SIEMENS

MICROMASTER
Encoder Module

Operating Instructions   Issue 04/04

User Documentation

1   Foreword

Qualified Personnel

For the purpose of this Instruction Manual and product labels, a "Qualified person" is someone who is familiar with the installation, mounting, start-up and operation of the equipment and the hazards involved.

He or she must have the following qualifications:

➢ Trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.

➢ Trained in the proper care and use of protective equipment in accordance with established safety procedures.

➢ Trained in rendering first aid.

Safety guidelines

This manual contains notices intended to ensure your personal safety, as well as to protect products and connected equipment against damage. Information relating to your personal safety is highlighted by a warning triangle. Warnings about property damage are displayed without a warning triangle. Depending on the degree of risk involved, safety-related information is presented in the following Categories:

⚠ DANGER

For the purpose of this documentation and the product warning labels, "Danger" indicates that death; severe personal injury or substantial damage to property will result if proper precautions are not taken.

⚠ WARNING

For the purpose of this documentation and the product warning labels, "Warning" indicates that death; severe personal injury or substantial damage to property **can** result if proper precautions are not taken.

CAUTION

With a warning triangle, "Caution" indicates that minor personal injury can result if proper precautions are not taken.

ATTENTION

Indicates that an undesirable effect or state can occur if attention is not paid to the advice given.

NOTE

For the purpose of this document, "Note" indicates important information relating to the product or highlights part of the documentation for special attention.

User Documentation

⚠ **WARNING**

Before installing and commissioning, please read these safety instructions and warning carefully and all the warning labels attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.

Proper Use

⚠ **WARNING**

- ➢ This equipment contains dangerous voltages and controls potentially dangerous rotating mechanical parts.
- ➢ Non-Compliance with Warnings or failure to follow the instructions contained in this manual can result in loss of life, severe personal injury or serious damage to property.
- ➢ Only suitably qualified personnel should work on this equipment, and only after becoming familiar with all safety notices and maintenance procedures contained in this manual.
- ➢ The user should be fully conversant with all warnings, cautions and notices contained within the MICROMASTER 440 Operating Instructions.
- ➢ The successful and safe operation of this equipment is dependent upon its proper handling, storage, installation, operation and maintenance.
- ➢ National safety regulations are also applicable.

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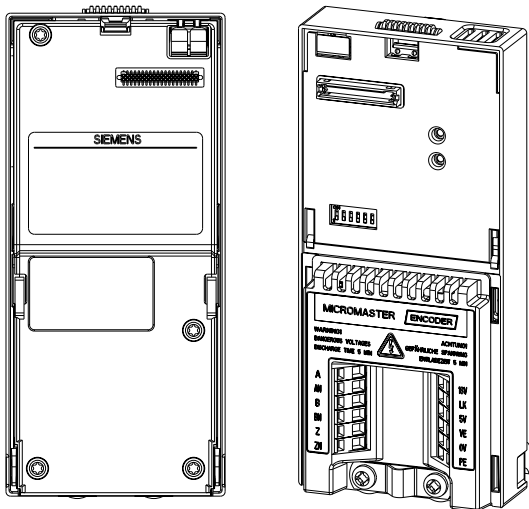
2   Overview

Figure 2-1   View of Encoder Module

The MICROMASTER Encoder Module has been designed to allow the MICROMASTER 440 inverter to interface with the most common types of digital encoders.

The Encoder Module can use High-voltage Transistor Logic (HTL) and Transistor Transistor Logic (TTL) digital encoders.

When the Encoder Module is fitted to the MICROMASTER 440 it allows closed-loop encoder feedback with the following benefits in comparison to Sensorless Vector Control (SLVC) and Variable Frequency (V/f) operation respectively

➢ Zero speed with full load torque capability

➢ Accurate speed control

➢ Enhanced dynamic performance of speed and torque control.

The module is supplied with power directly from the MICROMASTER 440 via the 40-way connector on the front of the inverter.

Notes

1. An external power supply has to be provided (See Figure 3-7 on page 11) for the proper operation of the Encoder Module, if:
➢ The encoder consumes a current of 140 mA or more at 18 to 24 V DC.
➢ The encoder consumes a current of 330 mA or more at 5 V DC.
➢ Cable lengths greater than 50 m are used.

2. The voltage of this power supply must comply with the Encoder Module requirements and not exceed 24 Volts DC.

3. The Encoder Module does not process any input from the encoder's Zero Pulse and the Inverted Zero Pulse. The terminals "Z" and "ZN" are provided for additional functionality, currently under development.

3   Installation

3.1   Prerequisites

3.1.1   Preparation of the Inverter

Caution

The Encoder Module will **only** function with the MICROMASTER 440 inverters and must have Version 2.0 or above software installed.

The version level of software install in the inverter can be confirmed by using one of the following procedures:

1. By accessing parameter r0018 which displays the current software version number.

2. By reading the Rating Label on the inverter as shown in Figure 3-1 below.

    The hardware version is indicated by the first three characters and the software version is indicated by the last three characters.
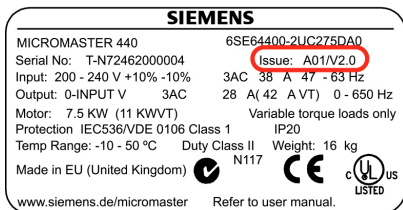

Figure 3-1 Inverter Rating Label

3.1.2   Preparation of the Encoder Module

The Encoder Module is mounted directly onto the MICROMASTER 440 input and output (I/O) board.

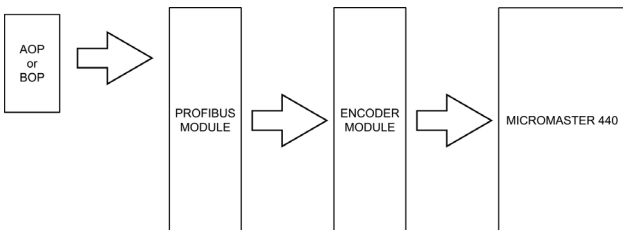Should more than one option be mounted on the inverter, the sequence shown in Figure 3-2 should be followed.

Figure 3-2 Option Mounting Sequence

Screening

To ensure the correct functioning of the encoder the guidelines listed below should be followed:

➢ Only twisted-pair screened cable should be used to connect the encoder to the Encoder Module.

➢ The cable screen must be terminated in the screen clamp of the Encoder Module as shown in Figure 3-3 below.

➢ If the encoder cable has a screen/earth/ground conductor, this should be terminated to the PE terminal of the Encoder Module.

➢ Signals cables must not be installed close to power cables.

Figure 3-3 Screen Clamp and PE Terminal

Connections

The MICROMASTER Encoder Module has 12 terminal connections, which are described in Table 3-1 below.

Table 3-1   Encoder Module Terminals

Terminal	Description
A	Channel A
AN	Channel A Inverted
B	Channel B
BN	Channel B Inverted
Z	Zero Pulse (not available. See Notes on page 5)
ZN	Zero Pulse Inverted (not available. See Notes on page 5)
18V	HTL Link Terminal (terminals LK & 18V only)
LK	Shaft Encoder Supply Voltage
5V	TTL Link Terminal (terminals LK & 5V only)
VE	Supply to Shaft Encoder
0V	Supply to Shaft Encoder
PE	Protective Earth

Encoder Status LED's

The MICROMASTER Encoder Module has three LED's, which indicate current operating status of the encoder module (see Figure 3-4 below).

Figure 3-4 Encoder Module LED's

The LED's have been designed to indicate a healthy or fault condition in the following areas:

➢ Channel A
➢ Channel B
➢ Zero Pulse

If the Encoder Module is working correctly the LED's will flash on and off as the shaft encoder is rotated. If a fault condition exists the LED's will either stop flashing and remain on or remain off.

NOTE

At high motor speeds the LED's appear permanently on – this is due to the high pulse rates.

Encoder DIP Switches

The DIP switches on the Encoder Module are provided to allow the user to select the correct settings for the encoder unit attached to the Encoder Module. See Figure 3-5 below.

Figure 3-5 Encoder Module DIP Switches

The settings of the DIP switches are explained in Table 3-2 below.

Table 3-2   DIP Switch Settings

DIP-Switch	1	2	3	4	5	6
Encoder Type						
TTL 120Ω Single-Ended Input	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
TTL Differential Input	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**
HTL >5 kΩ Single-Ended Input	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**
HTL Differential Input	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**

The default settings of the DIP switches allow the Encoder Module to be used with a HTL differential input encoder.

3.2   Examples of Connections

Figures 3-7, 3-8 and 3-9 show the various configurations of connection for the Encoder Module. A detailed description of the precise configurations of the encoder Module is given in Section 4 – Commissioning.

NOTE

The color-coding of the connection in the following Figures are for illustration purposes only and the actual colors will vary depending upon the type of cables used by the commissioning engineer.

Figure 3-6 shows a typical pulse encoder cable and how the encoder connections relate to the encoder terminals.

SIEMENS Rotary Pulse Encoder
1XP8001-1 / Up = 10 ... 30 V (HTL)
1XP8001-2 / Up = 5 V ± 10% (TTL)

Encoder Connector

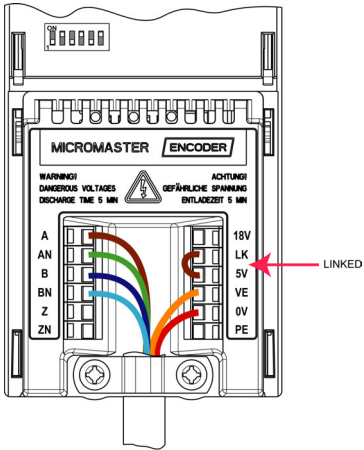| Encoder Connector Pin Designation	A	B	C	D	E	F	G	H	Schirm *Shield* blindag e *blindaje* schermo *skärm*	K	L	M
1xP8001 Encoder Designations	$\overline{U_{a2}}$	U_P	U_{a0}	$\overline{U_{a0}}$	U_{a1}	$\overline{U_{a1}}$	$\overline{U_{aS}}$	U_{a2}		0 V	0 V	U_P
MM4 Encoder Module Connections	BN	+24 V or +5 V	Z	ZN	A	AN	-	B		0 V	-	-

Figure 3-6 Typical Encoder Connections

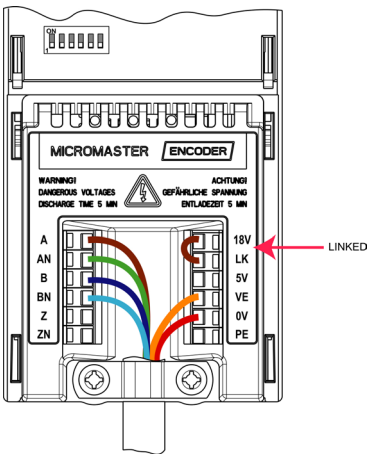Figure 3-7 TTL Encoder Connections (5V DC)
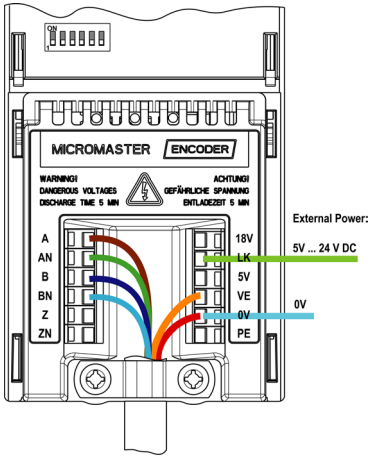

Figure 3-8 HTL Encoder Connections (18V DC)

Figure 3-9 Encoder with External Power Supply

4 Commissioning

⚠ **WARNING**

Before installing and commissioning, please read these safety instructions and warning carefully and all the warning labels attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.

➤ The inverter **MUST** be powered down before fitting the Encoder Module to the inverter.

➤ This equipment contains dangerous voltages and controls potentially dangerous rotating mechanical parts.

➤ Non-Compliance with Warnings or failure to follow the instructions contained in this manual can result in loss of life, severe personal injury or serious damage to property.

➤ Only suitably qualified personnel should work on this equipment, and only after becoming familiar with all safety notices and maintenance procedures contained in this manual.

➤ The user should be fully conversant with all warnings, cautions and notices contained within the MICROMASTER 440 Operating Instructions.

➤ The successful and safe operation of this equipment is dependent upon its proper handling, storage, installation, operation and maintenance.

➤ National safety regulations are also applicable.

The actions required to commission the MICROMASTER Encoder Module depend upon the type of encoder that is connected to the Encoder Module. These instructions will deal with each type of encoder individually.
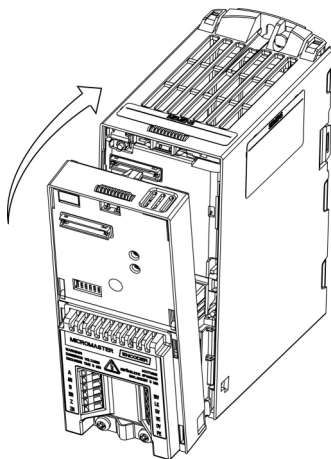

Figure 4-1 Fitting the Encoder Module

4.1   TTL Encoder

To commission the Encoder Module with a TTL Encoder, the following
procedure should be performed:

1.   Ensure the Inverter is switch off.
2.   Ensure the DIP-Switches have been set for the correct type of
      Encoder. See Table 3-2 on page 9.
3.   Fit the Encoder Module to the inverter as shown in Figure 4-1
      above.
4.   Connect the Channel A wire from the encoder to the 'A'
      terminal on the Encoder Module. See Figure 3-6 on page 9 and
      Figure 3-7 on page 10.
5.   Connect the Channel A inverted wire from the encoder to the
      'AN' terminal on the Encoder Module.
6.   Connect the Channel B wire from the encoder to the 'B'
      terminal on the Encoder Module.
7.   Connect the Channel B inverted wire from the encoder to the
      'BN' terminal on the Encoder Module.
8.   Connect terminals 'LK' and '5V' (see note) of the Encoder
      Module together (this terminal has short-circuit protection).
9.   Connect terminals 'VE' and '0V' of the Encoder Module to the
      power supply terminals of the encoder.
10.   Switch the Inverter ON.
11.   Proceed to Section 4.4 on page 15 for the parameterization
      procedure.

NOTES

➢ If the encoder type is a TTL differential and a long cable length is
  required (greater than 50 meters), DIP switches 2, 4, and 6 may be set
  to ON which enables the 120Ω terminating impedance.

➢ The 5 V terminal is a regulated supply to ±5%.

➢ The cable from the encoder to the Encoder Module should be one
  complete length.

➢ If the encoder type is a TTL single-ended encoder, there will only be a
  single wire for the 'A' Channel.

4.2   HTL Encoder

To commission the Encoder Module with a HTL Encoder, the following
procedure should be performed:

1.   Ensure the Inverter is switch off.
2.   Ensure the DIP-Switches have been set for the correct type of
      Encoder. See Table 3-2 on page 9.
3.   Fit the Encoder Module to the inverter as shown in Figure 4-1
      above.
4.   Connect the Channel A wire from the encoder to the 'A'
      terminal on the Encoder Module. See Figure 3-6 on page 9 and
      Figure 3-8 on page 11.
5.   Connect the Channel A inverted wire from the encoder to the
      'AN' terminal on the Encoder Module.

6.   Connect the Channel B wire from the encoder to the 'B' terminal on the Encoder Module.

7.   Connect the Channel B inverted wire from the encoder to the 'BN' terminal on the Encoder Module.

8.   Connect terminals 'LK' and '18V' (see note) of the Encoder Module together (this terminal has short-circuit protection).

9.   Connect terminals 'VE' and '0V' of the Encoder Module to the power supply terminals of the encoder.

10.   Switch the inverter ON.

11.   Proceed to Section 4.4 below for the parameterization procedure.

NOTE

➢ The 120Ω terminating impedance via the DIP switch must not be used in conjunction with an HTL encoder.

➢ The 18 V terminal is an unregulated supply to a maximum of 24 V.

➢ The cable from the encoder to the Encoder Module should be one complete length.

➢ If the encoder type is a TTL single-ended encoder, there will only be a single wire for the 'A' Channel.

4.3   External Power Supply

An external power supply has to be provided (See Figure 3-9 on page 11) for the proper operation of the Encoder Module, if:

➢   The encoder consumes a current of 140 mA or more at 18 to 24 V DC.

➢   The encoder consumes a current of 330 mA or more at 5 V DC.

➢   Cable lengths greater than 50 m are used.

The voltage of this power supply must comply with the Encoder Module requirements and not exceed 24 Volts DC.

The Encoder Module should be configured for the appropriate encoder type, either TTL or HTL and the power connections configured as shown in the Figures on pages 9, 10 and 11.

4.4   Encoder Module Parameterization

To enable the Encoder Module to function correctly with the inverter, the parameters in Table 4-1 below must be modified:

Table 4-1   Encoder Module Parameters

Param.	Name	Values		
r0061	Rotor Speed	Indicate the speed of the rotor. Used to check that the system is working correctly.		
r0090	Rotor Angle	Indicates the current angle of the rotor. This function is not available on single input channel encoders.		
P0400[3]	Encoder Type	0 = No Encoder		
		1 = Single Input Channel (A)		
		2 = Quadrature encoder without zero pulse (Channel A+B) - The term "Quadrature" means two periodic functions separated by a quarter cycle or 90 degrees.		
r0403	Status word of encoder	Displays status word of encoder in bit format:		
	Bit00	Encoder module active	0	No
			1	Yes
	Bit01	Encoder error	0	No
			1	Yes
	Bit02	Signal o.k.	0	No
			1	Yes
	Bit03	Encoder low speed loss	0	No
			1	Yes
	Bit04	HW timer used	0	No
			1	Yes
		Details: See description of seven-segment display given in the "Introduction to MICROMASTER System Parameters".		
P0408[3]	Encoder pulses per revolution	Specifies the number of encoder pulses per revolution.		
P0491[3]	Reaction on speed signal loss	Selects reaction on loss of speed signal. Settings: 0 = Do not change to SLVC 1 = Change to SLVC		
P0492[3]	Allowed speed difference	Used for high speed encoder loss detection. Selects the allowable difference in calculated speed signals between samples before it is considered to have lost the speed signal feedback. (Default = Calculated from inertia, range from 0 ... 100.00) Dependency: This parameter is updated when P345 Motor start-up time is changed or when a speed loop optimization is performed (P1960 = 1). There is a fixed delay of 40 mS before acting upon loss of encoder at high speeds. **Caution:** When Allowed speed difference is set to 0, then both high speed and low speed encoder loss detection is disabled, thus encoder loss will not be detected. If encoder loss detection is disabled and encoder loss occurs, then operation of the motor may become unstable.		

Param.	Name	Values
P0494[3]	Delay speed loss reaction	Used for low speed encoder loss detection. If the motor shaft speed is less than the value in P0492 then encoder loss is detected using a low speed encoder loss detection algorithm. This parameter selects the delay between loss of encoder at low speed and reaction to the encoder loss. (Default = Calculated from inertia, Range from 0 ... 64.000s) Dependency: This parameter is updated when P0345 Motor start-up time is changed or when a speed-loop optimization is performed (P1960 = 1). **Caution:** When this delay is set to 0, then low speed encoder loss detection is disabled and low speed encoder loss cannot be detected (high speed encoder loss detection will still operate if P0492 > 0). If low speed encoder loss detection is disabled and encoder should be lost at low speed, then operation of motor may become unstable.
P1300	Control Mode	21 = Closed loop speed control 23 = Closed loop torque control

⚠️ **WARNING**

- ➤ The "Flying Start" function of the MICROMASTER 440 inverter should only be used with a Quadrature Encoder.
- ➤ To perform a "Flying Start" the direction of the motor must be known to the encoder attached to the motor. A Single-Channel encoder cannot determine the direction of rotation of the motor; therefore it is **NOT** recommended that a "Flying Start" be performed when using a Single-channel encoder.

⚠️ **Caution**

1. Once the correct parameters values have been entered, it is recommended to operate the inverter in V/f mode (P1300=0) before speed/torque control with the encoder feedback is used and check that it functions correctly.

2. The user must observe the motor shaft to check the direction of rotation.

3. The direction of rotation must be checked against the value displayed in r0061.

4. If the direction of rotation does not match, then the output phases of the inverter or the encoder channels have to transposed to prevent unstable operation of the inverter in closed-loop control mode.

   Setting P1820 to 1 can be used to reverse the motor rotation without transposing the output phases.

NOTES

The encoder resolution (pulses per revolution) which may be entered will be limited by the maximum pulse frequency of the encoder option board (f_{max} = 300 kHz).
The following equation calculates the encoder frequency depending on the encoder resolution and the rotational speed (rpm). The encoder frequency has to be less than the maximum pulse frequency:

$$f_{max} > f = \frac{\text{Pulses per revolution x r.p.m.}[\frac{1}{min}]}{60}$$

Example: An Encoder may have 1024 pulses per revolution. It rotates at Nn= 2850 min -1. This delivers f = 48,64 kHz < fmax = 300kHz, therefore the Encoder can be used with the Encoder Module.

P0492 is measured in Hz per milliseconds. If the inverter output frequency varies faster than the maximum allowable change in output frequency, it will trip with a fault condition F0090.

5 Troubleshooting

There are two types of fault indication on the MICROMASTER Encoder Module:

> ➢ Three status LED's on the front panel for indicating the operational status of Channels A, B and Z (See Figure 5-1 below).
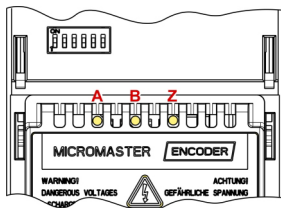> ➢ Fault code display specific to the Encoder Module on the AOP, BOP.

Figure 5-1 Encoder Module LED's

5.1   LED Indicators

The LED's monitor the continuity of the connections between the Encoder Module and the attached encoder.

Table 5-1 lists the possible conditions of the LED's and the remedial action required to resolve the fault condition.

NOTE

At high motor speeds the LED's appear permanently on – this is due to the high pulse rates.

Table 5-1 Encoder LED Display

LED	LED Condition	Meaning
All Channels	Flashing	Normal operating condition.
	Permanently ON	Fault condition has occurred or the Channel is not connected.
		Check the connections of the cables from the Encoder Module to the attached encoder.
	Permanently OFF	Fault condition has occurred.
		Check the connections of the cables from the Encoder Module to the attached encoder.

5.2   Fault Codes

The Encoder Module has only one fault code, which is – **F0090**. This condition occurs when the allowed frequency rate of change, set in P0492[3] is exceeded or when low speed encoder loss is detected.

NOTE

The reason for the encoder loss will be given in the level 3 parameter P0949:

- ➢ P0949 = 1 means encoder loss of channel A or channel B or channel A and channel B at high speed (shaft speed > P0492)
- ➢ P0949 = 2 means encoder loss of channel A or channel A and channel B at low speed (shaft speed < P0492)
- ➢ P0949 = 3 means encoder loss of channel B at low speed (shaft speed < P0492).

Should the encoder give a fault message **F0090** the following remedial action should be performed:

1. Check that an encoder is fitted. If the encoder is not fitted, set P0400=0 and select SLVC mode (P1300 = 20 or 22).
2. Check the connections between the encoder and the inverter.
3. Check the encoder is not faulty (select P1300 = 0 and run at a fixed speed then check the encoder feedback signal using r0061). Check for correct magnitude and direction of speed.
4. Increase the encoder loss threshold in P0492.
5. Increase encoder low speed loss detection delay in P0494.

6 Technical Specifications

Table 6-1   Technical Specifications

Operating Temperature	-10 ºC to +50 ºC
Storage Temperature	-40 ºC to +70 ºC
Humidity	95% relative humidity non-condensing
Maximum Pulse Frequency	300 kHz
Pulses per Revolution	Up to 5000
TTL and HTL selection	Via Link Wire
Degree of Protection	IP20
Encoder Power Supply	5 V (±5%) @ 330 mA or 18 V Unregulated @ 140mA short circuit proof
Dimensions	164 mm (h) x 73 mm (w) x 42 mm (d)

Drawing Number:

A 5 E 0 0 1 4 6 7 0 8 A 2

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