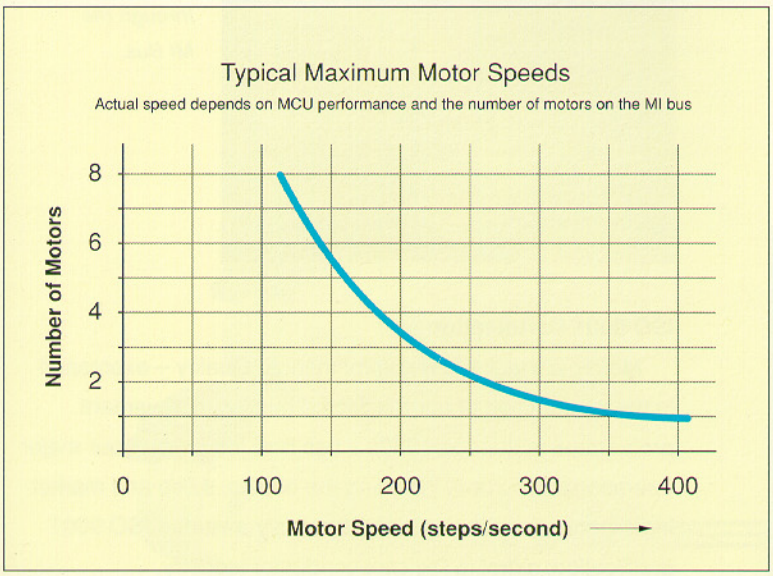
The Motorola MC33192 Stepper Motor Controller that is integrated into the Smart Motor is a single-chip solution designed specifically to operate in the harsh automotive environment. It provides four output signals to drive two-phase motors in either half or full step mode. The MC33192 consists of the MI Bus Controller, a functional block common to all MI Bus products, which manages communication with the MCU, noise detection, data encoding and the length of the push sequence; and the Motor Driver which controls a dual full-bridge driver for the stepper motor, and contains diagnostic features returning status information to the MCU through the MI Bus Controller. On-chip fault detection includes half-bridge drivers and motor windings, over temperature and non-functioning device. A ceramic resonator ensures acccurate operating frequency control for reliable data transmission, and the whole device is packaged in a 16-lead surface mount package designed for operation over the -40˚C to +100˚C ambient temperature range.



The MI Bus Protocol



MI Bus Timing Diagram



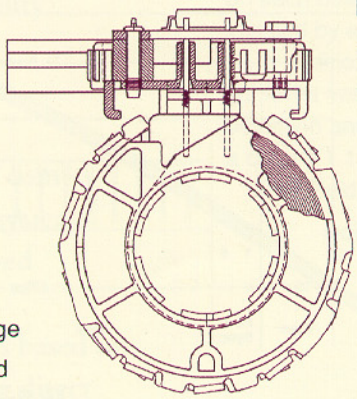
MI Bus Performance

The maximum motor speed in steps per second depends on the number of motors on the bus and the performance of the controlling MCU. The graph on the left shows typical speed variation against number of motors. The bus will normally operate at a minimum frequency of 20KHz; at this frequency the message construct time is 25us and can be handled easily by many standard MCUs.

The MC68HC11P2 is a member of Motorola's M68HC11 family of high performance 8-bit MCUs – already popular for automotive applications – and is especially suitable for MI Bus applications. It includes a Serial Communication Interface (SCI) that can be used as the MI Bus; data is transmitted (pushed) by the TxD pin and received (pulled) by the RxD pin. Message framing is managed automatically in hardware.

Partners in Technology

SAIA AG is the leading manufacturer of stepper motors for automotive applications in Europe; we also produce unidirectional and reversing synchronous motors, and reduction gears. SAIA has established an unparalleled reputation for delivering high quality products on short delivery cycles, supported by our worldwide sales and distribution network and backed by highly professional customer service.



Based in Murten, Switzerland, SAIA AG is a member of the SAIA-Burgess Electronics group. We produce a broad range of motors, switches and electronic controllers for use in the automotive industry; in air conditioning and building control systems; in computer and office equipment; in telecommunications; and in household appliances. In addition to a wide range of standard products, the development of tailored solutions for customers' requirements is one of our particular strengths.

We are represented by our own sales companies in all the major countries in Europe and North America, and by a worldwide distribution network.


SQS

Schweizerische Vereinigung
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Swiss Association for
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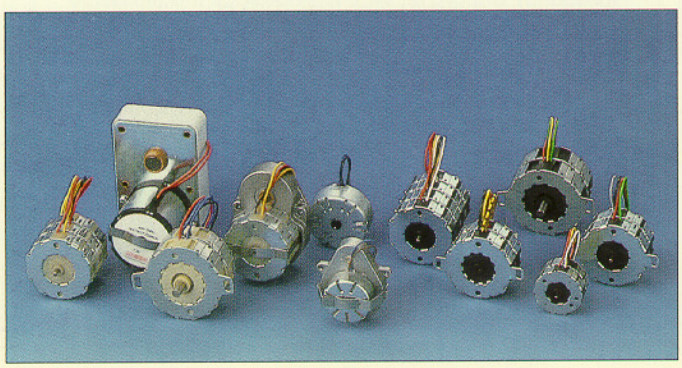
SAIA AG

the SQS Certificate, Category ISO 9001/EN 29 001

Quality is a measure of the degree to which products meet their market requirements. We believe that quality assurance includes market research, product development and refinement, the purchase of high quality raw materials and components, and competent technical support and customer training.

Our continuing emphasis on Quality was recognised with ISO 9001 certification from the SQS (Swiss Association for Quality Assurance Certificates) in 1991.

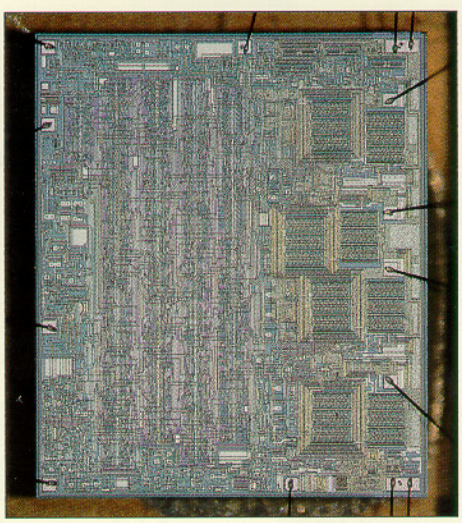


Motorola's Semiconductor Products Sector is a world leader in the design and manufacture of microelectronic components – we call them 'innovative systems on silicon'. We offer the industry's broadest portfolio, produced by an infrastructure that includes design, manufacturing, marketing and technical support in North America, Europe, Asia-Pacific and Japan.

Motorola is the largest US-based semiconductor supplier, ranking number 4 worldwide, and is the world's leading automotive semiconductor company.

Our advanced technology portfolio includes high-performance microprocessors, microcontrollers and peripherals; static random access memories; digital signal processors; bipolar and MOS digital-analog components; high speed and commodity logic; optoelectronics and fibre-optics; power and small-signal transistors; zener and tuning diodes; microwave devices; and custom, proprietary and application-specific circuits in a range of technologies.

These products serve the ever expanding needs of today's automotive, communications, computer, consumer and military markets, while Motorola remains strongly committed to the continuous development of advanced product, processing and packaging technologies for the future.



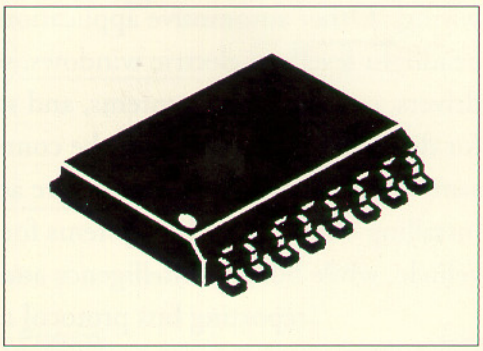
The die of Motorola's MC33192 Stepper Motor Controller, providing full motor control through the MI Bus.

ISO 9001 Certification

Motorola's well know commitment to Quality – expressed in the introduction of our Six-Sigma quality improvement programme in the mid-1980s – has now led to all of our major operations in Europe, including the design, sales and marketing organisations, being simultaneously awarded ISO 9001 certification: a first in the semiconductor industry.

MC33192 – MI Bus Interface Stepper Motor Controller

- Direct Control of Stepper Motors, Relays, etc. in Harsh Environments
- Single-Wire Open Bus Capability up to 10m in Length
- On-Chip Oscillator for Accurate and Reliable Data Transmission
- Programmable Address Bus System
- Fault Detection of Half-Bridge Drivers and Motor Windings
- MI Bus Error Diagnostic
- Non-Functioning Device Diagnostic
- Over Temperature Detection
- Assembled in 16-pin Plastic Surface Mount Package (SO-16L)



Maximum Ratings (T_A = 25°C unless otherwise noted)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Power Supply Voltage	V_{CC}			16	V DC
Digital Input Voltage	V_i	-0.3		V_{CC}+0.3	V DC
Output Current @ -40°C (V_{CE} max = 1.6V)	I_{OLT}			260	mA
Output Current @ 100°C (V_{CE} max = 1.6V)	I_{OHT}			150	mA
Storage Junction Temperature	T_J	-40		+150	°C
Operating Ambient Temperature	T_A	-40		+130	°C
Total Power Dissipation @ +100°C	P_T			0.5	W

Electrical Characteristics (V_{CC} = 12V DC, T_A = -40°C to +100°C)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Power Supply Voltage	V_{CC}	9	12	15.5	V DC
Quiescent Current @ 15.5V (Inh1, Inh2 = 0)	I_{QU}			12	mA
Continuous Sustaining Volatage	V_{CES}			25	V DC
Load Dump Voltage (250ms)	V_{DU}			40	V DC
Nominal Output Current	I_O		150		mA
Output Voltage Drop @ -40°C	V_{DP}			1.8	V DC
Output Voltage Drop @ 100°C	V_{DP}			1.6	V DC

Literature Distribution Centres:

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