

Variable Frequency Drive (VFD)

U1000 Industrial Matrix Drive

Mechanical Specification Submittal

# GENERAL

The U1000 Industrial Matrix configured package combines excellent harmonics, input power factor control, full regeneration, and energy saving in a design specifically suited for use in industrial applications requiring reliable motor control.

The configured package provides a U1000 industrial matrix drive in a NEMA 1 (UL Type 1) enclosure with a lockable input disconnect. The U1000 Industrial Matrix is a high performance PWM (pulse-width-modulated) AC drive. Three-phase input line power is converted to a sine-coded, variable frequency output, which provides optimum speed control of any conventional squirrel cage induction motor.

This drive has one control logic board for all horsepower ratings. Printed circuit boards employ surface mount technology, providing both high reliability, and small physical size. The dual 32 bit microprocessors deliver the computing power necessary for complete three phase motor control.

Operating Principle: VFD input three phase power is directly converted to variable AC output power. The main circuit consists of a compact input filter and bidirectional switches. Using pulse width modulation (PWM) inverter technology, produces an output waveform in a series of variable-width pulses. Unique firmware algorithms optimize motor magnetization through control of voltage, current and frequency applied to generate a nearly sinusoidal output waveform.

# STANDARDS (Drive)

UL 508C (Power Conversion)

CE mark 2006/42/EC MD

CE mark 2014/35/EU LVD

CE mark 2014/30/EU EMC

CE mark 2011/65/EU RoHS

EN 61800-3

EN 61800-5-1 (LVD)

EN 62061 (SIL CL3)

EN ISO 13849-1 (Cat 3, PLe)

EN 61800-5-2 (SIL3)

EN 61800-6-2

EN 50581

UL, cUL listed; CE, RCM, TUV marked

# CONFIGURED PANEL SERVICE CONDITIONS

Ambient service temperature:

Open Chassis (IP00): -10°C to 50°C (14°F to 122°F)

IP20, UL Type 1: -10°C to 40°C (14°F to 104°F)

Ambient storage temperature: -20°C to 60°C (-4°F to 158°F)

Humidity: 95% RH or less, non-condensing

Vibration/Shock:

10 to 20 Hz: 9.8 m/s² 20 to 55 Hz: 5.9 m/s² (2☐0028 to 2☐0081 and 4☐0011 to 4☐0077), 2.0 m/s² (2☐0104 to 2☐0248 and 4☐0096 to 4☐0414)

Altitude: Up to 1000 meters (3300 feet), higher by derating

Service factor: 1.0

# QUALITY ASSURANCE

In circuit testing of all printed circuit boards is conducted, to ensure proper manufacturing.

Final printed circuit board assemblies are functionally tested, via computerized test equipment.

All fully assembled controls are computer tested with induction motor loads to assure unit specifications are met.

The average MTBF (Mean Time Between Failure) is 28 years

# CONSTRUCTION (Drive)

Matrix technology employs a main power circuit consisting of embedded input line semiconductor fuses, a compact input filter and a system of 9 bi-directional switches that are arranged in a matrix, to convert a three-phase AC input voltage directly into a three-phase AC output voltage. It eliminates the need for a rectifying and DC smoothing circuit, which are used in traditional AC drive “inverters”. This results in a compact drive with reduced harmonic distortion.

Power and control electronics housings:

Open Chassis (IP00):

 240 V, Normal Duty: 10 HP through 100 HP

 Heavy Duty: 7.5 HP through 75 HP

 480 V, Normal Duty: 7.5 HP through 800 HP

 Heavy Duty 5 HP through 750 HP

Microprocessor based control circuit

Non-Volatile memory (EEPROM); all programming memory is saved when the VFD is disconnected from power.

Current transformers detect the output current for motor control and protective functions

Digital operator keypad and display, with copy function, provides local control and readout capability:

 Local/Remote

 Speed Reference command

 Reset command

Easy to remove heat sink cooling fan with programmable on/off control

USB Type B port for quick and easy PC Connection

# PROTECTION

Integrated Input Semiconductor Fusing Provides 100kA SCCR

Output current overload rating of 150 % of drive’s continuous heavy duty current rating for 60 seconds or 110% of drive’s continuous normal duty current rating for 60 seconds

Output short circuit protection

Current limited stall prevention (overload trip prevention) during acceleration, deceleration, and run conditions

Optically isolated operator controls

Fault display, last 10 faults storage, and detailed fault trace

“Hunting” prevention logic

Electronic ground fault protection

Electronic thermal motor overload protection (UL approved)

Power supply charge indication

Heat sink over temperature protection

Cooling fan operating hours recorded

Input/Output phase loss protection

Reverse prohibit capability

Short circuit withstand rating (SCCR) of 100K amps RMS

# OPERATION

Output frequency and speed display can be programmed for other speed-related and control indications, including: Hertz, revolutions per min (RPM), percent of maximum, or custom.

Power loss ride-thru (2 seconds or greater capable)

Time delay on start, peak avoidance

VFD accepts either a direct acting or a reverse acting speed command signal, i.e. a bi-polar speed command signal.

Bi-directional “Speed Search” capability, in order to start into a rotating load. Two types: current detection and residual voltage detection

DC injection braking, to prevent, for example, fan “wind milling”

Remote Run/Stop command input

Two programmable 0 to +/-10 VDC or 4-20ma analog outputs, proportional to drive monitor functions including: output frequency, output current, output power, PI feedback, output voltage and others…

5-Line 16 Character LCD display provides readout functions that include: output frequency, output voltage, output current, output power, DC bus voltage, interface terminal status, PI feedback and fault status.

Programmable industrial specific application macros

Over 100 programmable functions, resettable to factory presets

User parameter initialization, re-establish project specific parameters

Ramp-to-stop or coast-to-stop selection

Auto restart capability: 0 to 10 attempts with adjustable delay time between attempts

Flexible motor control: one custom selectable Volts/Hertz pattern and multiple preset Volts/Hertz patterns, Open loop vector control and closed loop vector control for induction machine and permanent magnet motors (IPM & SPM).

Auto speed reference input signal, adjustable for bias and gain

While the VFD is running, operational changes in control and display functions are possible, including:

 Acceleration time (0 to 6000 seconds)

 Deceleration time (0 to 6000 seconds)

 Frequency reference command

 Local/remote commands

 Monitor display

 Removable digital operator

Automatic energy saving, reduced voltage operation

# PRODUCT FEATURES

Full 100% continuous regenerative operation

Low Input Current Harmonics at All Speeds/Loads

Facilitates IEEE 519 Compliance

Higher Efficiency than Common Low Harmonic Solutions

VFD efficiency: 96% at half-speed; 98% at full-speed

Eliminate Harmonics with Embedded Across-the-Line Operation

Near Unity True Power Factor at Full Load (0.98 or better)

Industry-leading compact design

Integrated Input Fusing Provides 100kA SCCR

High Reliability with MTBF in Excess of 28 Years

Induction and Permanent Magnet Motor Control

Safe Torque Off (SIL3 and PLe)

0-400 Hz Output Frequency

120% Overload for 60 Seconds (ND)

150% Overload for 60 Seconds (HD)

Removable Terminal Block

High Carrier Frequency (Low Motor Noise) Capability

Multi-Language LCD Display with Copy Function

DriveWizard® Industrial Programing Software

Embedded PLC capability (DriveWorks EZ)

Start into Spinning Motor (Speed Search)

Open/Closed loop motor operation

Input phase insensitive; sequencing of the three phase input is unnecessary

Volt meter, ammeter, kilowatt meter, elapsed run time meter, and heat sink temperature monitoring functions

PI feedback Control

Feedback signal low pass filter

Feedback signal loss detection and selectable response strategy

Feedback signal inverse

24 Vdc, 150ma transducer power supply

Input and output terminal status indication

Diagnostic fault indication

 “S-curve” soft start / soft stop capability

Run/Fault output contacts

Serial communication loss detection and selectable response strategy

“Up/Down” floating point control capability (digital MOP)

Critical frequency rejection capability: 3 selectable, adjustable bandwidths

Remote speed reference (speed command) signal:

 0 to10 VDC / -10 to +10 VDC (20 kΩ)

 4 to 20 mA / 0 to 20mA DC (250 Ω)

Adjustable carrier frequency, from 4 kHz to 10 kHz

Programmable security code

16 preset speed references/commands

8 programmable multi-function input terminals (24Vdc) providing 60+ programmable features, including:

Preset Speeds

Customer Fault

Fault reset

Speed/Torque control Switch over

External Baseblock

Jog Control

3 programmable multi-function output relays (2 Form A and 1 Form C) rated 1 amps @ 250Vac & 30Vdc), providing 50+ functions, including:

 During Run

 Zero Speed

Speed Agree

Overtorque / undertorque detection

Serial communication status

One fixed “Fault” form C output relay (Rated 1 amps @ 250Vac & 30Vdc)

Built-in Modbus RTU communication

Protocols are accessible via RS-422/485 communication, which is standard

Stationary and Rotational motor auto-tuning

Motor Control Methods Include:

V/f Control

V/f Control with encoder feedback

Open loop vector

Closed loop vector

Open loop vector for PM

Closed loop vector for PM

Advanced open loop vector for PM

Motor Types:

Induction Machines

Surface Permanent Magnet (SPM) Motors

Interior Permanent Magnet (IPM) Motors

Temperature controlled fans

Side by side mounting

LCD keypad: Local/remote functions with a built-in copy feature

Flash upgradeable firmware

Customizable monitor display

Heat sink over temperature speed fold-back feature

Fan failure detection and selectable drive action

# FIELD INSTALLABLE OPTIONS

Network communication options include:

DeviceNet™ w/ ADR

EtherNet IP (single and dual Port)

EtherCAT

MECHATROLINK-II

MECHATROLINK-III

Modbus TCP/IP (single and dual Port)

PROFIBUS DP

PROFINET

Analog Input Option for high speed reference resolution

120VAC Logic Interface (8-input) option

Digital Input option for high speed reference resolution (8, 12, or 16 Bit).

Analog output option for high monitor reference resolution

Analog output option for high monitor reference resolution

Digital output expansion option (8 additional outputs)

Motor Feedback, including, open collector, line driver, and resolver