MTE1122

Energy Management Controller IC

FEATURES

- Energy Management Controller
- Based on 8-bit RISC Technology
- Proprietary Power Management Algorithm
- Reduces the power consumption of induction motor systems
- 5V Operation
- 18-pin PDIP and SOIC Packages
- 8-bit Analog-to-Digital (A/D) Converter
- Automatic Power-on Reset
- Power-up Timer
- Commercial and Industrial Temperature Range Operation
- Multiple parts can be slaved for three-phase operation

INTRODUCTION

The MTE1122 is an Energy Management Controller IC for single-phase induction motors. This CMOS device is based on Microchip Technology Inc's RISC processor core and proprietary algorithms. When combined with some external analog components, it will provide an electronic system that economically reduces the operating costs of small induction motors by as much as 58%. It will also allow motors to run cooler and with less vibration. The system operates on single phase 110 or 220 VAC.

PACKAGE TYPE

18-Lead PDIP/SOIC

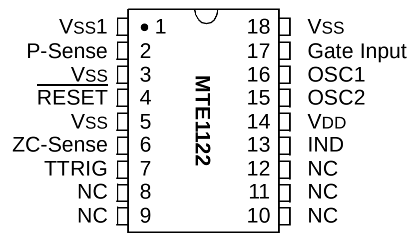


FIGURE 1: SYSTEM BLOCK DIAGRAM

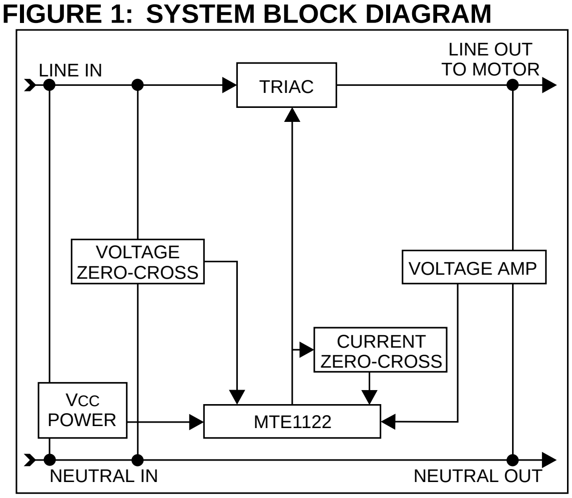
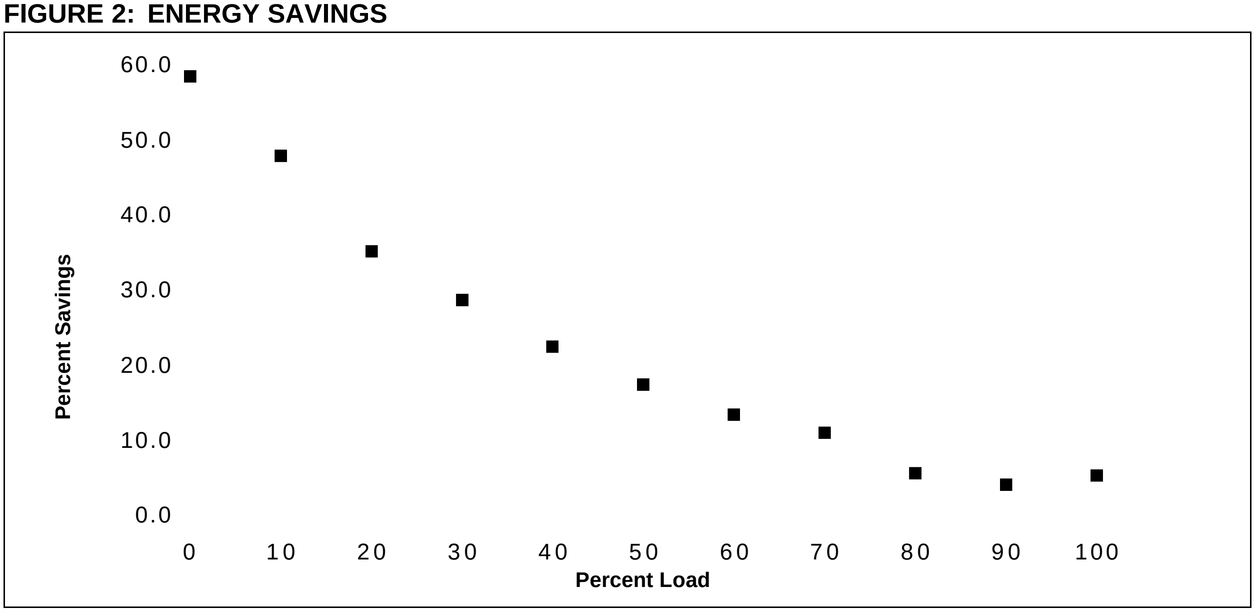


FIGURE 2: ENERGY SAVINGS



FUNCTIONAL DESCRIPTION

Single-phase induction motors run most efficiently at full load. As the applied load lessens, a greater portion of the energy consumed by the motor is wasted, mostly as heat.

It is estimated by the EPA that 50% of the energy produced in the US is consumed by small electric motors, and that 20% of this energy does no useful work. There are perhaps three major reasons for this:

1. Over-specification -- sometimes its easier or costs no more to specify a larger motor than determine actual loads.
2. Worst case design -- pumps, conveyers, fans, and the like must be able to operate properly with clogged filters, maximum heads, or specified loads. If filters are clean, or loads are lower, the motor will be running only partly loaded.
3. Idle time -- many times, systems can't be shut down conveniently when not in use.

Number 1 above can be corrected by proper design. For example, in modern refrigerators, the compressor systems have been optimized quite effectively. Numbers 2 and 3 can not be improved using traditional approaches. This is where the MTE1122 provides a new, cost-effective solution.

The MTE1122 calculates the amount of load on a motor connected to it, and adjusts the motor's supply voltage to match that load. For example, if the load is lower than the motor's rated load, the voltage to the motor can be reduced, thus decreasing the energy used by the motor.

A 1/3 HP motor will typically see 85 VAC at no load when powered through the MTE1122, for an energy savings of as much as 58%.

A system block diagram is shown in Figure 1. A graph of energy savings vs. motor load is shown in Figure 2.

A graph of motor efficiency with and without an MTE1122-based energy management controller (EMC) is shown in Figure 3. The data for the graphs are shown in Table 1. These figures are based on a 1/3 HP induction motor coupled to a dynamometer. Actual savings may vary based on motor size, motor load and motor construction.

PINOUT DESCRIPTIONS

P-Sense - analog input that is used by the device to measure the load voltage.

Gate Enable - analog input that monitors the voltage across the triac. It is used as a current feedback mechanism.

IND - TTL-compatible output that indicates that the system is operating normally. It is intended to control an LED or another indicator device.

ZC-Sense - TTL-compatible input that is used to determine the zero crossing point of the AC voltage waveform.

TTRIG - TTL-compatible output that is used to drive the triac.

$\overline{\text{RESET}}$ - TTL-compatible input used to reset the device by holding this pin low.

OSC1, OSC2 - Oscillator crystal or resonator connections.

FIGURE 3: MOTOR EFFICIENCY

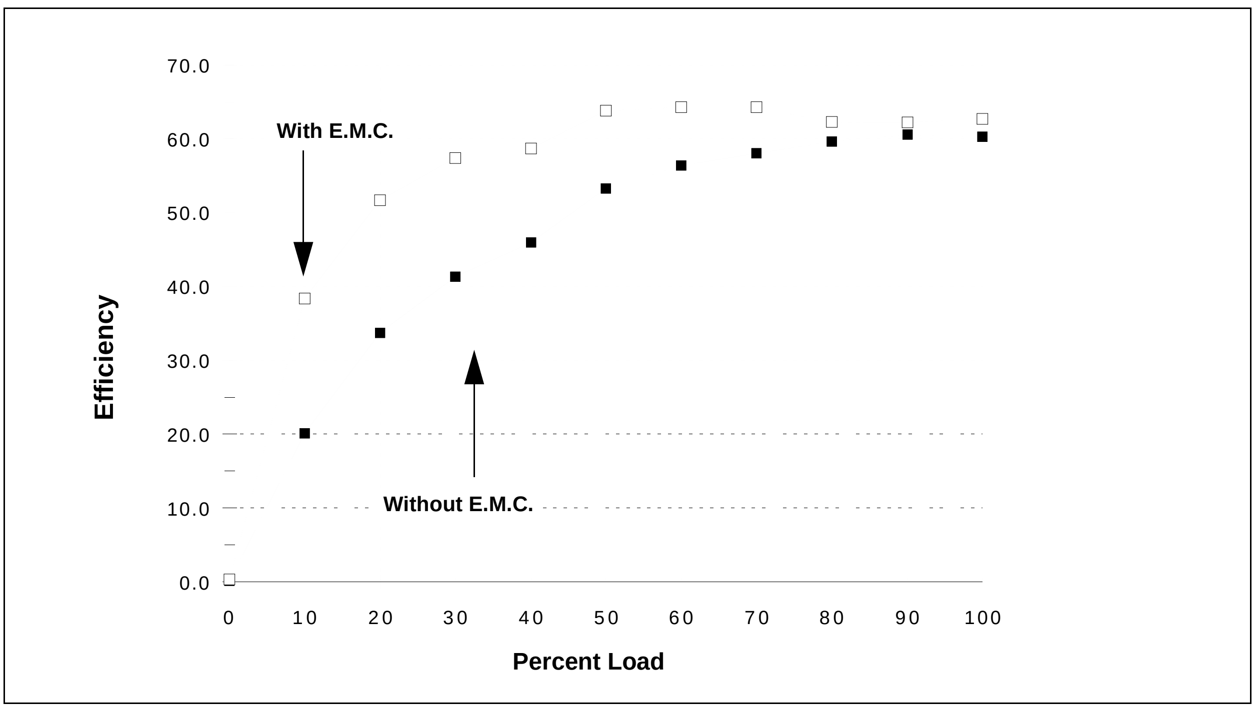


TABLE 1: OPERATING PARAMTER COMPARISONS

1/3 HP Motor without E.M.C.									
Load (%)	Load (Nm)	Vrms	Irms (A)	Power Factor	Power In (W)	RPM	Power Out (W)	Power Out (HP)	Efficiency (%)
0	0.00	115	5.7	0.18	120	1791	0	0.00	0.2
10	0.14	115	5.7	0.20	130	1788	26	0.04	20.1
20	0.29	115	5.7	0.24	160	1781	54	0.07	33.7
30	0.43	115	5.7	0.29	193	1777	80	0.11	41.4
40	0.57	115	5.7	0.35	229	1768	105	0.14	46.0
50	0.72	115	5.8	0.37	249	1764	133	0.18	53.3
60	0.86	115	5.8	0.42	280	1758	158	0.21	56.4
70	1.00	115	6.0	0.46	315	1750	183	0.25	58.0
80	1.14	116	6.1	0.49	348	1744	208	0.28	59.7
90	1.29	115	6.3	0.53	386	1736	234	0.31	60.6
100	1.43	116	6.5	0.57	428	1727	258	0.35	60.3

1/3 HP Motor with E.M.C.									
Load (%)	Load (Nm)	Vrms	Irms (A)	Power Factor	Power In (W)	RPM	Power Out (W)	Power Out (HP)	Efficiency (%)
0	0.00	113	3.1	0.14	50	1794	0	0.00	0.4
10	0.14	113	3.2	0.19	68	1786	26	0.04	38.4
20	0.29	113	3.5	0.26	104	1775	54	0.07	51.7
30	0.43	113	3.8	0.32	138	1764	79	0.11	57.4
40	0.57	113	4.1	0.38	178	1755	104	0.14	58.7
50	0.72	113	4.3	0.42	206	1749	132	0.18	63.8
60	0.86	112	4.6	0.47	243	1740	156	0.21	64.3
70	1.00	112	4.9	0.51	281	1730	181	0.24	64.3
80	1.14	112	5.3	0.55	329	1722	205	0.27	62.3
90	1.29	112	5.6	0.59	371	1713	231	0.31	62.2
100	1.43	111	6.0	0.61	406	1705	255	0.34	62.7

ELECTRICAL CHARACTERISTICS

Absolute Maximum Rating †

Ambient temperature under bias .... -55 to +125°C

Storage Temperature .... -65°C to +150°C

Voltage on any pin with respect to V_{SS} (except V_{DD} and RESET) .... -0.6V to V_{DD} +0.6V

Voltage on V_{DD} with respect to V_{SS} .... 0 to +7.5V

Voltage on RESET with respect to V_{SS} (Note 1) .... 0 to +14V

Total power Dissipation (Note 2) 800mW

Max. Current out of V_{SS} pin 150mA

Max. Current into V_{DD} pin 100mA

Input Clamping Current, IIK (VI<0 or VI>V_{DD}) .... ±20mA

Output Clamping Current, IOK (V0<0 or V0>V_{DD}) .... ±20mA

Max. Output Current sunk by any I/O pin 25mA

Max. Output Current sourced by any I/O pin 20mA

Note 1: Voltage spikes below V_{SS} at the RESET pin, inducing currents greater than 80mA, may cause latch-up. Thus, a series resistor of 50-100Ω should be used when applying a "low' level to the RESET pin rather than pulling this pin directly to V_{SS}.

Note 2: Total power dissipation should not exceed 800 mW for the package. Power dissipation is calculated as follows:
$P_{DIS} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD}-V_{OH}) \times I_{OH}\} + \sum(V_{OL} \times I_{OL})$

†NOTICE: Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device or compliance to AC and DC parametric specifications at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

TABLE 2: DC CHARACTERISTICS POWER SUPPLY PINS

Power Supply Pins	**Standard Operating Conditions (unless otherwise stated)** Operating temperature -40°C ≤ T_A ≤ + 85°C for industrial, 0°C ≤ T_A ≤ +70°C for commercial Operating voltage V_{DD} = 4.0V to 6.0V					
Characteristic	**Sym**	**Min**	**Typ** (Note 1)	**Max**	**Units**	**Conditions**
Supply Voltage	V_{DD}	4.0		6.0	V	
V_{DD} start voltage to guarantee power on reset	V_{POR}		Vss		V	
V_{DD} rise rate to guarantee Power-On Reset (Note 2)	S_{VDD}	0.05			V/ms	
Supply Current (Note 3)	I_{DD}		1.8	3.3	mA	F_{OSC} = 4 MHz, V_{DD} = 5.5V

Note 1: Data in the column labeled “Typical” is based on characterization results at 25°C. This data is for design guidance only and is not tested for, or guaranteed by Microchip Technology.
2: This parameter is characterized but not tested.
3: The supply current is mainly a function of the operating voltage and frequency. Other factors such as I/O pin loading and switching rate, oscillator type, internal code execution pattern, and temperature also have an impact on the current consumption.

TABLE 3: DC CHARACTERISTICS: ALL PINS EXCEPT POWER SUPPLY

All Pins Except Power	Standard Operating Conditions (unless otherwise stated) Operating temperature -40°C ≤ T_A ≤ + 85°C for industrial, 0°C ≤ T_A ≤ +70°C for commercial Operating voltage V_{DD} = 4.0V to 6.0V					
Characteristic	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Input Low Voltage: All Input Pins (Except OSC1) $\overline{RESET}$ OSC1	 V_{IL} V_{IH}	 V_{SS} V_{SS}		 0.2 V_{DD} 0.3 V_{DD}	 V V	
Input High Voltage: All Input Pins (Except $\overline{RESET}$, OSC1) $\overline{RESET}$ OSC1	 V_{IH} V_{IH} V_{IH}	 0.36 V_{DD} 0.85 V_{DD} 0.7 V_{DD}		 V_{DD} V_{DD} V_{DD}	 V V V	 4.5V ≤ V_{DD} ≤ 5.5V
Input Leakage Current: (Notes 1,2) IND, TTRIG, AC-Sense P-Sense, Gate Input $\overline{RESET}$ OSC1	 I_{IL}			 ±1 ±1 ±1 ±1	 µA µA µA µA	 V_{SS} ≤ V_{PIN} ≤ V_{DD}, Pin at hi-impedance V_{SS} ≤ V_{PIN} ≤ V_{DD}, Pin at hi-impedance V_{SS} ≤ V_{PIN} ≤ V_{DD} V_{SS} ≤ V_{PIN} ≤ V_{DD}
Output Low Voltage: All Output Pins	 V_{OL}			 0.6	 V	 I_{OL} = 8.5mA, V_{DD} = 4.5V, -40°C to +85°C
Output High Voltage: All Output Pins (Note 2)	 V_{OH}	 0.7 V_{DD}			 V	 I_{OH} 83.mA, V_{DD} = 4.5V, -40°C to +85°C

Note 1: The leakage current on the $\overline{RESET}$ pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.

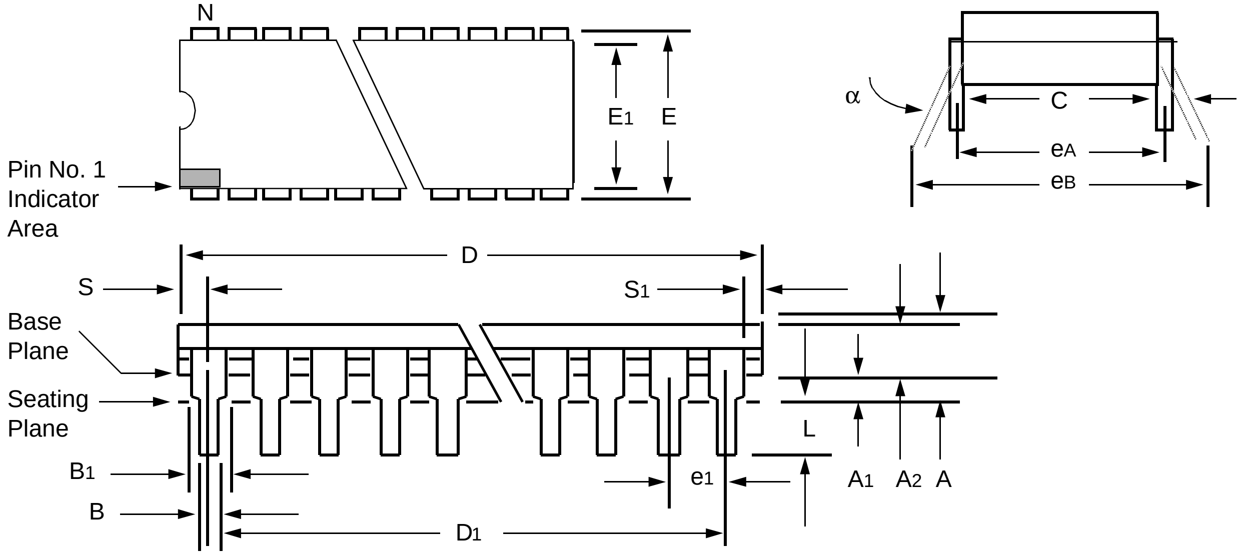
2: Negative current is defined as current coming out of the pin.

TABLE 4: AC CHARACTERISTICS

AC Characteristics	Standard Operating Conditions (unless otherwise stated) Operating temperature -40°C ≤ T_A ≤ + 85°C for industrial, 0°C ≤ T_A ≤ +70°C for commercial Operating voltage V_{DD} = 4.0V to 6.0V					
Characteristic	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Oscillator Frequency	F_{OSC}	4		4	MHz	
Clock in (OSC1) High or Low Time	T_{CKHLXT}	50			ns	Note 1
Clock in (OSC1) Rise or Fall Time	T_{CKRFXT}	25			ns	Note 1
RESET Pulse Width (low)	T_{MCL}	200			ns	Note 1

PACKAGING INFORMATION

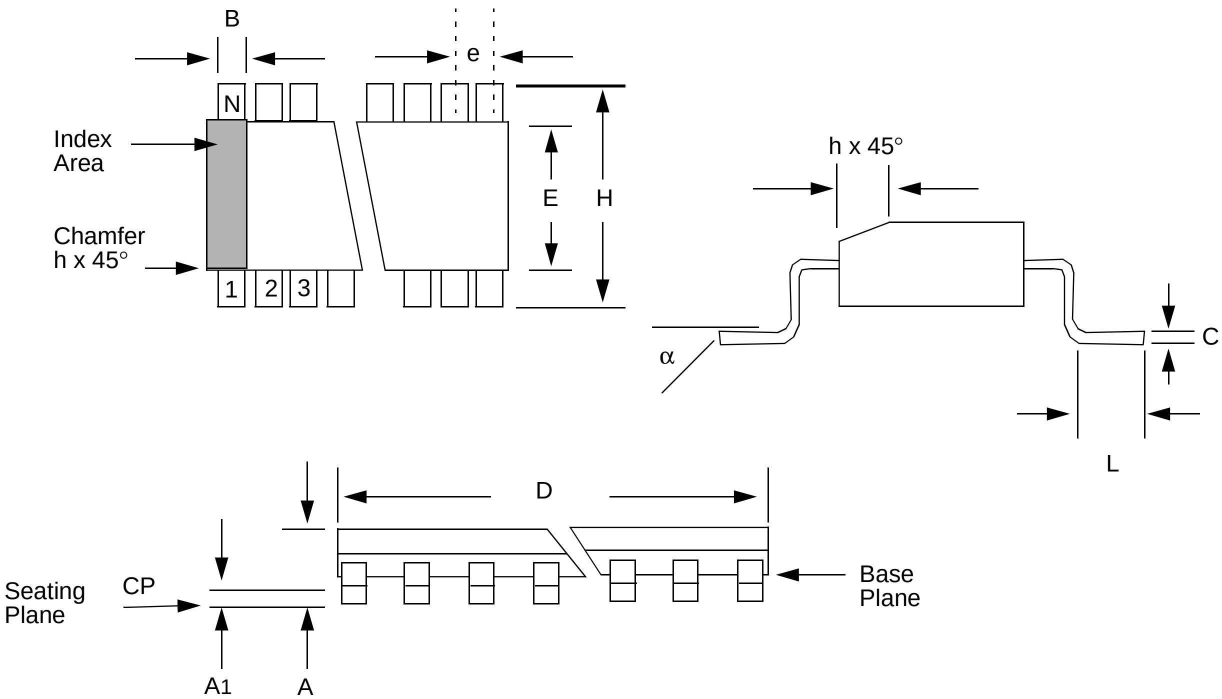
Package Type: 18-Lead Plastic Dual In-Line (300 mil)



Package Group: Plastic Dual In-Line (PLA)						
	Millimeters			Inches		
Symbol	Min	Max	Notes	Min	Max	Notes
α	0°	10°		0°	10°	
A	—	4.064		—	0.160	
A1	0.381	-		0.015	—	
A2	3.048	3.810		0.120	0.150	
B	0.3556	0.5588		0.014	0.022	
B1	1.524	1.524	Reference	0.060	0.060	Reference
C	0.203	0.381	Typical	0.008	0.015	Typical
D	22.479	23.495		0.885	0.925	
D1	20.320	20.320	Reference	0.800	0.800	Reference
E	7.620	8.255		0.300	0.325	
E1	6.096	7.112		0.240	0.280	
e1	2.4892	2.5908	Typical	0.098	0.102	Typical
eA	7.620	7.620	Reference	0.300	0.300	Reference
eB	7.874	9.906		0.310	0.390	
L	3.048	3.556		0.120	0.140	
N	18	18		18	18	
S	0.889	—		0.035	—	
S1	0.508	—		0.005	—	

Preliminary

Package Type: 18-Lead Plastic Surface Mount (SOIC - Wide, 300 mil Body)



Package Group: Plastic SOIC (SO)						
	Millimeters			Inches		
Symbol	**Min**	**Max**	**Notes**	**Min**	**Max**	**Notes**
α	0°	8°		0°	8°	
A	2.3622	2.6416		0.093	0.104	
A1	0.1016	0.29972		0.004	0.0118	
B	0.3556	0.4826		0.014	0.019	
C	0.2413	0.3175		0.0095	0.0125	
D	11.3538	11.7348		0.447	0.462	
E	7.4168	7.5946		0.292	0.299	
e	1.270	1.270	Reference	0.050	0.050	Reference
H	10.0076	10.6426		0.394	0.419	
h	0.381	0.762		0.015	0.030	
L	0.4064	1.143		0.016	0.045	
N	18	18		18	18	
CP	—	0.1016		—	0.004	

MTE1122 Product Identification System

To order or to obtain information, e.g., on pricing or delivery, please use the listed part numbers, and refer to the factory or the listed sales offices.

PART NO. X /XX

Package:	P	=	Plastic Dual In-line
	SO	=	Plastic SOIC
Temperature Range:	-	=	0°C to +70°C
	I	=	–40°C to +85°C
Device:	MTE1122		

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