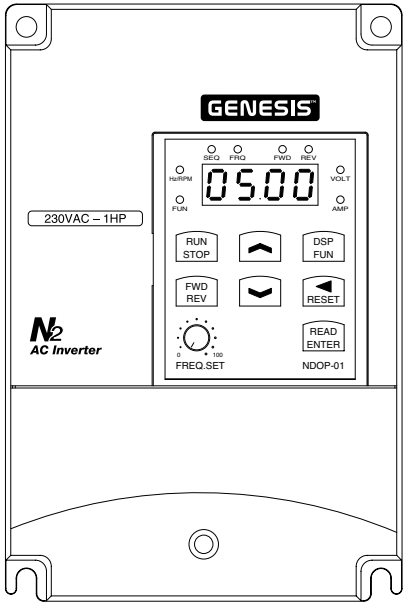
INSTALLATION AND OPERATION MANUAL

KBN2 DIGITAL AC ADJUSTABLE SPEED DRIVES

for Use with 1/2 - 30 HP Inverter Duty, TEFC and TENV 3-Phase Induction Motors

208/230 or 380 - 460 Volts, 50/60 Hz, 1 & 3 Phase AC Line Input



CE *

C-Tick *
N10980

c UL us
LISTED 16KJ.
POWER CONV.EQ
E177007

ISO 9002

Note: *This drive has been programmed to operate 60 Hz motors. For 50 Hz motor operation, see Section VIII-C-2, on page 32.*

* *See Note 1, on page 10.*

This Manual Covers Models:

KBN2-2250-1, 2201-1, 2202-1, 2203-1, 2305-1, 2307-1, 2310-1, 2315-1, 2320-1, 2330-1, 4301-1, 4302-1, 4303-1, 4305-1, 4307-1, 4310-1, 4315-1, 4320-1, 4330-1

See Safety Warning on page 6

The information contained in this manual is intended to be accurate. However, the manufacturer retains the right to make changes in design which may not be included herein.

GENESIS™
Automation and Control

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i. SIMPLIFIED INSTRUCTIONS

IMPORTANT – You must read these simplified operating instructions before proceeding. These instructions are to be used as a reference only and are not intended to replace the detailed instructions provided herein. You must read the Safety Warning, on page 6, before proceeding.

It is recommended that this drive be used with Inverter Duty or TENV motors which provide full rated torque over an extended speed range without overheating. If external fan cooling is provided, open-ventilated motors can also achieve an extended speed range at full rated torque. A box fan or blower with a minimum of 100 CFM per HP is recommended. Mount the fan such that the motor is surrounded by the airflow.

Application Information – Some motors have low speed characteristics which cause overheating and winding failure under light or no load conditions. If the motor is operated in this manner for an extended period of time, it is recommended that the unloaded motor current be checked from 2 - 15 Hz (60 - 450 RPM) to ensure that the motor current does not exceed the nameplate rating. Do not use motor if the motor current exceeds the nameplate rating.

Note: **This drive has been programmed to operate 60 Hz motors. For 50 Hz motors, see Section VIII-C-2, on page 32.**

WARNING! Disconnect the main power when making connections to the drive.

Note: *It is recommended that the bus capacitors be reconditioned if this product has been in storage for over one year. To recondition the capacitors, apply the AC line, with the control in the Stop Mode, for a minimum of one hour.*

A. AC Line Connection – Connect the AC line to Terminals L1, L2 (for single phase AC line input) or L1, L2, L3 (for 3-phase AC line input), of Terminal Block TM1, as described in Section IV-A, on page 16. Be sure the AC line input voltage matches the drive rated input voltage. See Section VIII-C-3, on page 32.

B. Ground Connection – Connect the ground wire (earth) to the ground screw as shown in Figures 3A, 3B, and 3C, on pages 16 and 17.

C. AC Line Fusing – Install a fuse or circuit breaker in the AC line (a magnetic contactor is recommended for models with 3-phase AC line input). Fuse each conductor that is not at ground potential. See Section VI, on page 25, for recommended ratings.

D. Motor Connection – Connect the motor to Terminals T1 (U), T2 (V), T3 (W) of Terminal Block TM1, as shown in Figures 3A, 3B, and 3C, on pages 16 and 17, and as described in Section IV-C, on page 17. Motor cable length should not exceed 100 feet (30 m) - special reactors may be required - contact the Sales Department.

E. Power Up and Basic Keypad Operation – When applying power to the drive, the Drive AC Line Input Voltage Setting [F030] will flash four times on the display and the VOLT LED will flash. The set frequency (factory setting is “05.00”) will then flash on the display, the VOLT LED will turn off, and the Hz/RPM LED will flash. To increase the motor speed, press the key until the desired frequency is displayed. To decrease the motor speed, press the key until the desired frequency is displayed. Press the RUN/STOP key to start the drive.

ii. SAFETY WARNING

Definition of Safety Warning Symbols

Electrical Hazard Warning Symbol – Failure to observe this warning could result in electrical shock or electrocution.

Operational Hazard Warning Symbol – Failure to observe this warning could result in serious injury or death.

This product should be installed and serviced by a qualified technician, electrician, or electrical maintenance person familiar with its operation and the hazards involved. Proper installation, which includes wiring, mounting in proper enclosure, fusing or other over current protection, and grounding can reduce the chance of electrical shocks, fires, or explosion in this product or products used with this product, such as electric motors, switches, coils, solenoids, and/or relays. Eye protection must be worn and insulated adjustment tools must be used when working with control under power. This product is constructed of materials (plastics, metals, carbon, silicon, etc.) which may be a potential hazard. Proper shielding, grounding, and filtering of this product can reduce the emission of radio frequency interference (RFI) which may adversely affect sensitive electronic equipment. If further information is required on this product, contact the Sales Department. It is the responsibility of the equipment manufacturer and individual installer to supply this Safety Warning to the ultimate end user of this product. (SW effective 11/1992).

This drive contains electronic Start/Stop circuits that can be used to start and stop the drive. However these circuits are never to be used as safety disconnects since they are not fail-safe. Use only the AC line for this purpose.

Be sure to follow all instructions carefully. Fire and/or electrocution can result due to improper use of this product.

This product complies with all CE directives pertinent at the time of manufacture. Contact the Sales Department for Declaration of Conformity. (See Note 1, on page 10.)

I. INTRODUCTION

Thank you for purchasing the GENESIS™ KBN2 Series Inverter. KB Electronics, Inc. is committed to providing total customer satisfaction by providing quality products that are easy to install and operate.

The KBN2 series of industrial inverters are designed for 3-phase induction motors thru 30 HP. Housed in NEMA-1 enclosures, they are available with 208/230 and 380/460 Volts AC - 50/60 Hz AC line input. The drives contain a remote mountable digital keypad with a 4-digit LED display and “status” indicators. In addition to output frequency, the display can be programmed to indicate a variety of functions including motor voltage and current, RPM, and custom units (Line Speed).

An isolated multifunction terminal block provides for external control of all drive operations. The start/stop circuitry can be wired in several ways, including 2-wire and 3-wire start/stop. In addition, three multifunction input terminals are programmable for a variety of functions including 7 preset speeds with timers and sequence control. An output relay and open collector output can also be programmed to allow monitoring of various parameters.

Analog input signal following for 0 - 5 VDC, 0 - 10 VDC, 0 - 20 mADC, 4 - 20 mADC, and custom input signals are also provided.

Other features include custom accel/decel curves, DC injection and dynamic braking, auto/manual restart, and 0 - 400 Hz operation, 1 - 12 kHz switching frequency, slip compensation, and PC Windows® based RS-232/485 DriveLink™ communications.

The KBN2 contains protection features designed to prevent drive and/or motor failure due to overload, phase-to-phase and phase-to-ground short circuit, over voltage, undervoltage, and overtemperature. The fault codes are shown in the digital display. All models are UL approved (USA and Canada) and 0.5 - 3 HP @ 230 Volts AC and all 460 Volt AC models are CE and C-tick (N10980) approved.

STANDARD FEATURES

- **Digital Keypad with 4-Digit LED Display and Status Indicators –** Used for drive operation (Start/Stop, Forward/Reverse, and Frequency change), programming, and provides indication of drive status (Frequency, Custom Units, Functions, Fault Codes). Contains built-in Speed Potentiometer.
- **Regenerative and DC Injection Braking –** Provides controlled rapid stopping.
- **Barrier Terminal Blocks –** Separate terminal blocks for power (AC line, motor) and external signal input wiring (potentiometer, multifunction input/output terminals, voltage/current following).
- **3 Multifunction Control Inputs –** Provides selection of 7 Preset Speeds, Jog, Stop, and 11 other functions.
- **External Forward-Stop-Reverse Control –** Provides external control of motor direction and run/stop (Forward/Stop, Reverse/Stop and Run/Stop, Forward/Reverse), and 3-wire start/stop.
- **Isolated External Signal Inputs –** Provides isolated terminals for external signals to control the drive output frequency (5 kΩ potentiometer, 0 - 5 VDC, 0 - 10 VDC, 0 - 5 VDC, 0 - 20 mADC, 4 - 20 mADC). Functions F026 - F029 are used to scale the drive for a wide range of input signals.
- **Multifunction Output Relay –** Provides normally open or normally closed relay contacts for indication of Auto Start, Power Loss, Rapid Stop, Coast-to-Stop, Overtorque, and Electronic Overload Protection.
- **Output Frequency Upper Limit –** Provides adjustment of output frequency upper limit (0.01 - 400.0 Hz).
- **Output Frequency Lower Limit –** Provides adjustment of output frequency lower limit (0.00 - 400.0 Hz).
- **Acceleration and Deceleration Time –** Provides adjustment of acceleration and deceleration time (0.1 - 3600 seconds). A second acceleration and deceleration time is available using the multifunction input terminals.

- **Operates 60 Hz and 50 Hz Motors –** Provides tailoring of the drive for 50 Hz or 60 Hz motors (factory set for 60 Hz motors).
- **Analog Output Voltage –** Provides connections for a 0 - 10 Volt DC analog output voltage proportional to the various drive functions (F046 is factory set to "0000" [Output Frequency]).
- **Slip Compensation and Preset Volts/Hz Curves with Program Modification –** Allows tailoring the drive for constant torque, variable torque (HVAC), and widely changing loads.
- **Voltage/Current Jumper –** Provides selection of voltage/potentiometer or current signal input.
- **Approvals –** UL (USA and Canada), CE, C-tick (N10980), ISO-9002. (See Note 1, on page 10.)

PROTECTION FEATURES (Fault Codes are Displayed)

- **Overvoltage and Undervoltage Protection –** Shuts down the drive if the line voltage goes above or below the operating range.
- **Regeneration Protection –** Eliminates tripping due to bus overvoltage caused by rapid deceleration of high inertial loads.
- **Trip Protection –** Prevents the motor from tripping during startup of high inertial loads.
- **Short Circuit Protection –** Shuts down the drive if a short circuit occurs at the motor (phase-to-phase or phase-to-ground).
- **Electronic Motor Overload Protection (I^2t) –** Provides motor overload protection, which prevents motor burnout and eliminates nuisance trips due to momentary overloads.
- **Electronic Drive Overload Protection (I^2t) –** Shuts down the drive if the load current exceeds the drive rating.
- **Overtemperature Protection –** Shuts down the drive if the temperature exceeds safe limits.

OPTIONAL ACCESSORIES (See Section X, on page 79)

- **RFI Filters –** Provide RFI suppression to meet CE and C-tick requirements.
- **Brake Resistor Kit (1 - 10 HP Models) –** Provides rapid stopping of the drive.
- **Digital Keypad Extension Cable Kit –** 3 Ft. (1 M), 6 Ft. (2 M), and 10 Ft. (3 M) extension cables provide remote mounting of the keypad.
- **Remote Speed Potentiometer Kit –** Allows remote mounting of the (5 kΩ) speed potentiometer to control motor speed.
- **RS-232 or RS-485 Communication Kits –** Provide PC Windows® based RS-232/485 DriveLink™ communications to facilitate programming.
- **DownLoad Module™ (DLM) –** Programming device uploads and downloads drive programs.

TABLE 1 – MODEL NUMBER IDENTIFICATION

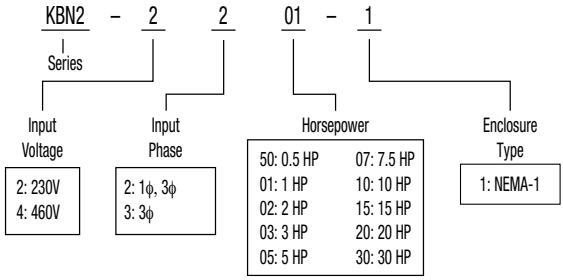


TABLE 2 – GENERAL PERFORMANCE SPECIFICATIONS

Description	Specification	Factory Setting
AC Line Input Voltage (VAC)	208/230 (-10%, +15%), 380 - 460 (±10%)	220.0 / 460.0
Input AC Line Frequency Range (Hz)	48 - 62	—
Output Waveform	Sine Coded PWM	—
Frequency Range (Hz)	0.01 - 400.0	60
Switching Frequency Range (kHz)	1 - 12	10
Frequency Resolution (Hz Increments)	0.01 up to 100 Hz and 0.1 above 100 Hz	—
Acceleration/Deceleration Range (Seconds)	0.1 - 3600	5
Overvoltage Trip Point @ 230 VAC, @ 460 VAC (VAC)[1]	290, 580	—
Undervoltage Trip Point @ 230 VAC, @ 460 VAC (VAC)[1]	140, 280	—
Overload Rating (% for 1 Minute)	150	—
Output Frequency Lower Limit Range (Hz)	0.0 - 400.0	0
Output Frequency Upper Limit Range (Hz)	1.0 - 400.0	60
Braking Torque without Braking Resistor (%)	20	20
Braking Torque with Braking Resistor (%) [2]	20 - 100	20
Operating Temperature Range (ºC)	-10 to 50 [3]	—
Humidity (Relative, Non-Condensing) (%)	0 - 95	—
Maximum Vibration (G)	0.5	—
Output Relay Contact Rating (Terminals 1, 2)	1 Amp @ 30 Volts DC, 250 Volts AC	—
Open Collector Output Rating (Terminals 10, 11)	5 mA at 35 VDC	—
External Analog Signal Input	0 - 5 VDC, 0 - 10 VDC, 0 - 20 mADC, 4 - 20 mADC [4], Scalable	0 - 10 VDC
External Speed Potentiometer (Ω)	5k or 10k	—
Analog Output Voltage (Volts DC)[5]	0 - 10	—

Notes: 1. *Based on 230/460 Volts nominal AC line input voltage.* ***2.*** *Models KBN2-2250-1, 2201-1, 2202-1, 2203-1, 2305-1, 2307-1, 2310-1, 4301-1, 4302-1, 4303-1, 4305-1, 4307-1, 4310-1 require optional Brake Resistor to achieve maximum braking. Braking resistor option is not available on other models.* ***3.*** *In order to achieve 50 C maximum ambient temperature at full drive rating, the top dust cover on all models thru 10 HP must be removed. Drive rating with the cover installed is 40 C.* ***4.*** *To set the drive for 4 - 20 mADC input, F011 must be set to "0002", F027 must be set to "0020", and the jumper must be installed in the "2-3" position of Jumper JP1.* ***5.*** *Proportional to the mode setting. See Section IX, Functions F045 and F046, on pages 62 and 63. (maximum allowable load current is 1 mADC)*

TABLE 3 – ELECTRICAL RATINGS

Model No.[1]	Part No.	Rated Horsepower HP	Rated Horsepower kW	Nominal AC Line Input Voltage [2] (Volts AC - 50/60 Hz)	Maximum AC Line Input Current (Amps AC)	Phase Input (ϕ)	Nominal Output Voltage [3] (Volts AC)	Maximum Continuous Output Load Current (RMS Amps/Phase)	Pkg. Ref.
KBN2-2250-1	12000	.5	.37	230	7.5, 4.5[4]	1, 3	0 - 230	3.1	D
KBN2-2201-1	12010	1	.75	230	11.0, 6.5[4]	1, 3	0 - 230	4.5	
KBN2-2202-1	12020	2	1.5	230	19.0, 11[4]	1, 3	0 - 230	7.5	E
KBN2-2203-1	12030	3	2.2	230	27.0, 16.0[4]	1, 3	0 - 230	10.5	F
KBN2-2305-1	12040	5	3.7	230	19	3	0 - 230	17.5	
KBN2-2307-1	12050	7.5	5.6	230	29	3	0 - 230	26	G
KBN2-2310-1	12060	10	7.5	230	39	3	0 - 230	35	
KBN2-2315-1	12070	15	11	230	54	3	0 - 230	49	H
KBN2-2320-1	12080	20	15	230	70	3	0 - 230	64	
KBN2-2330-1	12090	30	22	230	96	3	0 - 230	87	
KBN2-4301-1	12100	1	.75	460	2.3	3	0 - 460	2.3	E
KBN2-4302-1	12110	2	1.5	460	3.8	3	0 - 460	3.8	
KBN2-4303-1	12120	3	2.2	460	5.2	3	0 - 460	5.2	F
KBN2-4305-1	12130	5	3.7	460	8.8	3	0 - 460	8.8	
KBN2-4307-1	12140	7.5	5.6	460	14	3	0 - 460	13	G
KBN2-4310-1	12150	10	7.5	460	19	3	0 - 460	17.5	
KBN2-4315-1	12160	15	11	460	28	3	0 - 460	25	H
KBN2-4320-1	12170	20	15	460	35	3	0 - 460	32	
KBN2-4330-1	12180	30	22	460	53	3	0 - 460	48	

Notes: 1. *Models KBN2-2305-1, 2307-1, 2310-1, 2315-1, 2320-1, and 2330-1 are not CE and C-tick compliant.* ***2.*** *Actual drive input voltage is set by Function F030. See Section VIII-C-3, on page 32.* ***3.*** *The maximum output voltage is equal to the AC line input voltage.* ***4.*** *Indicates 1ϕ, 3ϕ AC line input current.*

Application Note: A 3ϕ rated drive can be used on 1ϕ AC line input by using the next higher HP rating. However, the AC line current will be approximately 1.7 times higher than the 3ϕ rated AC line input current. Example, a 15 HP rated drive (KBN2-2315-1) can be used on a 10 HP motor with 1ϕ AC line input. The AC line input current, at full load, would be 66 amps (39 x 1.7). Connect the 1ϕ AC line to Terminals L1 and L2 of Terminal Block TM1.

FIGURE 1A – MECHANICAL SPECIFICATIONS (Inches / mm)
for Models KBN2-2250-1, 2201-1 (Pkg. D)
(Remove Top Cover for 50 °C Rating)

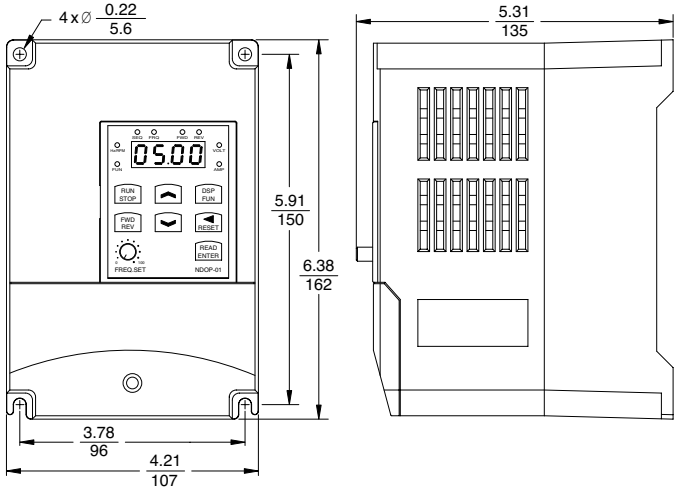


FIGURE 1B – MECHANICAL SPECIFICATIONS (Inches / mm)
for Models KBN2-2202-1, 4301-1, 4302-1 (Pkg. E)
(Remove Top Cover for 50 °C Rating)

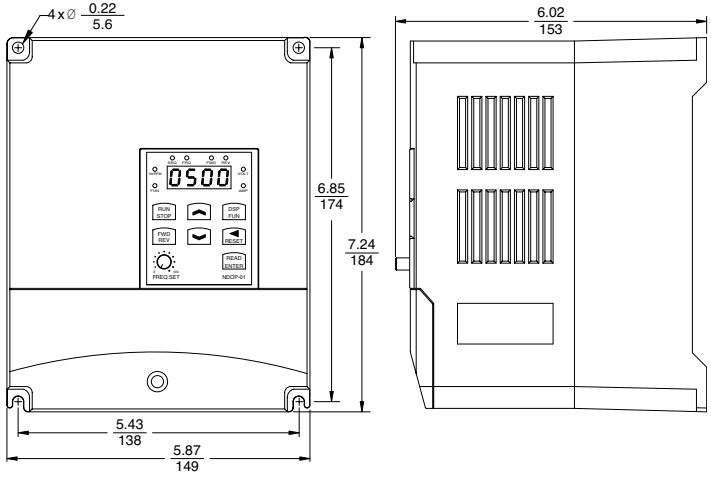


FIGURE 1C – MECHANICAL SPECIFICATIONS (Inches / mm)
for Models KBN2-2203-1, 2305-1, 4303-1, 4501-1 (Pkg. F)
(Remove Top Cover for 50 °C Rating)

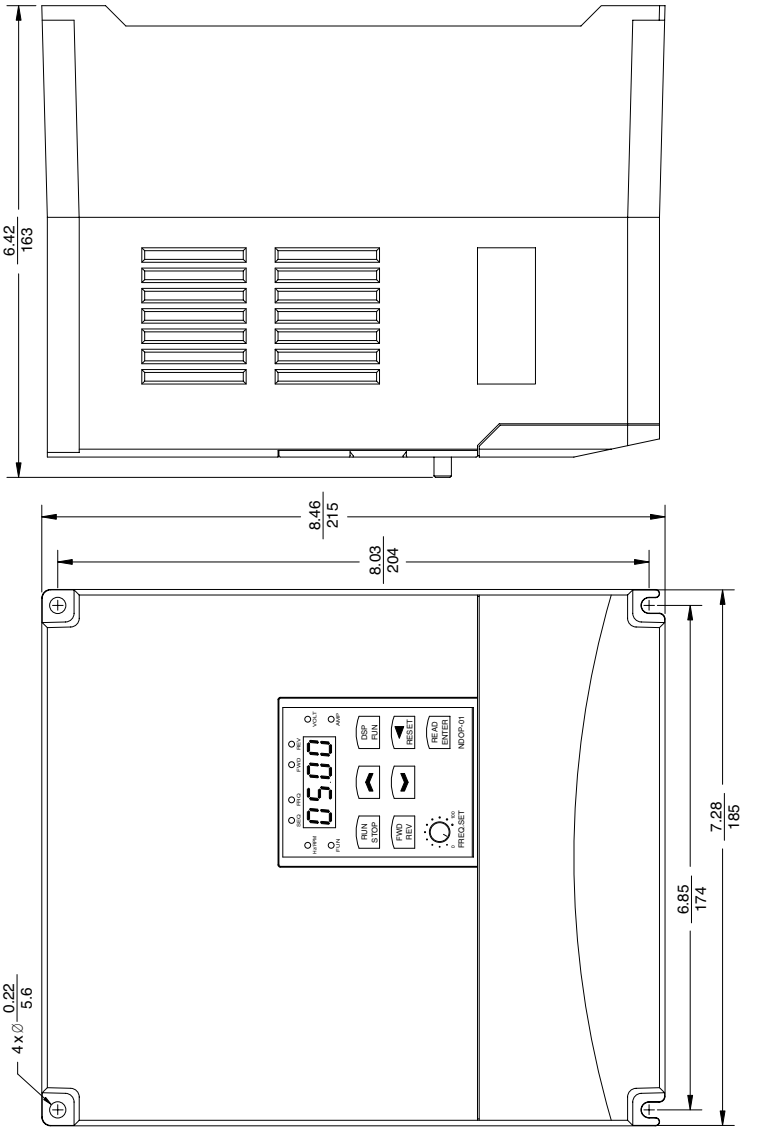


FIGURE 1D – MECHANICAL SPECIFICATIONS (Inches / mm)
for Models KBN2-2307-1, 2310-1, 4307-1, 4310-1 (Pkg. G)
(Remove Top Cover for 50 °C Rating)

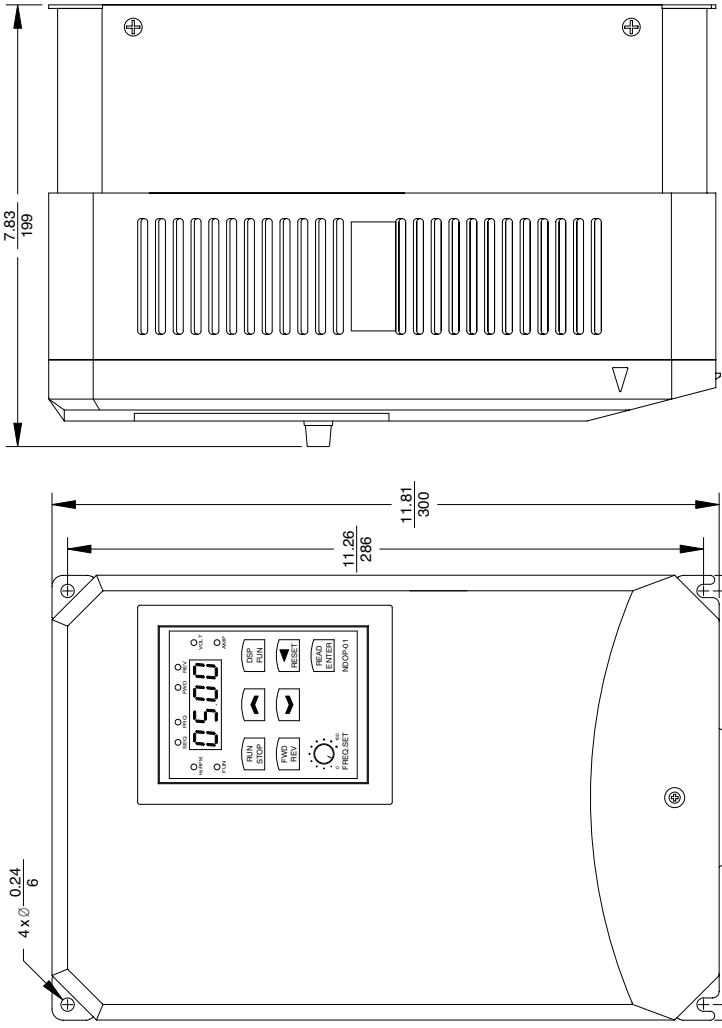
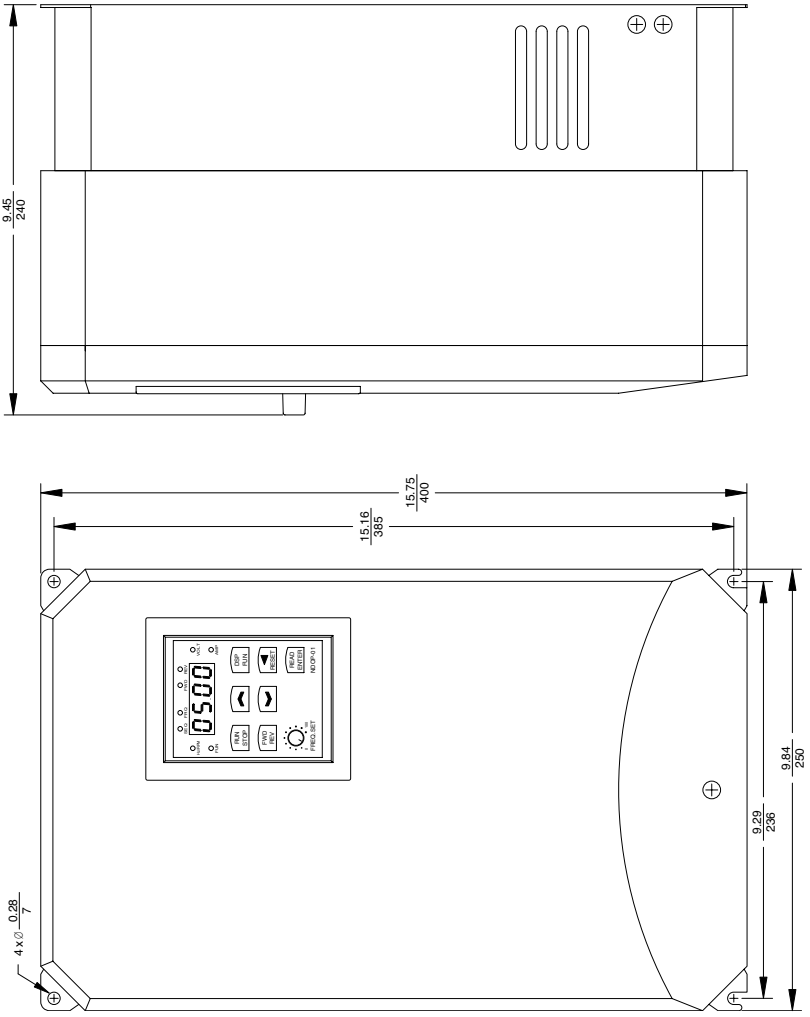


FIGURE 1E – MECHANICAL SPECIFICATIONS (Inches / mm)
for Models KBN2-2315-1, 2320-1, 2330-1, 4315-1, 4320-1, 4330-1 (Pkg. H)



II. MOUNTING INSTRUCTIONS

It is recommended that the drive be mounted vertically on a flat surface with adequate ventilation. Leave enough room below the drive to allow for AC line, motor connections, and other wiring that is required. Care should be taken to avoid extreme hazardous locations where physical damage can occur. When mounting the drive in an enclosure, the enclosure must be large enough to allow for proper heat dissipation so that the ambient temperature does not exceed 50 ºC. See Figures 1A -1E, on pages 11 - 14.

Note: *The top cover, on all models thru 10 HP, must be removed to achieve 50 ºC ambient temperature at full drive rating. Rating with cover installed is 40 ºC. All other models are rated 50 ºC.*

III. RECONDITIONING THE BUS CAPACITORS

It is recommended that the bus capacitors be reconditioned if this product has been in storage for over one year. To recondition the capacitors, apply the AC line, with the control in the Stop Mode, for a minimum of one hour.

IV. TERMINAL BLOCK TM1 WIRING INSTRUCTIONS (Power Connections)

WARNING! Read Safety Warning, on page 6, before using this drive. Disconnect the main power when making connections to the drive.

For Terminal Block TM1 wiring information, see Table 4, on page 16.

FIGURE 2A – PKG. D, E, F, G
TERMINAL BLOCK TM1 DESIGNATION

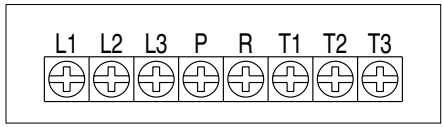
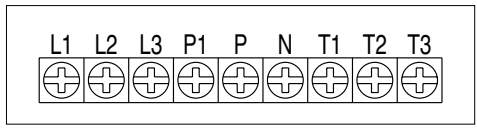


FIGURE 2B – PKG. H
TERMINAL BLOCK TM1 DESIGNATION



Important Application Note – To avoid erratic operation, do not bundle the AC line and motor wires with wires from signal following, start/stop contact, or any other signal wires. Also, do not bundle motor wires from multiple drives in the same conduit. Use shielded cables on all signal wiring over 12" (30 cm). The shield should be earth grounded on the drive side only. Wire the drive in accordance with the National Electrical Code requirements and other local codes that may apply. See Figures 3A, 3B, and 3c, on pages 16 and 17.

Be sure to properly fuse each AC line input conductor that is not at ground potential. Do not fuse neutral or grounded conductors. A separate AC line switch or contactor must be wired as a disconnect so that each ungrounded conductor can be disconnected. For all 3-phase AC line input models, a magnetic contactor with the appropriate current rating is recommended. See Section VI, on page 25.

Note: *To access terminals, loosen the captive front panel screw and remove the cover. After wiring is complete, replace the cover and tighten, but do not over tighten, the screw*.

TABLE 4 – TERMINAL BLOCK TM1 WIRING INFORMATION

Pkg.	Model No.	Part No.	Maximum Wire Size (Cu)		Recommended Tightening Torque	
			AWG	mm^2	in-lbs	kg-cm
D	KBN2-2250-1	12000	16	1.3	8.5	10
	KBN2-2201-1	12010				
E	KBN2-2202-1	12020	14	2.1	8.5	10
	KBN2-4301-1	12100				
	KBN2-4302-1	12110				
F	KBN2-2203-1	12030	10	5.3	15.5	18
	KBN2-2305-1	12040				
	KBN2-4303-1	12120				
	KBN2-4305-1	12130				
G	KBN2-2307-1	12050	10	5.3	15.5	15
	KBN2-2310-1	12060				
	KBN2-4307-1	12140				
	KBN2-4310-1	12150				
H	KBN2-2315-1	12070	6	13.3	22	25
	KBN2-2320-1	12080				
	KBN2-2330-1	12090	4	21.2	22	25
	KBN2-4315-1	12160	6	13.3	22	25
	KBN2-4320-1	12170				
	KBN2-4330-1	12180				

A. AC Line Connection – Wire the AC line to Terminals L1, L2 (for single phase AC line) or to Terminals L1, L2, L3 (for 3-phase AC line) of Terminal Block TM1, as shown in Figures 3A, 3B, and 3C, on page 17.

Notes: 1. *The drive rated AC line voltage (208/230, 380/460 Volts AC) must match the actual AC line input voltage, as described in Section VIII-C-3, on page 32.* ***2.*** *If one of the AC line inputs is a neutral (N), wire it to Terminal L2.*

B. Ground Connection – Connect the ground wire (earth) to the ground screw as shown in Figures 3A, 3B, and 3C, on page 17.

FIGURE 3A – PKG. D, E, F
POWER CONNECTIONS WITH 1ϕ AC LINE INPUT

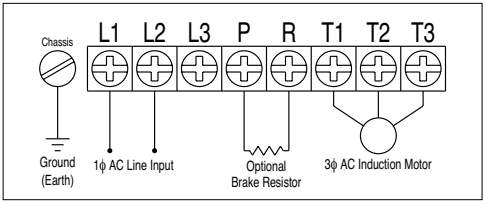
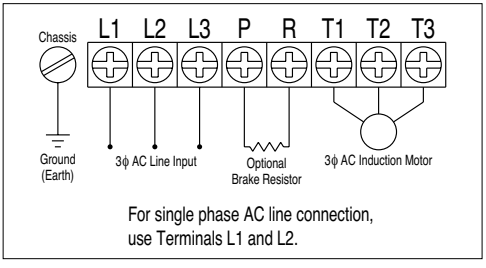
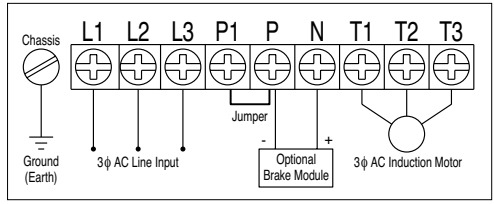


FIGURE 3B – PKG. D, E, F, G
POWER CONNECTIONS WITH 3ϕ AC LINE INPUT



C. Motor Connection – Wire the motor to Terminals T1 (U), T2 (V),T3 (W) of Terminal Block TM1, as shown in Figures 3A, 3B, on page 16, and 3C. Motor cable length should not exceed 100 feet (30 m). If exceeding 100 feet (30 m), special AC line reactors may be required, contact our Sales Department.

FIGURE 3C – PKG. H POWER CONNECTIONS



Note: *Be sure the motor rated voltage (208/230, 380/460 Volts AC) matches the control output voltage.*

See Section IV, Important Application Note, on page 15.

D. Optional Brake Resistor Connection – To improve braking, an optional external Brake Resistor can be connected to Terminals "P" and "R" of Terminal Block TM1, as shown in Figures 3A and 3B, on page 16. This Brake Resistor allows maximum braking torque. This option is only available for Models KBN2-2250-1, 2201-1, 2202-1, 2203-1, 2305-1, 2307-1, 2310-1, 4301-1, 4302-1, 4303-1, 4305-1, 4307-1, 4310-1. See Section X-B, on page 81.

CAUTION! To avoid overheating, do not mount the brake resistor under the drive.

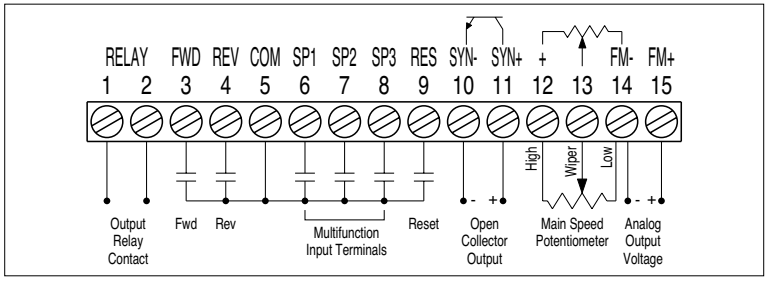
V. TERMINAL BLOCK TM2 WIRING INSTRUCTIONS (Signal Connections)

The KBN2 contains 15 signal terminals which can be used for various functions. For Terminal Block TM2 wiring information, see Table 5, on page 18.

Note: *If external signal wiring is not used, proceed to Section VI, on page 25.*

IMPORTANT! To avoid erratic operation, do not bundle the AC line and motor wires with wires from signal following, start/stop contact, or any other signal wires. Use shielded cables on all signal wiring over 12" (30 cm). The shield should be earth grounded on the drive side only. Wire the drive in accordance with the National Electrical Code requirements and other local codes that may apply.

FIGURE 4 – TERMINAL BLOCK TM2 DESIGNATION AND GENERAL CONNECTION DIAGRAM (All Models)



Application Note – Although this section covers the wiring of Terminal Block TM2, the respective programming functions are also presented. Function programming is also covered in Drive Operation, in Section VIII, on page 27. Also see the Programmable Functions (Detailed), Section IX, starting on page 55.

TABLE 5 – TERMINAL BLOCK TM2 WIRING INFORMATION (All Models)

Description	Maximum Wire Size (Cu)		Recommended Tightening Torque	
	AWG	mm^2	in-lbs	kg-cm
All Signal Input and Outputs (Terminals 1 - 15)	18	0.8	5	6

Notes: 1. *Terminal "5" is the "Common" for the Start/Stop circuit and the Multifunction Input Terminals. The maximum allowable load current is 20 mADC.* ***2.*** *All terminals of Terminal Block TM2 are isolated from the AC line and motor wiring. This eliminates the need for isolated input signals.* ***3. Function codes are sometimes represented with one or more "x". An "x" is used when the code is used for functions other than the function presently discussed (example: xx01).***

A. External Run/Stop Forward/Reverse Connection – External control of Run/Stop and Forward/Reverse is achieved by wiring contacts to Terminals 3, 4, 5, and 6 as shown in Figures 5A - 5D. To program the drive for external Run/Stop, set Function F010 to "0001" [External Contacts]. The settings for external Run/Stop control using F003 are shown in Table 6, on page 19.

The drive is factory programmed for Forward/Stop using Terminal 3 and Reverse/Stop using Terminal 4. To program the drive for Run/Stop using Terminal 3 and Forward/Reverse using Terminal 4, set F003 to "xx01". For 3-wire Start/Stop, set Function F003 to "XX10". See Section VIII-D-2, on page 33 for programming information.

WARNING! The Stop Contact is never to be used as a Safety Disconnect since it is not fail-safe. Use only the AC line for this purpose.

FIGURE 5A
FORWARD/STOP-REVERSE/STOP CONNECTION (Maintained Contacts) (F003 Set to "xx00") (Factory Setting)

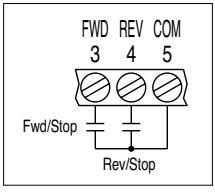


FIGURE 5B
RUN/STOP-FORWARD/REVERSE CONNECTION (Maintained Contacts) (F003 Set to "xx01")

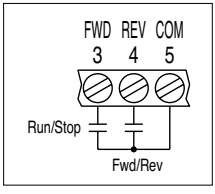


FIGURE 5C
3-WIRE START/STOP CONNECTION (Momentary Contacts) (F003 Set to "xx10")

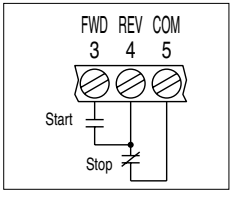


FIGURE 5D – 3-WIRE START/STOP CONNECTION WITH REVERSE (Momentary Contacts) (F003 Set to "xx10") (Use a Maintained Contact for Reverse)

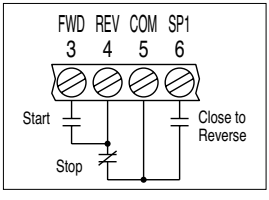


TABLE 6 – EXTERNAL RUN/STOP-FORWARD/REVERSE CONTROL [F003]

Contact Configuration	F003 Code Setting*	Contact Status		Drive Operation
		Term. 3	Term. 4	
Forward/Stop-Reverse/Stop (Maintained Contacts) See Figure 5A, on page 18.	0000 (Factory Setting)	Open	Open	Stop
		Closed	Open	Forward
		Open	Closed	Reverse
		Closed	Closed	Stop
Run/Stop-Forward/Reverse (Maintained Contacts) See Figure 5B, on page 18.	0001	Open	Open	Stop
		Closed	Open	Forward
		Open	Closed	Stop
		Closed	Closed	Reverse

**Set F010 [Run/Stop Control] to "0001" [External Contacts].*

B. External Frequency Control – Terminals 12, 13, and 14 can be wired in a variety of ways to control the output frequency of the drive. See Table 7. F011 [Frequency Control Method] is used to program the drive to control motor frequency with an external signal instead of the keypad, as described in Section VIII-D-3, F011, on page 34. Function F011 is factory set to "0000" [Keypad].

Jumper JP1/JP2 is used to set the drive for potentiometer, voltage, or current input signal. The jumper is factory installed in the "1-2" position of Jumper JP1 for 0 - 5 Volts DC signal input or a speed potentiometer connected to Terminal Block TM2.

TABLE 7 – SIGNAL INPUT, F011, AND JUMPER JP1/JP2 SETTING

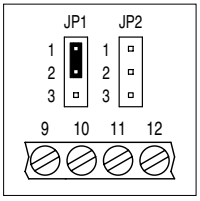
Frequency Control Method	F011 Code Setting	JP1 Setting	JP2 Setting	Jumper Position
Keypad (Factory Setting)	0000*	1 - 2*	—	
Potentiometer on Keypad	0001	1 - 2*	—	
Remote 5 kΩ (or 10 kΩ) Potentiometer	0002	1 - 2*	—	
0 - 5 VDC Voltage Following				
0 - 10 VDC Voltage Following	0002	—	2 - 3	
0 - 20 mADC or 4 - 20 mADC Current Following**	0002	2 - 3	—	
Up/Down Frequency Control using Multifunction Input Terminals	0003	1 - 2*	—	

**Factory Setting. ** To set the drive for 4 - 20 mADC input, F027 must be set to "0020" (Factory setting is "0000")*

Application Note – The KBN2 can be programmed to accept a wide range of voltage or current input signals using Functions F026 - F029, as described in Section VIII-D-4, on pages 35 - 37.

Location of Jumper JP1/JP2: To access Jumper JP1/JP2, loosen the captive front panel screw and lift off the cover. The jumper is located above Terminal Block TM2, as shown in Figure 6.

FIGURE 6 – TYPICAL LOCATION OF JUMPER JP1/JP2



1. **Remote Speed Potentiometer Connection –** A 5 kΩ (or 10 kΩ) remote speed potentiometer can be connected to Terminal Block TM2 to control motor speed. Connect the high side of the potentiometer to Terminal 12, the wiper to Terminal 13, and the low side to Terminal 14, as shown in Figure 7A. Set F011 [Frequency Control Method] to "0002" and be sure the jumper is installed in the "1-2" position of Jumper JP1 (factory setting), as shown in Figure 7B. (See Section VIII-D-3, on page 34.

FIGURE 7A REMOTE SPEED POTENTIOMETER CONNECTION

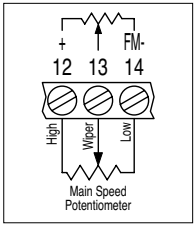
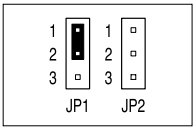


FIGURE 7B JUMPER JP1 SET FOR EXTERNAL SPEED POTENTIOMETER (FACTORY SETTING)



2. **Voltage Following Connection –** A 0 - 5 or 0 - 10 Volt DC analog signal input can be connected to Terminal Block TM2 to control motor speed. Connect the signal voltage (+) to Terminal 13 and the common (-) to Terminal 14, as shown in Figure 8A. Set F011 [Frequency Control Method] to "0002" [Analog Signal]. For 0 - 5 Volt DC analog signal voltage, be sure the jumper is installed in the "1-2" position (factory setting) of Jumper JP1. For 0 - 10 Volt DC analog signal voltage, install the jumper in the "2-3" position of Jumper JP2, as shown in Figure 8B.

FIGURE 8A VOLTAGE FOLLOWING CONNECTION

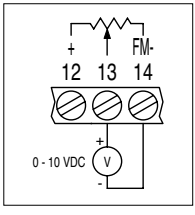


FIGURE 8B JP2 SET FOR 0 - 10 VDC VOLTAGE FOLLOWING SIGNAL OUTPUT

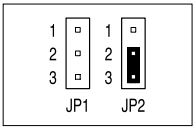
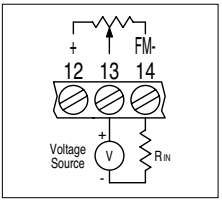


FIGURE 8C – VOLTAGE FOLLOWING CONNECTION WITH SERIES RESISTOR



Notes: 1. *F011 [Frequency Control Method] is factory set to "0000" [Keypad].* ***2.*** *Functions F026, F027, and F028 can be used to rescale the drive for other input signals.* ***3.*** *Input impedance of Terminal 13 is 20 kΩ.*

Application Note – If the input signal is greater than the drive setting, a resistor must be installed in series with the signal input, as shown in Figure 8C, on page 20. Calculate the series resistor (R_{IN}) using the following formula. Be sure the drive is set for 0 - 5 VDC signal input (F011 set to "0002" and the jumper is installed in the "1-2" position of Jumper JP1). (See Table 7, on page 19.)

$R_{IN} = (V_{IN}$ X 33kΩ) -165kΩ

Example – If the signal input is 20 Volts DC, R_{IN} = (20V X 33kΩ) - 165kΩ = 495kΩ. Use the next higher resistor value, which is 500kΩ

FIGURE 9A
CURRENT FOLLOWING CONNECTION

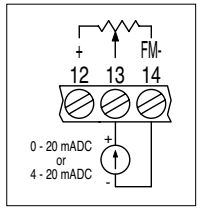
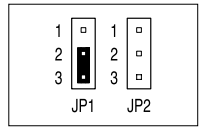


FIGURE 9B
JUMPER JP1 SET FOR CURRENT FOLLOWING SIGNAL INPUT



3. Current Following Connection

A 0-20 mA DC or 4-20 mA DC analog signal input can be connected to Terminal Block TB2 to control motor speed. Connect the signal current (+) to Terminal 13 and the common (-) to Terminal 14, as shown in Figure 9A. Install the jumper in the "2-3" position of Jumper JP1, as shown in Figure 9B. Function F011 must be set to "0002". For a 4 - 20 mADC signal, F027 must be set to "0020" (factory setting is "0000").

4. Multifunction Input Terminals Connection

The Multifunction Input Terminals "6", "7", and "8" can be programmed for a variety of functions. See Programming Functions (Detailed), Section IX, F056 - F058, on pages 65 and 66. Several of the programmable functions can be used for External Frequency Control. These include Up/Down Frequency Control, Preset Speed Operation (7 frequency settings), and Jog.

The terminals are activated by closing or opening (depending on the settings of Functions F056, F057, and F058) a contact referenced to Terminal "5" (COM). See Figures 10A, 10B, and 10C, on page 22.

FIGURE 10A – MULTIFUNCTION INPUT TERMINALS CONNECTION WITH NORMALLY OPEN CONTACTS (CLOSE TO ACTIVATE)

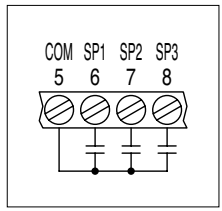
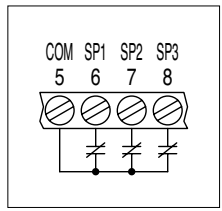
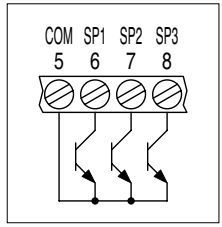


FIGURE 10B – MULTIFUNCTION INPUT TERMINALS CONNECTION WITH NORMALLY CLOSED CONTACTS (OPEN TO ACTIVATE)



a. External Up/Down Frequency Control – External contacts can be used to simulate the ▲ and ▼ keys on the digital keypad. Any two of Terminals 6, 7, and 8 can be programmed for Up/Down Frequency Control using Functions F056, F057 (or F058). See figures 11A, 11B, and 11C.

FIGURE 10C – MULTIFUNCTION INPUT TERMINALS CONNECTION WITH OPEN COLLECTOR



To program Terminal 6 for Up Control using normally open contacts, set Function F056 to "0012". (To program Terminal 6 for Up Control using normally closed contacts, set Function F056 to "0028".) The incremental rate of change of the Up Control for frequency setting, using external contacts, is proportional to the Acceleration Time #1 setting [F001].

To program Terminal 7 for Down Control using normally open contacts, set Function F057 to "0013". (To program Terminal 7 for Down Control using normally closed contacts, set Function F057 to "0029".) The incremental rate of change of the Down Control for frequency setting, using external contacts, is proportional to the Deceleration Time # 1 setting [F002].

Note: *For Up/Down Frequency Control using the Multifunction Input Terminals, Function F011 must be set to "0003" [Up/Down Frequency Control].*

TABLE 8 – SETTINGS FOR EXTERNAL UP/DOWN FREQUENCY CONTROL

Function Number	Function Description	Code	Code Description
F011	Frequency Control Method	0003 (Factory Setting is "0000")	Up/Down Frequency Control
F056	Multifunction Input Terminal 6 (SP1)	0012 (Factory Setting is "0000")	Up Command
F057	Multifunction Input Terminal 7 (SP2)	0013 (Factory Setting is "0001")	Down Command

FIGURE 11A – UP/DOWN FREQUENCY CONTROL CONNECTION WITH NORMALLY OPEN CONTACTS

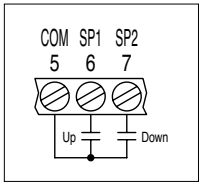


FIGURE 11B – UP/DOWN FREQUENCY CONTROL CONNECTION WITH NORMALLY CLOSED CONTACTS

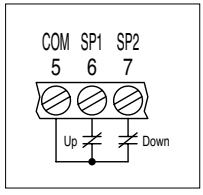
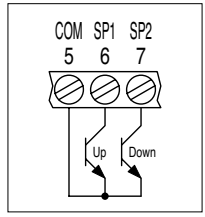


FIGURE 11C – UP/DOWN FREQUENCY CONTROL CONNECTION WITH OPEN COLLECTOR



b. Preset Speed Operation – Many applications require preset speed operation. The drive is capable of providing (7) preset speeds using a combination of Terminals "6", "7", "8". See Table 9.

Terminal "6" has been factory programmed for Preset Speed # 1 using Function F056 (factory set to "0000"). Terminal "7" has been factory programmed for Preset Speed # 2 using Function F057 (factory set to "0001"). Terminal "8" has been factory programmed for Preset Speed # 4 (factory set to "0002"). To obtain Preset Speed # 3, Terminals "6" (SP1) and "7" (SP2) must be connected together. Normally open or normally closed contacts may be used, as shown in Figures 10A and 10B, on page 21. Functions F017 through F023 are used to program the frequency for Preset Speed # 1 through Preset Speed # 7. See Section IX, F017 - F023, on page 58.

TABLE 9 – SELECTING PRESET SPEEDS USING MULTIFUNCTION INPUT TERMINALS 6, 7, 8

Preset Speed	Factory Setting	Function Number to Set Frequency	Multifunction Input Terminal*		
			Term. 6 (SP1)	Term. 7 (SP2)	Term. 8 (SP3)
1	5.0 Hz	F017	Activated	—	—
2	10.00 Hz	F018	—	Activated	—
3	20.00 Hz	F019	Activated	Activated	—
4	30.00 Hz	F020	—	—	Activated
5	40.00 Hz	F021	Activated	—	Activated
6	50.00 Hz	F022	—	Activated	Activated
7	60.00 Hz	F023	Activated	Activated	Activated
Keypad (Factory Setting)	5.00 Hz	F025	—	—	—

**"Activated" means that the terminal has been selected. If the terminal is programmed for normally open contacts, closing the contact will activate the terminal. If the terminal is programmed for normally closed contacts, opening the contact will activate the terminal.*

***Note:** When switching two or three contacts together, the operation time must be within 10 mS.*

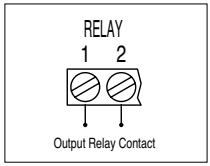
***Notes: 1.** Using the programming functions, the drive is capable of assigning a separate "timed" function (Process Timer) for each of the Preset Speeds which are controlled by Multifunction Input Terminals "6", "7", and "8". See Section V-B-4, on page 21. In addition, the timed Preset Speeds can be programmed in a linked sequence so that one timed Preset Speed will automatically follow the next. (example: Preset Speed # 1 ➤ Preset Speed # 2 ➤ ..... ➤ Preset Speed # 7). If F084 [Process Timer Operation Mode] is set to "0101", the Process Timer will repeat continuously through all the Preset Speeds until the drive is stopped. **2.** If the drive has been programmed for Process Timers, the Preset Speeds can no longer be set for continuous operation. **3.** When Process Timers are enabled, a specific time greater than zero must be assigned to each preset in order for the Preset Speed to operate. **4.** If "000.0" time is programmed in ALL Process Timers and Process Timer Operation is attempted, the drive will trip and the error code "CPF" will flash on the display. Press the </RESET key to reset the drive. **5.** A run command and a forward or reverse direction must be selected for Preset Speeds to operate.*

c. Jog Speed Operation – The drive provides selection for a "jog" speed. To select the jog frequency which is programmed in Function F024 (factory setting is 2.00 Hz), wire normally open or normally closed contacts to one of the Multifunction Input Terminals. To program one of the Multifunction Input Terminals for Jog using normally open contacts, set Function F056, F057, or F058 to "0003". To program one of the Multifunction Input Terminals for Jog using normally closed contacts, set Function F056, F057, or F058 to "0019"

C. Multifunction Output Relay Connection – Normally open (NO) or normally closed (NC) relay contacts are provided at Terminals 1 and 2 of Terminal Block TM2. These contacts change state depending on the setting of Functions F097 and F098, as described in Section IX, on pages 72 and 73. F097 and F098 are both factory set to "0000" [Output Relay is Not Operational]. See Figure 12.

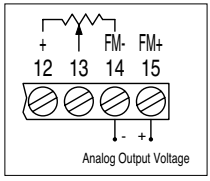
Note: *The Output Relay contacts are rated 1 Amp at 30 Volts DC or 250 Volts AC.*

FIGURE 12
MULTIFUNCTION OUTPUT RELAY CONNECTION



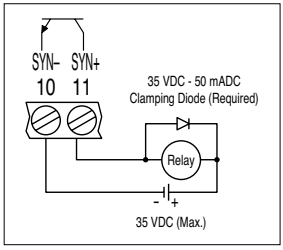
D. Multifunction Analog Output Connection – Terminals 14 and 15, of Terminal Block TM2, provide an isolated 0 - 10 Volt DC analog signal output proportional to the function for which it is programmed, as described in Section IX, F046, on page 63. F046 [Multifunction Analog Output] is factory set to "0000" [Output Frequency] which will provide an isolated 0 - 10 VDC voltage proportional to the drive output frequency. See Figure 13. Other functions include "0001" [Set Frequency], "0002" [Drive Output Voltage], and "0003 [Bus Voltage]. The Analog Output Voltage can be rescaled using Function F045. See Section IX, F045, on page 62. (Maximum allowable load current is 1 mADC)

FIGURE 13
MULTIFUNCTION ANALOG OUTPUT CONNECTION



E. Multifunction Open Collector Output Connection – An isolated open collector output is provided at Terminals 10 and 11, of Terminal Block TM2, which will change state when the drive operates as programmed in F061 [Multifunction Output Terminals 10,11]. F061 is factory set to "0000" [Run], which will cause the Multifunction Open Collector Output Terminal to change state when the drive is in Run Mode. A typical application for Open Collector Output is shown in Figure 14. Other functions include "0001" [Frequency Reached (Target Frequency)], "0002" [Set Frequency (F008/F009)], "0003" [Frequency Detection (> F008) - Frequency Reached], "0004" [Frequency Detection (< F008) - Frequency Reached], "0005" [Overload Detection]. The Open Collector Output circuit is rated 35 Volts DC at 50 mA DC.

FIGURE 14
MULTIFUNCTION OPEN COLLECTOR OUTPUT CONNECTION



F. Reset Connection – A normally open momentary contact can be connected to Terminals 5 and 9, of Terminal Block TM2, to reset the drive after a fault has cleared, as shown in Figure 15. (Also see Section IX, F016, on page 57).

FIGURE 15A
RESET CONNECTION

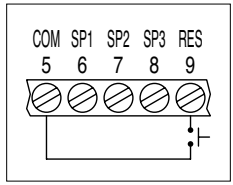
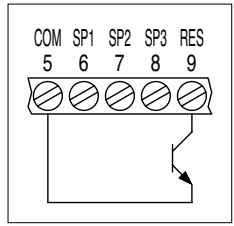


FIGURE 15B
RESET CONNECTION
WITH OPEN COLLECTOR



G. RS-232 or RS-485 Communication Cable Connection – When installing the optional RS-232 or RS-485 Communication Cable, remove the jumper that is installed on CON12. CON12 is located above Terminal Block TM2. Be sure the factory installed jumper is in the "1-2" position of CON12, if not using RS-232 or RS-485 communications. RS-232 or RS-485 is used to progam the drive using a PC. The Download Module (DLM) can also be used to program the drive. See Section X-E, on page 79.

VI. AC LINE FUSING

This drive does not contain AC line input fuses. Most electrical codes require that each ungrounded conductor contain circuit protection. Install a fuse or circuit breaker in series with each ungrounded conductor. For all 3-phase AC line input models, a magnetic contactor with the appropriate current rating is recommended. Do not fuse neutral or grounded conductors. See Table 10. Check all electrical codes that apply to the application. Do not install a fuse or circuit breaker in series with motor leads.

TABLE 10 – RECOMMENDED FUSE, CIRCUIT BREAKER, OR MAGNETIC CONTACTOR RATING

Model	Rating (Amps AC)
KBN2-2250-1	10, 5*
KBN2-2201-1	15, 10*
KBN2-2202-1	20, 10*
KBN2-2203-1	30, 15*
KBN2-2305-1	30
KBN2-2307-1	60
KBN2-2310-1	60
KBN2-2315-1	100
KBN2-2320-1	100
KBN2-2330-1	150

Model	Rating (Amps AC)
KBN2-4301-1	5
KBN2-4302-1	10
KBN2-4303-1	15
KBN2-4305-1	20
KBN2-4307-1	40
KBN2-4310-1	40
KBN2-4315-1	70
KBN2-4320-1	70
KBN2-4330-1	100

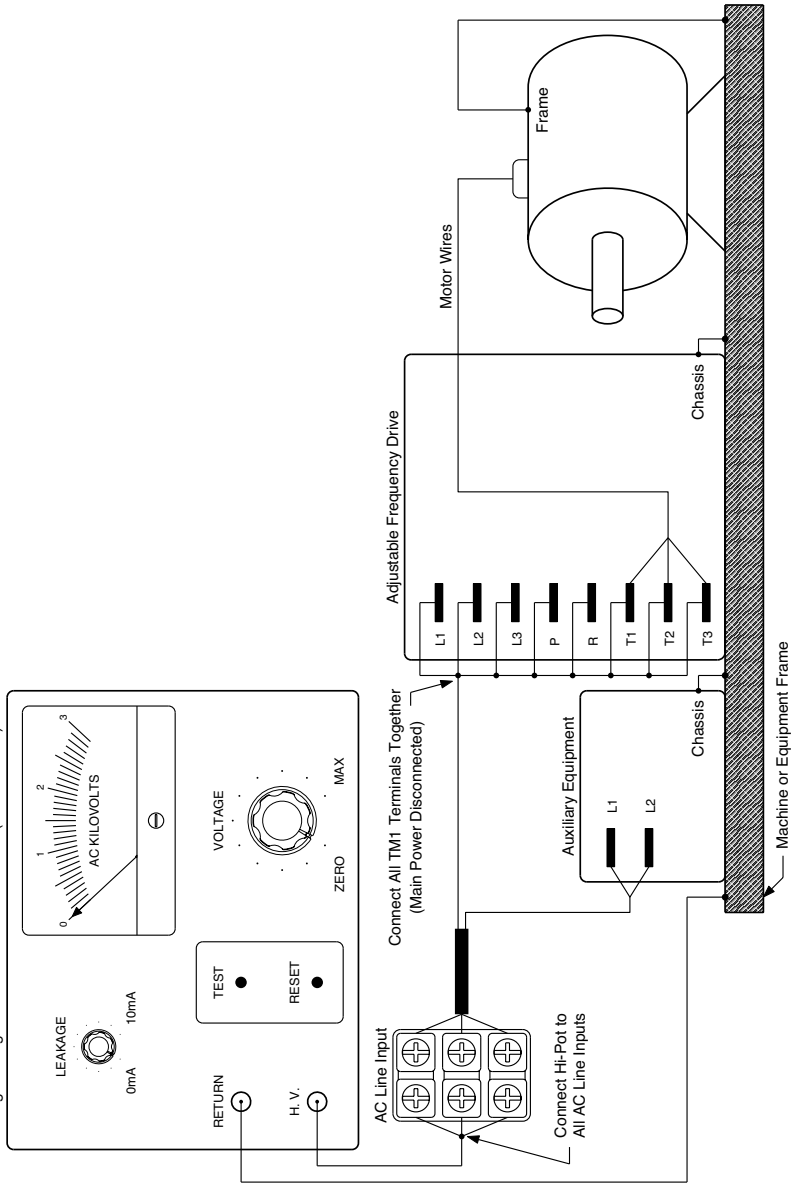
** Rating is given for 1ϕ , 3ϕ AC line input.*

VII. RECOMMENDED HIGH VOLTAGE DIELECTRIC WITHSTAND TESTING (Hi-Pot)

Testing agencies such as UL, CSA, etc., usually require that the equipment undergo a hi-pot test. In order to prevent catastrophic damage to the drive, which has been installed in the equipment, it is recommended that the following procedure be followed. A typical hi-pot test setup is shown in Figure 16, on page 26. All drives have been factory hi-pot tested in accordance with UL requirements.

Note: *When performing the hi-pot test, disconnect the AC power.*

FIGURE 16 – HI-POT SETUP



CAUTION! To avoid damage to the drive, **do not connect any terminals of Terminal Block TM2 to the hi-pot tester.**

A. Connect all equipment AC power input lines together and connect them to the H. V. lead of the hi-pot tester. Connect the RETURN lead of the hi-pot tester to the frame on which the control and other auxiliary equipment are mounted.

B. The hi-pot tester must have an automatic ramp-up to the test voltage and an automatic ramp-down to zero voltage.

Note: *If the hi-pot tester does not have automatic ramping, then the hi-pot output must be manually increased to the test voltage and then manually reduced to zero. This procedure must be followed for each machine to be tested. A suggested hi-pot tester is Slaughter Model 2550.*

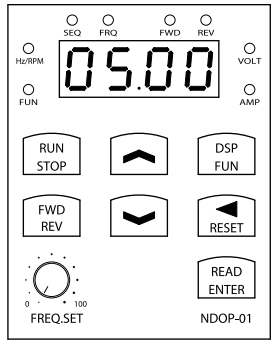
⚠ **CAUTION!** Instantaneously applying the hi-pot voltage will cause irreversible damage to the drive.

VIII. DRIVE OPERATION

Before operating this drive, read the following instructions on Digital Keypad operation and programming functions. See Figure 17, for the digital keypad layout. The display can indicate various functions of the drive: set frequency, motor RPM, output current and voltage, custom units, function numbers, function codes or values, and fault codes.

If an error message appears while programming the drive, see Table 22, on pages 74 - 76.

FIGURE 17 – DIGITAL KEYPAD LAYOUT



A. Digital Keypad Description – The digital keypad has 7 keys which are used to program drive functions and control various features, as described below. Eight LEDs are provided to indicate the drive's operational status. A potentiometer is also provided on the keypad to set drive frequency. See Figure 17. ***Note:*** *To avoid damage, never operate the keypad with a screwdriver or other sharp-ended tool.*

Run/Stop Key – Starts or stops the drive. If the drive is stopped, press the RUN/STOP key to start the drive. F010 must be set to "0000" (factory setting). If the drive is running, press the RUN/STOP key to stop the drive.

Forward/Reverse Key – Changes motor direction. If the drive is set to run the motor in the forward direction, press the FWD/REV key change motor direction to reverse. The FWD LED will turn off, and the REV LED will illuminate. If the drive is set to run the motor in the reverse direction, press the FWD/REV key to change motor to forward. The REV LED will turn off, and the FWD LED will illuminate. F010 must be set to "0000" (factory setting).

Up Key – Increases output frequency, increases set frequency, increases to the next higher function number, or changes the function's value or code setting. If the drive is running, press the ▲ key to increase the output frequency. If the drive is stopped, press the ▲ key to increase the set frequency. If a function number is displayed, press the ▲ key to increase the function displayed to the next higher function number. If a function value or code is displayed, press the ▲ key to increase the function's value or code setting.

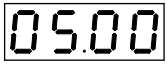
Down Key – Decreases output frequency, decreases set frequency, decreases to the next lower function number, or changes the function's value or code setting. If the drive is running, press the ▼ key to decrease the output frequency. If the drive is stopped, press the ▼ key to decrease the set frequency. If a function number is displayed, press the ▼ key to decrease the function displayed to the next lower function number. If a function value or code is displayed, press the ▼ key to decrease the function value or code setting.

Display/Function Key – Changes the display between Display Mode and Function Mode. If DSP/FUN is pressed while frequency is displayed, the display will indicate the previously entered function number. If DSP/FUN is pressed while a function number is displayed, the display will change to display output frequency. Note: The DSP/FUN key can be used to display Motor RPM, Motor Voltage, Motor Current, Drive Bus Voltage, and Custom Units, depending on the setting of Functions F047 and F051.

Shift/Reset Key – Resets the drive after a fault has cleared or moves the display digit to be set one position to the left. The display digit will "flash", indicating it can be changed with the ▲ or ▼ keys.

Read/Enter Key – Displays or enters a function value or code setting. If the desired function number is displayed, press the READ/ENTER key to display the function's value or code. If the desired value or code is displayed, press the READ/ENTER key to program the function to the new value or code.

Keypad Potentiometer – Sets motor frequency. Operation is from 0 - 100% of the range set by the Lower and Upper Output Frequency Limits. To program the drive for Keypad Potentiometer Operation, set Function F011 to "0001".



4-Digit LED Display – When power is applied to the drive, the 4-digit LED display will flash the drive AC line voltage setting (Volts AC) programmed in F030 four times and then flash the set frequency speed (factory setting is "05.00"). When the drive is in "run", the output frequency is displayed. When the drive is stopped with the keypad, the set frequency is displayed.

LED Status Indicators – The drive is designed with 8 LEDs mounted on the digital keypad to display the drive's operational status, as described below. When power is applied to the drive (in factory setting), the "VOLT", and "FWD" LEDs will illuminate on the display and the POWER LED, (located on the drive PC board, to the right of Terminal Block TM1) will also illuminate.

TABLE 11 – LED STATUS INDICATORS

○ FUN	When the FUN LED is illuminated, the display shows a Function Number and the drive is in Program Mode.
○ FWD	When the FWD LED is illuminated, the drive is set for Forward Direction.
○ Hz/RPM	When the Hz/RPM LED is illuminated, the display shows Frequency (in Hz) or RPM.
○ REV	When the REV LED is illuminated, the drive is set for Reverse Direction.
○ SEQ	When the SEQ LED is illuminated, the drive is set for External Run/Stop (F010 set to "0001").
○ VOLT	When the VOLT LED is illuminated, the display shows Motor voltage (Volts AC) [F047 = xxx1] or bus voltage (Volts DC) [F047 = xx1x].
○ FRQ	When the FRQ LED is illuminated, the drive is set for External Frequency Control or Keypad Potentiometer Control.
○ AMP	When the AMP LED is illuminated, the display shows Motor current (Amps AC) [F047 = x1xx].

B. Digital Keypad Operation – Examples of basic keypad operation are described below.

1. **Setting Drive Output Frequency Using the Keypad –** The drive is factory set to run at 5.00 Hz when the drive is in the Run Mode. (Press the RUN/STOP Key to start or stop the drive.)

   a. To change the Set Frequency (drive in Stop Mode):

      1. Press the </RESET key to move the setable digit to the left and the ▲ or ▼ key until the desired frequency is displayed. ***Note:*** *The setable digit will flash.*

      2. Press the RUN/STOP key to run the drive at the new Set Frequency.

      Note: *Figure 18, on page 30, is a flow chart which illustrates the sequence to change and program the Set Frequency from 5.00 Hz to 43.21 Hz using the keypad.*

   b. To change the Run Frequency (drive in Run Mode):

      1. Press the </RESET key to move the setable digit to the left and the ▲ or ▼ key until the desired frequency is displayed. ***Note:*** *The setable digit will flash.*

      2. Press the READ/ENTER key to run the drive at the new Set Frequency.

2. **Programming the Drive –** The drive contains many functions that can be programmed for specific application. A summary list of all programmable functions is provided in Table 17, beginning on page 46.

FIGURE 18 – FLOW CHART TO CHANGE SET FREQUENCY – Drive in STOP Mode

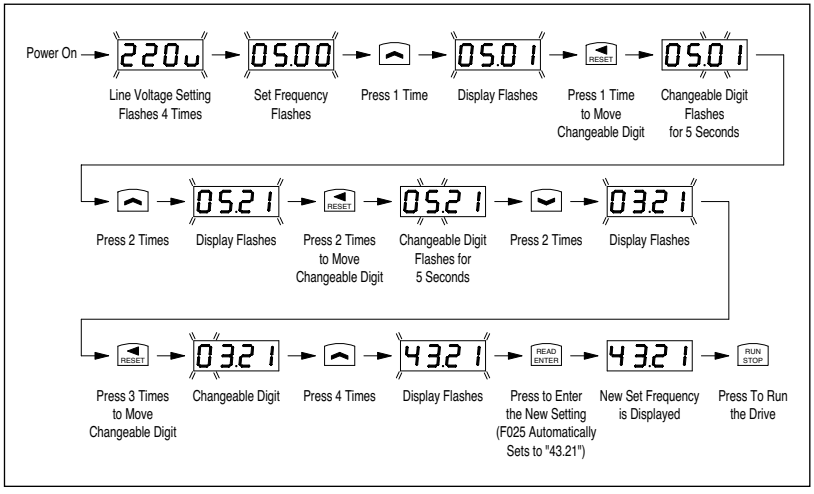
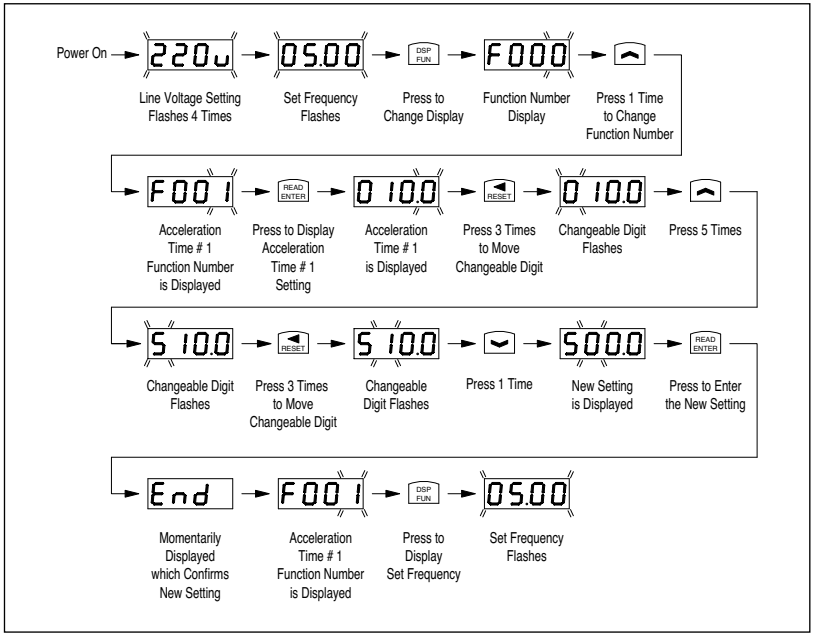


FIGURE 19 – FLOW CHART TO PROGRAM F001 (ACCELERATION TIME # 1)



Acceleration Time # 1 [F001] – Sets the acceleration time (seconds) of the drive. F001 can be changed while the drive is in Stop Mode or Run Mode.

Example – Figure 19, on page 30, illustrates the sequence to program F001 for a 500 second acceleration time.

To change the setting of F001:

a. Press the DSP/FUN key to display Function Number.

b. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "F001" is displayed. ***Note:*** *The setable digit will flash.*

c. Press the READ/ENTER key. "010.0" seconds will be displayed (factory setting).

d. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until the desired acceleration time is displayed. ***Note:*** *The setable digit will flash. The programmable range is 0.1 - 3600 seconds.* (**Note**: "000.0" cannot be set.)

e. Press the READ/ENTER key to "enter" the new acceleration time. "End" will be momentarily displayed, which confirms the new acceleration time setting. "F001" will be displayed.

f. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

C. Important Programming Functions – All drive functions have been factory programmed, as shown in Table 17, on page 46. Detailed descriptions of all programmable functions are given in Section IX, on page 53.

Function codes are sometimes represented with one or more "x". An "x" is used when the code is used for functions other than the function presently discussed (example: xx01).

1. Motor Current Rating [F070] – In order for the Motor Overload Protection Feature to be effective, Function F070 must be set to the motor nameplate current rating (Amps AC) if the actual motor current differs nominally from the factory setting.

Note: *For the factory default setting for motor current, see Table 20, on page 68.*

To enter the motor nameplate current rating into F070:

a. The drive must be in Stop Mode (press the RUN/STOP key).

b. Press the DSP/FUN key to display Function Number.

c. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "F070" is displayed. ***Note:*** *The setable digit will flash.*

d. Press the READ/ENTER key. The factory default setting of Motor Current Rating will be displayed. See Table 20, on page 68.

e. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until the actual motor nameplate current rating is displayed. ***Note:*** *The setable digit will flash.*

f. Press the READ/ENTER key to "enter" the new Motor Current Rating. "End" will be momentarily displayed, which confirms the new Motor Current Rating setting. "F070" will be displayed.

g. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

2. **60 Hz, 50 Hz Motor Operation (Volts/Hz Pattern) [F005] –** The drive has been factory programmed for 60 Hz motors used in Constant Torque applications (F005 is factory set to "0009"). To convert to 50 Hz motors used on constant torque applications, set F005 to "0000", as described below.

   a. The drive must be in Stop Mode (press the RUN/STOP key).

   b. Press the DSP/FUN key to display Function Number.

   c. Press the ▲ or ▼ key until "F005" is displayed. ***Note:*** *The setable digit will flash.* ***Note:*** *The </RESET key may also have to be used.*

   d. Press the READ/ENTER key. "0009" will be displayed (factory setting).

   e. Press the ▼ key nine times. "0000" will be displayed.

   f. Press the READ/ENTER key to "enter" the new code. "End" will be momentarily displayed, which confirms the new code setting ("0000"). Then "F005" will be displayed.

   g. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

   Note: *If the application requires full motor torque over a wide speed range, it is recommended that an Inverter Duty or TENV Motor be used. To achieve full torque rating, the Electronic Motor Overload Protection (Function F069) should be set to "xx1x". See Section IX, Function F069, on page 68.*

3. **AC Line Input Voltage [F030] –** Function F030 is used to set the drive to the nominal AC line input voltage. F030 is factory set to "220.0" for 208/230 Volt AC line input models and "460.0" for 380/460 Volt AC line input models.

   a. 208/230 Volt AC Input Models – Factory set to F030 = "220.0" which will operate with an AC line input voltage of 208 to 230 Volts AC. If the AC line input voltage is outside the range of 208 to 230 Volts AC, use F030 to set the nominal input voltage.

   b. 380/460 Volt AC Input Models – Factory set to F030 = "460.0" which will operate with an AC line input voltage of 440 to 470 Volts AC. If the actual AC line input voltage is outside the range of 440 to 470 Volts AC, use F030 to set the nominal input voltage.

   Example – If the AC line input voltage for a 460 Volt AC model is actually 380 Volts AC, change the setting of F030 as follows.

   1. Press the DSP/FUN key to display Function Number.

   2. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "F030" is displayed. ***Note:*** *The setable digit will flash.*

3. Press the READ/ENTER key. “460.0” will be displayed (factory setting).
4. Press the </RESET key two times and press the ▲ key two times. “480.0” will be displayed.
5. Press the </RESET key one time and press the ▼ key one time. “380.0” will be displayed.
6. Press the READ/ENTER key to “enter” the actual AC line input voltage. “End” will be momentarily displayed, which confirms the new actual AC line input voltage. “F030” will be displayed.
7. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

D. Other Useful Programming – Other programming functions, such as **External Control of Run/Stop and Forward/Reverse, External Control of Motor Frequency, Manual and Auto Restart, Load Regulation and Torque Boost, and Display Modes** are described below.

1. **External Run/Stop-Forward/Reverse Control [F010] –** Changes the Run, Stop, and Reverse commands from the keypad to external contacts, as described in Section V-A, on page 18. F010 is factory set to “0000” to Run and Stop the drive using the keypad.

   WARNING! The Stop Contact is never to be used as a Safety Disconnect since it is not fail-safe. Use only the AC line for this purpose.

   To change the Run/Stop-Forward/Reverse Control from Keypad to External Contacts:

   a. The drive must be in Stop Mode (press the RUN/STOP key).

   b. Press the DSP/FUN key to display Function Number.

   c. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until “F010” is displayed. ***Note:*** *The setable digit will flash.*

   d. Press the READ/ENTER key. “0000” will be displayed (factory setting).

   e. Press the ▲ key one time. “0001” will be displayed.

   f. Press the READ/ENTER key to “enter” the new code. “End” will be momentarily displayed, which confirms the new code setting. “F010”will be displayed.

   g. Press DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

   Notes: 1. *In order for the reverse function to operate, F003 must be set to “x0xx” [Enable Reverse Run] (factory setting).* ***2.*** *The STOP key on the keypad is always operative, even if F010 is set to “0001” [External Contacts].*

2. **External Forward-Stop-Reverse Control [F003] –** Sets the drive for either Forward/Stop-Reverse/Stop (factory setting), Run/Stop-Forward/Reverse, or 3-Wire Start/Stop, as described in Section IX, Function F003, on page 54.

   WARNING! The Stop Contact is never to be used as a Safety Disconnect since it is not fail-safe. Use only the AC line for this purpose.

a. The drive must be in Stop Mode (press the RUN/STOP key).

b. Press the DSP/FUN key to display Function Number.

c. Press the </RESET Key to move the setable digit one position to the left and the ▲ or ▼ key until "F003" is displayed. ***Note:*** *The setable digit will flash.*

d. Press the READ/ENTER key. "0000" will be displayed (factory setting).

e. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until the desired code setting is displayed. ***Note:*** *The setable digit will flash. The programmable codes for F003 are as follows.*

F003 = xx00: Forward/Stop-Reverse/Stop (Factory Setting)
xx01: Run/Stop-Forward/Reverse
xx10: 3-Wire Start/Stop Control

f. Press the READ/ENTER Key to "enter" the desired External Forward-Stop-Reverse control Code ("0000", "0001", "0010").

g. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

Note: *F003 is also used to enable or disable reverse operation. Additionally, when Multifunction Input Terminals are programmed for Up/Down Frequency Control, F003 is used to display either the "Set Frequency" (RPM or Custom Units) or "zero" when the drive is in "STOP". (See Section IX, Function F003, on page 54.)*

3. Frequency Control Method [F011] – Set the drive for either keypad, potentiometer on keypad, external potentiometer, voltage following, or current following frequency control, as described in Section V-B, on page 19 . F011 is factory set to "0000" to control output frequency with the keypad. To change the Frequency Control Method:

a. The drive must be in Stop Mode (press the RUN/STOP key).

b. Press the DSP/FUN key to display Function Number (Fxxx).

c. Press the </RESET Key to move the setable digit one position to the left and the ▲ or ▼ key until "F011" is displayed. ***Note:*** *The setable digit will flash.*

d. Press the READ/ENTER key. The function code setting will be displayed. Factory setting is "0000".

e. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until the desired code setting is displayed. The programmable codes for F011 are as follows.

F011 = 0000: Keypad (Factory Setting)
0001: Potentiometer on Keypad
0002: External Analog Signal Input or Remote Potentiometer
0003: Up/Down Frequency Control (See Section V-B-4-a, on page 22)

f. Press the READ/ENTER key to "enter" the Frequency Control Method. "End" will be momentarily displayed, which confirms the Frequency Control Method setting. "F011" will be displayed.

g. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

Note: *A jumper must be installed in the proper position of Jumper JP1/JP2 to set the drive for voltage or current signal input, as described in Section V-B-2 and V-B-3, on pages 20 and 21. See Section VIII-D-4.*

4. Analog Signal Input Scaling [F026, F027, F028, F029] – The drive can be set for standard signal inputs (0 - 5 VDC, 0 - 10 VDC, 0 - 20 mADC, and 4 - 20 mADC). Use Function F011 and select the proper position of Jumper JP1/JP2 to set the drive for the closest standard input signal to the actual signal used. See Table 12 and Figure 20.

TABLE 12 – SIGNAL INPUT AND JUMPER JP1/JP2 SETTING (F011 SET TO "0002")

Drive Input Signal Range	JP1 Setting	JP2 Setting	Jumper Position
0 - 5 VDC	1 - 2 (Factory Setting)	—	
0 - 10 VDC	—	2 - 3	
0 - 20 mADC or 4 - 20 mADC*	2 - 3	—	

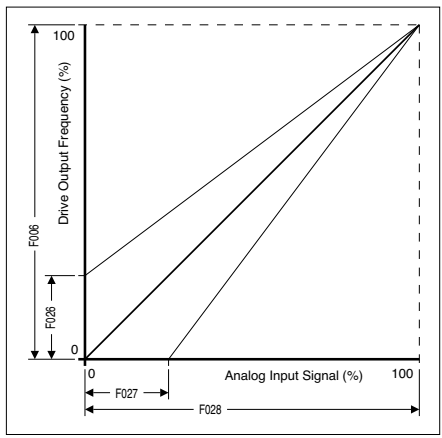
** To set the drive for 4 - 20 mADC input, F027 must be set to "0020" (Factory setting is "0000").*

a. Frequency Offset [F026] – This function sets the drive output frequency lower limit at the minimum input signal.

Example – If the drive has been set for a 4 - 20 mADC input signal and the desired drive minimum frequency is 30 - 60 Hz, set F026 to "0030" (30 Hz).

Notes: 1. *F026 is equivalent to F007 [Output Frequency Lower Limit].*
2. *F026 is factory set to "00.00" (0.00 Hz).*

FIGURE 20 – INPUT SIGNAL SCALING



b. Analog Input Signal Reference Ratio [F027] – This function sets the range of the input signal and is defined by the following formula.

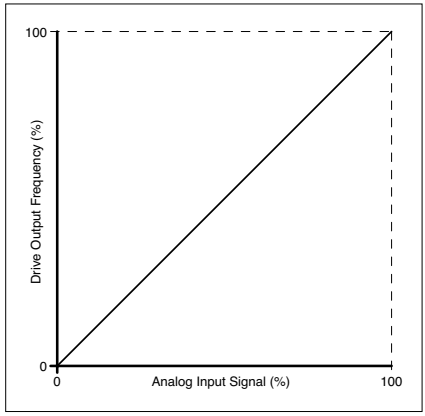
F027 = (Minimum Input Signal ÷ Maximum Input Signal) X 100

Example – If the supplied input signal is 4-20 mADC and the drive has been set for a 0-20 mADC input signal (F011 set to "0002" and jumper installed in the "2-3" position of Jumper JP1), set F027 as follows.

F027 = (4 ÷ 20) X 100 = 0.2 X 100 = 20 (20 %). Set F027 to "0020".

Notes: 1. *F011 is factory set to "0000".* ***2.*** *The jumper is factory installed in the "1-2" position of Jumper JP1.* ***3.*** *F027 is factory set to "000.0" (0.0 %).*

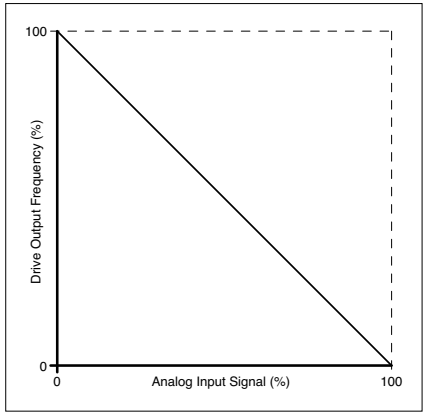
FIGURE 21A – LOW-TO-HIGH ANALOG INPUT SIGNAL SLOPE (POSITIVE)



c. Analog Input Scaling Reference Ratio [F028] – This function sets the scaling of the maximum value of the actual input signal as compared to the drive input signal setting and is defined by the following formula.

F028 = (Supplied Input Signal Upper Limit ÷ Drive Input Signal Setting) X 100

FIGURE 21B – HIGH-TO-LOW ANALOG INPUT SIGNAL SLOPE (NEGATIVE)



Example – If the actual input signal is 0-4 Volts DC and the drive is set for a 0-5 Volt DC signal input (the jumper installed in the "1-2" position of Jumper JP1 (factory installed) and F011 set to "0002"), then set F028 as follows.

F028 = (4 ÷ 5) X 100 = 0.8 X 100 = 80 (80 %). Set F028 to "0080".

Application Note – The drive will not accept an input signal with a greater magnitude than the upper limit of the drive input signal setting. If the input signal is greater than the drive setting, see Sections V-B-2 and V-B-2, on pages 21 and 22 and Application Note, on top of page 21.

Example – If the drive is set for a 0 - 10 VDC signal input, the actual signal input cannot exceed 10 Volts DC.

d. Analog Input Signal Slope [F029] – This function sets the slope of the input signal (Low-to-High / High-to-Low) to the output frequency, as shown in Figures 21A and 21B on page 36.

Example – The drive is set for a 0 - 10 Volts DC input signal. However, the actual input signal is 10 - 0 Volts DC. Use F029 to change the input signal slope from low-to-high to high-to-low.

5. Manual and Automatic Restart (F010, F016, F032, F035) – The drive can be programmed for a manual restart (factory setting) or to automatically restart after a fault has cleared, as described below. Also see Application Note (Auto Restart Delay [F034]) in Section VIII-D-5-b, Note 3, on page 38.

WARNING! Do not set the drive for Automatic Restart unless you are sure it will not cause injury or death in your application.

a. Manual Restart for "All Faults" Including AC Power Loss (Keypad Operation and External Run/Stop Contacts) – The drive has been factory programmed for a manual restart for "all faults" including a Short-Term AC power loss. See Tables 13A and 13B. Also see "All Faults" Notes, on page 39.

TABLE 13A – MANUAL RESTART FOR "ALL FAULTS" INCLUDING AC POWER LOSS – KEYPAD OPERATION (FACTORY SETTING)

Function Number	Function Description	Code/Value	Description of Code/Value
F010	Run/Stop-Forward/Reverse Control	0000*	Keypad Operation
F032	Automatic AC Line Start (for Short-Term** Power Loss)	0000*	Disable Automatic AC Line Start
F035	Number of Auto Restart Attempts	0000*	Zero Auto Restart Attempts

** Factory Setting. ** Short-Term Power Loss: Display is illuminated ("LU-C" is displayed). Long-Term Power Loss: Display is off.*

TABLE 13B – MANUAL RESTART FOR "ALL FAULTS" INCLUDING AC POWER LOSS – EXTERNAL RUN/STOP CONTACTS

Function Number	Function Description	Code/Value	Description of Code/Value
F010	Run/Stop-Forward/Reverse Control	0001	External Run/Stop Contacts
F016	Auto AC Line Start	0011	Disable Auto AC Line Start when External Run Command is On
F032	Automatic AC Line Start (for Short-Term** Power Loss)	0000*	Disable Automatic AC Line Start
F035	Number of Auto Restart Attempts	0000*	Five Auto Restart Attempts

** Factory Setting. ** Short-Term Power Loss: Display is illuminated ("LU-C" is displayed). Long-Term Power Loss: Display is off.*

Note: To restart the drive after a short-term AC power loss (display illuminated "LU-C"), close and open the Reset contact or press the </RESET key. To eliminate the need to Reset the drive after a short-term power loss, set F032 = 0001 [Enable Automatic AC Line Start] . To restart the drive after a long-term AC power loss (display off), open and close the Run contact.

b. Automatic Restart for "All Faults" Except AC Power Loss (Keypad Operation and External Run/Stop Contacts) – The drive has been factory programmed for a manual restart for "all faults" including a Short-Term** AC power loss. To program the drive for automatic restart for "all faults" except AC power loss, see Tables 14A and 14B.

> ⚠ **WARNING!** Do not set the drive for Automatic Restart unless you are sure it will not cause injury or death in your application.

TABLE 14A – AUTOMATIC RESTART FOR "ALL FAULTS" EXCEPT AC POWER LOSS – KEYPAD OPERATION

Function Number	Function Description	Code/Value	Description of Code/Value
F010	Run/Stop-Forward/Reverse Control	0000*	Keypad Operation
F032	Automatic AC Line Start (for Short-Term** Power Loss)	0000*	Disable Automatic AC Line Start
F035	Number of Auto Restart Attempts	0005	Five Auto Restart Attempts

** Factory Setting. ** Short-Term Power Loss: Display is illuminated ("LU-C" is displayed). Long-Term Power Loss: Display is off.*

TABLE 14B – AUTOMATIC RESTART FOR "ALL FAULTS" EXCEPT AC POWER LOSS – EXTERNAL RUN/STOP CONTACTS

Function Number	Function Description	Code/Value	Description of Code/Value
F010	Run/Stop-Forward/Reverse Control	0001	External Run/Stop Contacts
F016	Auto AC Line Start	0011	Disable Auto AC Line Start when External Run Command is On
F032	Automatic AC Line Start (for Short-Term** Power Loss)	0000*	Disable Automatic AC Line Start
F035	Number of Auto Restart Attempts	0005	Five Auto Restart Attempts

** Factory Setting. ** Short-Term Power Loss: Display is illuminated ("LU-C" is displayed). Long-Term Power Loss: Display is off.*

Notes: 1. *When Function F016 is set to "0011", the drive can be Reset for "Short-Term" Power Loss without having to open and close the Run contact.*

> ⚠ **WARNING! If Function F016 is left at factory setting ("0000"), the drive will automatically restart due to a "long-term" power loss.**

2. Auto Restart Delay [F034] – *The drive can also be set to delay the Automatic Restart (after a fault has cleared) for up to 800 seconds. This feature is useful for applications where a certain amount of time should elapse (after a fault has cleared) before turning back on. Set F034 to the desired delay time, in Seconds (example: To set the Auto Restart Delay Time to 120 seconds, set F034 to "0120" (factory setting is "0000"). This feature does not operate for Automatic AC Line Start.*

c. Automatic Restart for All Faults Including AC Power Loss (with and without External Run/Stop Contacts) – If the application requires that the drive automatically restart after a fault has cleared, including an AC power loss, set functions F010, F016, F032, and F035 as shown in Table 15, on page 39.

Note: If external contacts for Run/Stop Operation are not required, the drive must still be set for "external contacts" (F010 set to "0001") and a jumper must be installed between Terminals 3 and 5 of Terminal Block TM2.

> ⚠ **WARNING!** Do not set the drive for Automatic Restart unless you are sure it will not cause injury or death in your application.

TABLE 15 – AUTOMATIC RESTART FOR "ALL FAULTS" INCLUDING AC POWER LOSS WITH OR WITHOUT EXTERNAL RUN/STOP CONTACTS**

Function Number	Function Description	Code/Value	Description of Code/Value
F010	Run/Stop-Forward/Reverse Control	0001	External Run/Stop Contacts
F016	Auto AC Line Start	0000*	Enable Auto AC Line Start when External Run Command is On
F032	Automatic AC Line Start (for Short-Term*** Power Loss)	0001	Enable Automatic AC Line Start
F035	Number of Auto Restart Attempts	0005	Five Auto Restart Attempts

** Factory Setting. ** For Automatic Restart **without** External Run/Stop Contacts, install a jumper between terminals "3" (FWD), and "5" (COM) of Terminal Block TM2. *** Short-Term Power Loss: Display is illuminated ("LU-C" is displayed). Long-Term Power Loss: Display is off.*

"All Faults" Notes: 1. *The faults that are automatically reset are indicated by the following codes: OC-S, OC-A, OC-C, OC-d, OC-b, OU-C, LU-C, OH-C.* ***2.*** *The drive must be manually restarted for an overcurrent fault (OL1, OL2, OL3) by pressing the </RESET key or using an external reset. (See Table 22, on pages 74 and 75, for Fault Codes Description.)*

Application Note: **Normal Start Mode or Spin-Start Mode with High Inertial Loads –** In Normal Start Mode, when the AC line is reapplied (after the display turns off), the drive brakes the motor to zero speed and then accelerates (using F001) to the set speed. In Spin-Start Mode, when the AC line is reapplied (after the display turns off), the drive catches the spinning load and quickly accelerates it to the set speed. The drive is factory set for Normal Start Mode (F048 is set to "0000"). To set the drive for Spin-Start Mode, set F048 to "x1xx". Note, in Manual Restart Mode, if the drive is stopped and started with the Start/Stop Switch, the drive will "catch" the spinning load and accelerate (using F001) to the set speed, whether it is in Normal Start Mode or Spin-Start Mode.

6. **Load Regulation and Torque Boost (F047, F072, F005, F075, F076, F070) –** The drive contains two methods of stabilizing motor speed as a function of load. Between the operating range of 15 Hz to 60 Hz, Slip Compensation is used to stabilize motor speed. Below 15 Hz, Torque Boost is used. Depending on the load type, Slip Compensation and/or Torque Boost can be used.

   a. **Motor Current Display (F047) –** In order to analyze proper motor operation, it is desirable to set the drive to read motor current (Amps AC). This is accomplished by setting Function F047 to "0100" [Enable Motor Current Display] as follows. Function F047 can be set with the drive in Run Mode or Stop Mode.

To change the code setting of F047 from “0000” to “0100”:

1. Press the DSP/FUN key to display Function Number.
2. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until “F047” is displayed. ***Note:*** *The setable digit will flash.*
3. Press the READ/ENTER key. The function setting will be displayed. Factory setting is “0000”.
4. Press the </RESET key two times to move to the second digit and press the ▲ key one time. “0100” will be displayed.
5. Press the READ/ENTER key to “enter” the new Display Mode. “End” will be momentarily displayed, which confirms the new Display Mode setting. “F047” will be displayed.
6. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.
7. Press the DSP/FUN key to toggle between Frequency, Function Number, and Motor Current.

b. Load Type (F072, F005) – Generally, motor loads can be categorized into three types: 1 - Constant Torque, 2 - Variable Torque, and 3 - Widely Changing Load.

1. **Constant Torque Load (F072) –** A load that does not vary substantially over the drive’s speed range (example: conveyors, printing presses). The drive is factory set to operate most constant torque loads over a 4:1 speed range (15 - 60 Hz). If a wider range of operation is required, Torque Boost must be set using Function F072. F072 can be set with the drive in Run Mode or Stop Mode.

   To change the setting of F072 from “000.0” to “004.0” (4.0% is recommended as an initial setting). ***Note:*** *The 4% boost is in addition to the 7.5% boost established by the factory Volts/Hz curve.*

   a. Press the DSP/FUN key to display Function Number.

   b. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until “F072” is displayed. ***Note:*** *The setable digit will flash.*

   c. Press the READ/ENTER key. The function setting will be displayed. Factory setting is “000.0”.

   d. Press the </RESET key one time to move to the third digit. ***Note:*** *The setable digit will flash (00”0”.0).*

   e. Press the ▲ key four times. “004.0” is displayed .

   f. Press the READ/ENTER key to “enter” the new Torque Boost. “End” will be momentarily displayed, which confirms the new Torque Boost setting. “F072” will be displayed.

   g. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

Motor Current Procedure – After resetting Torque Boost, use the Motor Current Display to read motor current. Use the DSP/FUN key to toggle the display between the last function number (F072), Frequency (Hz), and Motor Current (Amps AC). ***Note:*** *When motor current is indicated on the display, the "AMP" LED on the keypad will illuminate.*

To ensure the nameplate motor current is not exceeded, vary the drive frequency over the entire operating range while reading the Motor current Display. This should be done at no load and full load. If the load current exceeds the motor nameplate rating when above 15 Hz, the load may be excessive due to improperly adjusted belts or defective bearings. If the load current exceeds the motor nameplate rating below 15 Hz, the boost may need to be adjusted above or below its initial setting.

2. **Variable Torque Load (F005) –** A load that increases as the speed of operation increases (fans, blowers, centrifugal pumps). To set the drive for Variable Torque Loads, use Function F005 [Volts/Hz Pattern] as follows. **Set F005 to "0013" for 60 Hz motors or to "0004" for 50 Hz motors. See Section IX, Function F005, on page 55.**

   To set the drive for a Variable Torque Load:

   a. The drive must be in Stop Mode (press the RUN/STOP key).

   b. Press the DSP/FUN key to display Function Number.

   c. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "F005" is displayed. ***Note:*** *The setable digit will flash.*

   d. Press the READ/ENTER key. The function setting will be displayed. Factory setting is "0009".

   e. Press a the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "0013" (for 60 Hz motors) or "0004" (for 50 Hz motors) is displayed. ***Note:*** *The setable digit will flash.*

   f. Press the READ/ENTER key to "enter" the setting for Variable Torque Loads ("0013" or "0004"). "End" will be momentarily displayed, which confirms the Variable Torque Load setting. "F005" will be displayed.

   g. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

   Note: *To ensure the system is operating properly, the motor current should be monitored over the entire speed range. See Motor Current Procedure above.*

3. **Widely Changing Load (F075, F076) –** A load that can increase or decrease at any set speed (example: drill presses, positive displacement pumps, machine tools). In order for the drive to stabilize motor speed over a widely changing load, a combination of Slip Compensation and Torque Boost may have to be used. If the motor operating speed range is limited to 4:1 ratio (15 - 60 Hz) Slip Compensation must be used.

To set Slip Compensation, use the following functions. See Table 16, on page 43.

Notes: 1. *If a 50 Hz motor is used, Function F005 will have to be reprogrammed (see Section VIII-C-2, on page 32) and Motor Full Load Rating must be entered using F070 (see Table 20, on page 68).* ***2.*** *Slip Comp does not function properly when controlling multiple motors with a single drive.*

a. Motor No Load Current [F075] – ***Note:*** *If the motor no load current cannot be taken, use the factory default setting.* See Table 21, Section IX, Function F075, on page 69. Motor No Load Current (Amps AC) can be easily read using the Motor Current Procedure, as described in Section VIII-D-6-b-1, on page 41. To read the correct no load current, run the motor at no load at a frequency of approximately 40 Hz or above.

To set the Motor No Load Current after taking the motor no load current reading:

1. The drive must be in Stop Mode (press the RUN/STOP key).
2. Press the DSP/FUN key to display Function Number.
3. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "F075" is displayed. ***Note:*** *The setable digit will flash.*
4. Press the READ/ENTER key. The factory default setting for Motor No Load Current will be displayed, as shown in Table 21, on page 70.
5. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until the actual Motor No Load Current (Amps AC) is displayed. ***Note:*** *The setable digit will flash.*
6. Press the READ/ENTER key to "enter" the Motor No Load current. "End" will be momentarily displayed, which confirms the Motor No Load Current. "F075" will be displayed.
7. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

Notes: 1. *If the motor cannot be operated at "no load", run it at the lowest possible load in the application.* ***2. If the no load current cannot be obtained, the factory default setting can be used.***

b. Motor Rated Slip [F076] – Motor Rated Slip (Hz) can be obtained using the following formula. Function F076 is factory set to "00.00".

$$\text{Motor Slip (Hz)} = \text{Asynchronous Motor Frequency (60 Hz or 50 Hz)} - \frac{\text{Nameplate Rated Motor RPM} \times \text{Number of Motor Poles}}{120}$$

Example: Motor Slip = 60 - [(1725 X 4) ÷ 120] = 60 - 57.5 = 2.5 Hz

To set the Motor Rated Slip:

1. Press the DSP/FUN key to display Function Number.
2. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until "F076" is displayed. ***Note:*** *The setable digit will flash.*
3. Press the READ/ENTER key. The factory default setting for Motor Rated Slip will be displayed. ("00.00").
4. Press the </RESET key to move the setable digit one position to the left and the ▲ or ▼ key until the desired Motor Rated Slip (Hz) is displayed. ***Note:*** *The setable digit will flash.*
5. Press the READ/ENTER key to "enter" the Motor Rated Slip. "End" will be momentarily displayed, which confirms the Motor Rated Slip setting. "F076" will be displayed.
6. Press the DSP/FUN key to return to the frequency display or press the ▲ or ▼ key to change to another function number.

   If the operating speed range is below 15 Hz, Torque Boost must also be used. See Section VIII-D-6-b-1 on page 40, for Torque Boost setting using Function F072. Be sure to follow the Motor Current Procedure, as described in Section VIII-D-6-b-1, on page 41. The drive is now ready to control widely changing loads over the operating speed range. See Table 16.

   Notes: 1. *Asynchronous Motor Frequency is 50 Hz or 60 Hz.* ***2.*** *F076 can be set with the drive in Run Mode or Stop Mode.*

4. **Special Motors –** Although most motors are designed for 50 Hz and/or 60 Hz operation at full output voltage of the drive, some motors operate at other frequencies. Figure 22, on page 44, illustrates how the drive can be set for a motor rated 400 Hz - 230 Volts AC. Section IX, Functions F037 through F041, on pages 60 and 61. Set F005 to "0018" [Custom Volts/Hz Pattern].

TABLE 16 – FUNCTIONS F070, F071, F075, F076, F005 SET FOR WIDELY CHANGING LOADS

Function Number	Description	Setting
F070	Motor Current	Enter motor nameplate current rating or use the factory default setting.
F071	Torque Boost	"004.0" (factory setting is "0000").
F075	Motor No Load Current	Enter the actual motor no load current or use the factory default setting.
F076	Rated Slip	See formula above.
F005	Volts/Hz Curve	"0009" (factory Setting) for 60 Hz Motors. "0000" for 50 Hz Motors.

7. **Display Modes [F047, F051, F052] –** Sets the display to show various parameters. Figure 23, on page 44, shows the basic display of Motor Frequency and Function Number. Press the DSP/FUN key repeatedly to toggle the display through Motor Frequency and Function Number.

a. Motor Voltage, Bus Voltage, and Motor Current Display Modes [F047] – Adds Motor Voltage, Bus Voltage, and Motor Current to the basic display. Function F047 is factory set to "0000", which disables the displays. Figure 24, shows Motor Voltage, Bus Voltage, and Motor Current added to the basic display. Press the DSP/FUN key repeatedly to toggle the display through Drive Output Frequency (or Motor RPM), Function Number, Motor Voltage, Bus Voltage, and Motor Current. To enable all three parameters set F047 to "0111". The respective "status" indicator will illuminate when a specific parameter is displayed. See Section IX, F047, on page 63.

FIGURE 22 – CUSTOM VOLTS/HZ PATTERN FOR A 400 Hz - 230 VOLT AC MOTOR

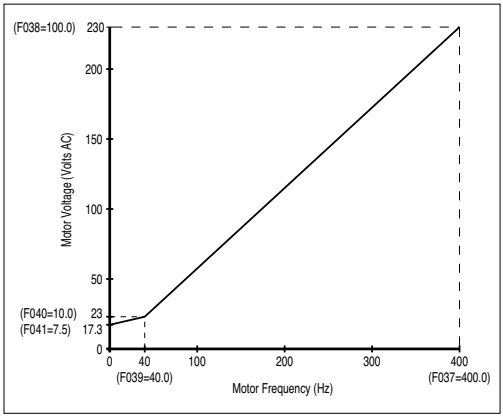


FIGURE 23 – FLOW CHART FOR BASIC DISPLAY

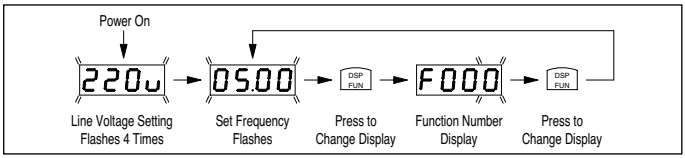
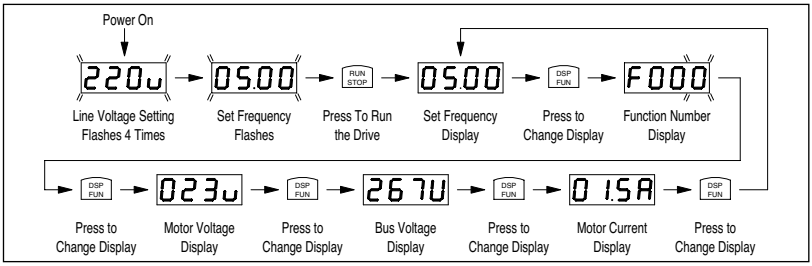


FIGURE 24 – FLOW CHART SHOWING MOTOR VOLTAGE, BUS VOLTAGE AND MOTOR CURRENT ADDED TO THE BASIC DISPLAY

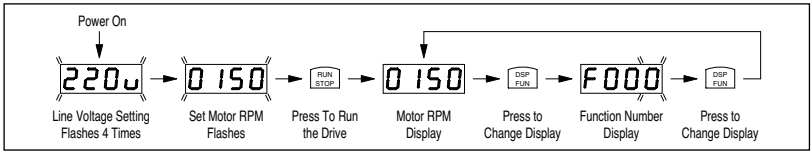


Note: *The digital display will distinguuish between Motor Voltage and Bus Voltage by displaying a small "u" for Motor Voltage and a large "U" for Bus Voltage.*

b. Drive output Frequency and Motor RPM [F051] – Changes the basic display from Drive Output Frequency to Motor RPM. Function F051 is factory set to "0000", to display Drive Output Frequency. Figure 25 shows the basic display changed to Motor RPM and Function Number. To change the display to Motor RPM, set F051 to "0001". (See Section IX, Function F051, on page 64.)

Notes: 1. *The RPM display has been factory set for 4-pole motors using F036 = "0004". For motors with other than 4-poles, set F036 to the actual number of motor poles.* ***2.*** *F051 is also used to set the decimal place for Function F052 [Line Speed Display (Custom Units)].*

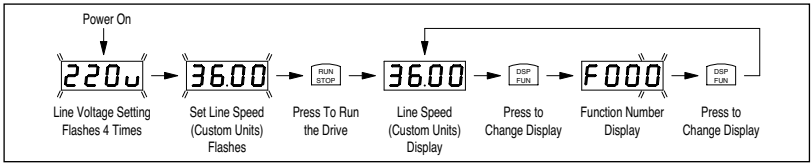
FIGURE 25 – FLOW CHART SHOWING THE BASIC DISPLAY CHANGED FROM DRIVE OUTPUT FREQUENCY TO MOTOR RPM



c. Line Speed Display (Custom Units) [F052] – Changes the basic display from Drive Output Frequency to Custom Units. F052 is factory set to "1800", which represents motor RPM at full output speed of the drive. Enter the significant digits of the desired Custom Units value. This value is equal to the actual process output at the Output Frequency Upper Limit setting of the drive (F006). Use Function F051 to set the decimal place. Figure 26 shows the Custom Units set to 36.00. See Section IX, Functions F051 and F052, on page 64.

Example – To display 36.00 at full output frequency of the drive, set F052 to "3600" (four significant digits) and set F051 to "0004" (code represents two decimal places).

FIGURE 26 – FLOW CHART SHOWING THE BASIC DISPLAY CHANGED FROM DRIVE OUTPUT FREQUENCY TO LINE SPEED (CUSTOM UNITS)



8. Overtorque Control [F077, F078, F079] – In addition to Motor Overload Protection, the drive can also provide overtorque indication or shut down in applications where the torque (or load) cannot be exceeded. Example: to prevent breakage in a film winding application if the load on the film increases beyond a preset point. Overtorque indication can be monitored using Terminals 10, 11 (Open Collector, F061 = "0005") or Terminals 1, 2 (Output Relay, F098 = "0001"). The display will indicate "OL3" when the drive is in overtorque.

Function F077 is used to "enable" Overtorque Control and set the mode of operation.

Function F078 sets the Overtorque Threshold as a percent of full rated motor current. Example: if a motor is used in an application where the load cannot exceed 100 % of full rated torque, set F078 = "0100".

Function F079 sets the amount of time the load is allowed to stay in "overtorque" before the display indicates the overload condition ("OL3") and a programmed "overtorque" function activates.

E. Programmable Functions (Summary) – All functions have been factory set for most applications, as shown in Table 17. See Section IX, beginning on page 53, for a detailed description of each function.

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F000	Drive Horsepower (Code)	0001 - 0040 (See Table 18, on page 53)	—	53	—
F001*	Acceleration Time # 1 (Seconds)	0.1 - 3600	010.0	53	
F002*	Deceleration Time # 1 (Seconds)	0.1 - 3600	010.0	54	
F003	External Forward-Stop-Reverse Control (F010 must be set to "0001")	xx00: Forward/Stop-Reverse/Stop xx01: Run/Stop-Forward/Reverse xx10: 3-Wire Start/Stop Control x0xx: Enable Reverse Command x1xx: Disable Reverse Command 0xxx: When the Multifunction Input Terminals are Programmed for Up/Down Frequency Control, the "Set Frequency" will Remain when the Drive is in "STOP" 1xxx: When the Multifunction Input Terminals are Programmed for Up/Down Frequency Control, the "Set Frequency" will Revert to "Zero" when the Drive is in "STOP"	0000	54	
F004	Parameter Lockout	xxx0: Enable F017 - F025 xxx1: Disable F017 - F025 xx0x: Enable All Functions Except F017 - F025 xx1x: Disable All Functions Except F017 - F025	0000	54	
F005	Volts/Hz Pattern	0000: Constant Torque - 50 Hz Motors 0004: Variable Torque (HVAC) - 50 Hz Motors 0009: Constant Torque - 60 Hz Motors 0013: Variable Torque (HVAC) - 60 Hz Motors 0018: Custom Volts/Hz Pattern See F037 - F041)	0009	55	
F006	Output Frequency Upper Limit (Hz)	0.01 - 400.0	60.00	56	
F007	Output Frequency Lower Limit (Hz)	0.00 - 400.0	0.00	56	
F008	Multifunction Open Collector Output - Frequency Reached (Hz)	0.00 - 400.0	0.00	56	
F009	Bandwidth Setting (±) (Hz)	0.00 - 30.00	0.00	56	
F010	Run/Stop-Forward/Reverse Control	0000: Keypad Operation 0001: External Run/Stop Contacts (See F003)	0000	56	
F011	Frequency Control Method	0000: Keypad (See F025) 0001: Potentiometer on Keypad 0002: External Analog Signal Input or Remote Potentiometer 0003: Up/Down Frequency Control Using Multifunction Input Terminals 6, 7 (or 8)	0000	56	

** Functions which can be changed while the drive is in Run Mode.*

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST (CONTINUED)

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F012	Trip Prevention	xxx0: Enable Trip Prevention During Acceleration xxx1: Disable Trip Prevention During Acceleration xx0x: Enable Trip Prevention During Deceleration xx1x: Disable Trip Prevention During Deceleration x0xx: Enable Trip Prevention In Run Mode x1xx: Disable Trip Prevention In Run Mode 0xxx: Trip Prevention Deceleration Time Set by F002 1xxx: Trip Prevention Deceleration Time Set by F015	0000	57	
F013	Trip Prevention Level During Acceleration (%)	30 - 200	110	57	
F014	Trip Prevention in Run Mode (%)	30 - 200	160	57	
F015*	Trip Prevention Deceleration Time (Seconds)	0.1 - 3600	3.0	57	
F016	Auto AC Line Start, Reset, Run/Stop Signal Verification Scan Time	xxx0: Enable Auto AC Line Start when External Run Command is On xxx1: Disable Auto AC Line Start when External Run Command is On xx0x: Enable Reset Only if Run Command is Off xx1x: Enable Reset Whether Run Command is On or Off 00xx: Scan Time: 20 mS 01xx: Scan Time: 10 mS 10xx: Scan Time: 6 mS 11xx: Scan Time: 2 mS	0000	57	
F017*	Preset Speed # 1 Frequency (Hz)	00.00 - 400.0	5.00	58	
F018*	Preset Speed # 2 Frequency (Hz)	00.00 - 400.0	10.00	58	
F019*	Preset Speed # 3 Frequency (Hz)	00.00 - 400.0	20.00	58	
F020*	Preset Speed # 4 Frequency (Hz)	00.00 - 400.0	30.00	58	
F021*	Preset Speed # 5 Frequency (Hz)	00.00 - 400.0	40.00	58	
F022*	Preset Speed # 6 Frequency (Hz)	00.00 - 400.0	50.00	58	
F023*	Preset Speed # 7 Frequency (Hz)	00.00 - 400.0	60.00	58	
F024*	Jog Frequency (Hz)	00.00 - 400.0	2.00	58	
F025*	Keypad Frequency (Hz)	00.00 - 400.0	5.00	58	
F026*	Analog Input Frequency Offset (Hz)	00.00 - 400.0	0.00	58	
F027*	Analog Input Signal Reference Ratio (%)	0.0 - 100.0	0.0	58	
F028*	Analog Input Scaling Reference Ratio (%)	0.0 - 100.0	100.0	59	
F029*	Analog Input Signal Slope (Low-to-High / High-to-Low)	0000: Low-to-High (Positive Slope) 0001: High-to-Low (Negative Slope)	0000	59	
F030*	AC Line Input Voltage (Volts AC)	180.0 - 528.0	220/460	59	
F031*	AC Power Loss Ride-Through Time (Seconds)	0.0 - 2.0	0.5	59	

** Functions which can be changed while the drive is in Run Mode.*

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST (CONTINUED)

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F032	Automatic AC Line Start (for Short-Term Power Loss)	0000: Disable Automatic AC Line Start 0001: Enable Automatic AC Line Start	0000	59	
F033*	Analog Signal Input Scan Time (mS X 2)	1 - 100	100	59	
F034	Auto Restart Delay Time (Seconds)	0.0 - 800.0	0.0	59	
F035	Number of Auto Restart Attempts	0 - 10	0	60	
F036	Number of Motor Poles	2 - 72	4	60	
F037	Volts/Hz Pattern Maximum Frequency (Hz)	50.00 - 400.0	60.00	60	
F038	Volts/Hz Pattern Voltage Ratio (%)	0.0 - 100.0	100.0	60	
F039	Volts/Hz Pattern Mid Frequency (Hz)	0.11 - 400.0	3	60	
F040	Volts/Hz Pattern Mid Voltage Ratio (%)	0 - 100.0	7.5	60	
F041	Volts/Hz Pattern Voltage Ratio at 0.1 Hz (%)	0 - 100.0	7.5	61	
F042	Start Frequency (Hz)	0.10 - 10.00	1.00	61	
F043	Switching Frequency (Code)	0000: 1.0 kHz 0006: 3.6 kHz 0012: 8.0 kHz 0001: 1.2 kHz 0007: 4.0 kHz 0013: 9.0 kHz 0002: 1.8 kHz 0008: 4.8 kHz 0014: 10 kHz 0003: 2.0 kHz 0009: 5.0 kHz 0015: 12 kHz 0004: 2.4 kHz 0010: 6.0 kHz 0005: 3.0 kHz 0011: 7.2 kHz	0014	61	
F044	Stop Method	0000: Controlled Deceleration-to-Stop with DC Injection Braking (Rapid Stop) 0001: Coast-to-Stop	0000	61	
F045*	Analog Output Voltage Gain (%)	0 - 200	100	62	
F046*	Multifunction Analog Output Voltage Mode (Terminals 14, 15)	0000: Output Frequency 0002: Drive Output Voltage 0001: Set Frequency 0003: Bus Voltage	0000	63	
F047*	Display Mode (Volt., Curr.)	xxx0: Disable Motor Voltage Display xxx1: Enable Motor Voltage Display xx0x: Disable Bus Voltage Display xx1x: Enable Bus Voltage Display x0xx: Disable Motor Current Display x1xx: Enable Motor Current Display	0000	63	
F048	Dynamic Brake, Stop Priority, Spin-Start, Automatic Voltage Regulator	xxx0: Enhanced Braking xxx1: Standard Braking xx0x: Stop Key Enabled with External Contacts (F010 = "0001") xx1x: Stop Key Disabled with External Contacts (F010 = "0001") x0xx: Spin-Start Controlled by Multifunction Input Terminals x1xx: Enable Spin-Start when the Drive is in Run Mode 0xxx: Enable Automatic Voltage Regulator 1xxx: Disable Automatic Voltage Regulator	0000	63	

** Functions which can be changed while the drive is in Run Mode.*

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST (CONTINUED)

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F049*	Acceleration Time # 2 (Seconds)	0.1 - 3600	10.0	63	
F050*	Deceleration Time # 2 (Seconds)	0.1 - 3600	10.0	64	
F051*	Display Mode (Freq., RPM, Line Speed Decimal Place)	0000: Drive Output Frequency is Displayed 0001: Motor RPM is Displayed (see F036) 0002: Line Speed Displayed in Whole Numbers (xxxx) 0003: Line Speed Displayed with One Decimal Place (xxx.x) 0004: Line Speed Displayed with Two Decimal Places (xx.xx) 0005: Line Speed Displayed with Three Decimal Places (x.xxx)	0000	64	
F052*	Line Speed Display (Custom Units)	0 - 9999	1800	64	
F053	DC Injection Brake Time (Seconds)	0.0 - 25.5	0.5	65	
F054	DC Injection Brake Start Frequency (Hz)	0.1 - 10.0	1.5	65	
F055	DC Injection Brake Level (%)	0.0 - 20.0	8.0	65	
F056	Multifunction Input Terminal 6 (SP1)	**Close Contact to Activate (NO)** 0000: Preset Speed # 1 0001: Preset Speed # 2 0002: Preset Speed # 4 0003: Jog 0004: Accel/Decel # 2 0005: Rapid Stop (E.S.) 0006: Coast-to-Stop (b.b.) 0007: Spin-Start 0008: Energy Saving 0009: Remote Signal Operation 0010: Communication Selection 0011: Frequency Hold During Accel/Decel 0012: Up Command 0013: Down Command 0014: Sequence Control 0015: Master/Auxiliary Speed **Open Contact to Activate (NC)** 0016: Preset Speed # 1 0017: Preset Speed # 2 0018: Preset Speed # 4 0019: Jog 0020: Accel/Decel # 2 0021: Rapid Stop (E.S.) 0022: Coast-to-Stop (b.b.) 0023: Spin-Start 0024: Energy Saving 0025: Remote Signal Operation 0026: Communication Selection 0027: Frequency Hold During Accel/Decel 0028: Up Command 0029: Communication Section 0030: Sequence Control 0031: Master/Auxiliary Speed	0000	65	
F057	Multifunction Input Terminal 7 (SP2)		0001	66	
F058	Multifunction Input Terminal 8 (SP3)		0002	66	
F059	Reserved	—	—	67	
F060	Reserved	—	—	67	

** Functions which can be changed while the drive is in Run Mode.*

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST (CONTINUED)

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F061	Multifunction Output Terminals 10, 11 (Open Collector)	0000: Run 0001: Frequency Reached 0002: Set Frequency (F008 ± F009) 0003: Frequency Greater than Target Frequency (F008) 0004: Frequency Less than Target Frequency (F008) 0005: Trip Due to Overload 0006: Change 0000 (Run) from Normally Open to Normally Closed	0000	67	
F062	Reserved	—	—	67	
F063	Reserved	—	—	67	
F064	Reserved	—	—	67	
F065	Skip Frequency # 1 (Hz)	0.00 - 400.0	0.00	67	
F066	Skip Frequency # 2 (Hz)	0.00 - 400.0	0.00	67	
F067	Skip Frequency # 3 (Hz)	0.00 - 400.0	0.00	67	
F068	Skip Frequency Bandwidth (Hz)	0.00 - 10.0	0.00	67	
F069	Electronic Motor Overload Protection Operation Mode	xxx0: Enable Electronic Motor Overload Protection xxx1: Disable Electronic Motor Overload Protection xx0x: Electronic Motor Overload Protection Set for Non Inverter Duty Motor xx1x: Electronic Motor Overload Protection Set for Inverter Duty Motor x0xx: Constant Torque (OL = 103%) (150% for 1 minute) x1xx: Variable Torque (OL = 113%) (123% for 1 minute) 0xxx: Coast-to-Stop after Overload Protection is Activated 1xxx: Drive will Not Trip when Overload Protection is Activated (“OL1” will be Displayed)	0000	68	
F070	Motor Rated Current (Amps AC)	Enter the Motor Nameplate Rated Current	Table 20	68	
F071	Drive Overload Protection Enable/Disable and Torque Boost Mode	xxx0: Enable Drive Overload Protection xxx1: Disable Drive Overload Protection x0xx: Enable F072 x1xx: Disable F072	0000	68	
F072*	Volts/Hz Curve Modification (Torque Boost) (%)	0.0 - 10.0	0.0	69	
F073	Reserved	—	—	69	
F074	Reserved	—	—	69	
F075	Motor No Load Current (Amps AC)	Enter the No Load Motor Current	Table 21	69	
F076*	Motor Rated Slip (Hz)	0.00 - 6.00	0.00	69	
F077	Overtorque Control	xxx0: Disable Overtorque Detection xxx1: Enable Overtorque Detection xx0x: Enable Overtorque Detection Only if at Set Frequency xx1x: Enable Overtorque Detection while the Drive is in Run Mode x0xx: Drive will Continue to Operate After Overtorque is Detected x1xx: Coast-to-Stop After Overtorque is Detected	0000	70	

** Functions which can be changed while the drive is in Run Mode.*

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST (CONTINUED)

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F078	Overtorque Detection Level (%)	30 - 200	160	70	
F079	Overtorque Detection Time (Sec.)	0.0 - 25.0	0.1	71	
F080	Accel/Decel S-Curve Time # 1 (Sec.)	0.0 - 4.0	0.2	71	
F081	Accel/Decel S-Curve Time # 2 (Sec.)	0.0 - 4.0	0.2	71	
F082	Energy Saving Mode	xx00: Disable Energy Saving xx01: Energy Saving Controlled by Multifunction Input Terminals	0000	71	
F083*	Energy Saving Gain (%)	0 - 100	80	71	
F084	Process Timer Operation Mode	xxx0: Disable Process Timer xxx1: Enable Process Timer xx0x: Set Frequency Output After Process Timer Completes xx1x: Zero Speed Output After Process Timer Completes x1xx: Automatically Repeat Process Timer Operation	0000	71	
F085	Process Timer # 1 Time (Seconds)	0.0 - 3600	0.0	71	
F086	Process Timer # 2 Time (Seconds)	0.0 - 3600	0.0	71	
F087	Process Timer # 3 Time (Seconds)	0.0 - 3600	0.0	71	
F088	Process Timer # 4 Time (Seconds)	0.0 - 3600	0.0	71	
F089	Process Timer # 5 Time (Seconds)	0.0 - 3600	0.0	71	
F090	Process Timer # 6 Time (Seconds)	0.0 - 3600	0.0	71	
F091	Process Timer # 7 Time (Seconds)	0.0 - 3600	0.0	71	
F092*	Vibration Control Time (Seconds)	1 - 100	5	72	
F093	Vibration Control Gain (%)	0.0 - 100	0	72	
F094	Vibration Control Bias (%)	0 - 30	0	72	
F095	Factory Setting	—	—	72	
F096	Factory Setting	—	—	72	
F097	Multifunction Output Relay (Terminals 1, 2)	xxx0: Disabled in Auto Restart Mode xxx1: Operational in Auto Restart Mode xx0x: Disabled During Momentary Power Loss xx1x: Operational During Momentary Power Loss x0xx: Disabled in Rapid Stop mode x1xx: Operational in Rapid Stop Mode 0xxx: Disabled in Coast-to-Stop Mode 1xxx: Operational in Coast-to-Stop Mode	0000	72	
F098	Multifunction Output Relay (Terminals 1, 2)	xxx0: Disabled when Overtorque Control is Activated xxx1: Operational when Overtorque Control is Activated xx0x: Disabled when Electronic Motor Overload Protection is Activated xx1x: Operational when Electronic Motor Overload Protection is Activated x0xx: Contacts are Normally Open x1xx: Contacts are Normally Closed 0xxx: Disabled when Drive Overload Protection is Activated 1xxx: Operational when Drive Overload Protection is Activated	0000	72	

** Functions which can be changed while the drive is in Run Mode.*

TABLE 17 – PROGRAMMABLE FUNCTIONS SUMMARY LIST (CONTINUED)

Function Number	Function Description	Function Range/Code	Factory Setting	Page No.	User Setting
F099	Reserved	—	—	73	
F100	Communication Identification Number	1 - 32	1	73	
F101	Communication Baud Rate (bps)	0000: 4800 0001: 9600 0002: 19200 0003: 38400	0001	73	
F102	Communication Parameters	xxx0: 1 Stop Bit xxx1: 2 Stop Bits xx0x: Even Parity xx1x: Odd Parity x0xx: Without Parity x1xx: With Parity 0xxx: 8-Bit Data 1xxx: 7-Bit Data	1100	73	
F103	Factory Setting Only	—	—	73	
F104	Factory Setting Only	—	—	73	
F105	Factory Setting Only	—	—	73	
F106	Factory Setting Only	—	—	73	
F107	Reserved	—	—	73	
F108	Reserved	—	—	73	
F109	Reserved	—	—	73	
F110	Reserved	—	—	73	
F111	Reserved	—	—	73	
F112	Reserved	—	—	73	
F113	Reserved	—	—	73	
F114	Reserved	—	—	73	
F115	Reserved	—	—	73	
F116	Reserved	—	—	73	
F117	Reserved	—	—	73	
F118	Reserved	—	—	73	
F119	Reserved	—	—	73	
F120	Reserved	—	—	73	
F121	Reserved	—	—	73	
F122	Reserved	—	—	73	
F123	Reset Drive to Factory Settings	1110: Reset for 50 Hz Motor Operation 1111: Reset for 60 Hz Motor Operation	0000	73	
F124	CPU Program Version	—	—	74	
F125	Logs Last 3 Faults that Occurred	See Table 22, on pages 74 - 76.	—	74	

** Functions which can be changed while the drive is in Run Mode.*

IX. PROGRAMMABLE FUNCTIONS (Detailed)

The KBN2 Series drive contains user programmable functions which are described below. See Section VIII-A and VIII-B, on pages 27-31, for Digital Keypad Description and Operation.

Note: *Function F123 is used to reset the drive to factory settings. Function F123, however, will not change the settings in Functions F000, F030, F100 - F122, and F124.*

FUNCTION CODE REPRESENTATION

"x0xx" and "x1xx" indicate that only the "0" in "x0xx" and the "1" in "x1xx" is significant in describing the function presented. The "x" is used for another function described under the same function number.

F000 DRIVE HORSEPOWER CODE

Factory Setting: Set According to Model No. F000 is used to set the drive to the horsepower of the motor used with the drive. See Table 18.

TABLE 18 – DRIVE MODEL AND HORSEPOWER CODE SETTING

Model No.	Part No.	Drive Rating		F000 Code (Factory Setting)
		HP	kW	
KBN2-2250-1	12000	.50	.37	0001
KBN2-2201-1	12010	1	.75	0002
KBN2-2202-1	12020	2	1.5	0003
KBN2-2203-1	12030	3	2.2	0004
KBN2-2305-1	12040	5	3.7	0005
KBN2-2307-1	12050	7.5	5.6	0006
KBN2-2310-1	12060	10	7.5	0007
KBN2-2315-1	12070	15	11	0008
KBN2-2320-1	12080	20	15	0009
KBN2-2330-1	12090	30	22	0040
KBN2-4301-1	12100	1	.75	0010
KBN2-4302-1	12110	2	1.5	0011
KBN2-4303-1	12120	3	2.2	0012
KBN2-4305-1	12130	5	3.7	0013
KBN2-4307-1	12140	7.5	5.6	0014
KBN2-4310-1	12150	10	7.5	0015
KBN2-4315-1	12160	15	11	0016
KBN2-4320-1	12170	20	15	0017
KBN2-4330-1	12180	30	22	0018

F001 ACCELERATION TIME #1

Factory Setting: 10.00 Seconds. F001 sets Acceleration Time # 1. The acceleration time is the time it takes for the drive output to reach full speed as set in F006 [Output Frequency Upper Limit]. The acceleration time is based on zero speed to full speed.

If the drive is set to less than full speed, the acceleration time will be proportionally less. When accelerating high inertial loads, the acceleration time may be automatically extended due to the Trip Prevention Circuitry feature.

Programmable Range: 0.1 - 3600 Seconds

Note: *A second acceleration time (Acceleration Time # 2) is available by using one of the Multifunction Input Terminals ("6", "7", or "8"). See Section IX, Function F049, on page 63.*

F002 DECELERATION TIME # 1

Factory Setting: 10.00 Seconds. F002 sets Deceleration Time # 1. The deceleration time is the time it takes for the drive output setting to reach zero speed, as set in F007 [Minimum Output Frequency], after a stop or zero speed command is given. The deceleration time is based on full speed to zero speed.

If the drive is initially set to other than full speed, the deceleration time will be proportionally less. Also, when decelerating high inertial loads, the automatic regeneration protection circuit may activate. This circuit will extend the deceleration time to prevent the drive from tripping, due to overcharging the bus capacitors.

Programmable Range: 0.1 - 3600 Seconds

Note: *A second deceleration time (Deceleration Time # 2) is available by using one of the Multifunction Input Terminals ("6", "7", or "8"). See Section IX, Function F050, on page 64.*

F003 EXTERNAL FORWARD-STOP-REVERSE CONTROL

Factory Setting: 0000. F003 sets the drive for external forward/stop-reverse/stop or run/stop-forward/reverse control. Set F010 [Start/Stop Control] to "0001", for external Start/Stop operation. See Section V-A, on page 18.

F003 = xx00: Forward/Stop-Reverse/Stop
xx01: Run/Stop-Forward/Reverse
xx10: 3-Wire Start/Stop Control
x0xx: Enable Reverse Command
x1xx: Disable Reverse Command
0xxx: When the Multifunction Input Terminals are Programmed for Up/Down Frequency Control, the "Set Frequency" will Remain when the Drive is in "STOP"
1xxx: When the Multifunction Input Terminals are Programed for Up/Down Frequency Control, the Set Frequency will Revert to "Zero" when the Drive is in "STOP"

Notes: 1. *If both the FWD and REV contacts are closed, the drive will be in Stop Mode.* ***2.*** *If Reverse Operation does not function and "LOC" is displayed, change F003 to "x0xx".*

F004 PARAMETER LOCKOUT

Factory Setting: 0000. F004 enables or disables (locks out) a set of functions.

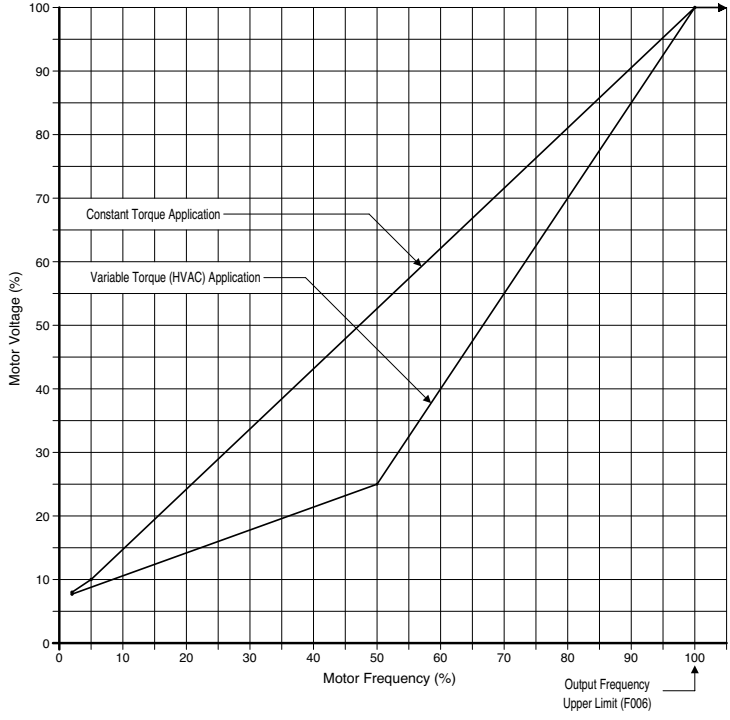
F004 = xxx0: Enable F017 - F025 (Preset Speeds)
xxx1: Disable F017 - F025 (Eliminates the ability to tamper with the Preset Speed Settings.)
xx0x: Enable All Functions Except F017 - F025
xx1x: Disable All Functions Except F017 - F025

F005 VOLTS/Hz PATTERN

Factory Setting: 0009 – F005 sets the Volts/Hz pattern for 60 Hz and 50 Hz motors or to set a Custom Volts/Hz Pattern. See Figure 27. The Volts/Hz pattern can be modified for specific applications by utilizing Function F072 [Volts/Hz Curve Modification (Torque Boost)]. See Section IX, F072, on page 69.

F005 = 0000: Constant Torque - 50 Hz Motors
0004: Variable Torque (HVAC) - 50 Hz Motors
0009: Constant Torque - 60 Hz Motors
0013: Variable Torque (HVAC) - 60 Hz Motors
0018: Custom Volts/Hz Pattern (See F037 - F041)

FIGURE 27 – VOLTS / Hz PATTERN (F005)



F006 OUTPUT FREQUENCY UPPER LIMIT

Factory Setting: 60.00 Hz. F006 sets the Output Frequency Upper Limit (maximum output frequency) of the drive.

Programmable Range: 0.01 - 400 Hz

F007 OUTPUT FREQUENCY LOWER LIMIT

Factory Setting: 0.00 Hz. F007 sets the Output Frequency Lower Limit (minimum output frequency) of the drive.

Programmable Range: 0.00 - 400 Hz

F008 MULTIFUNCTION OPEN COLLECTOR OUTPUT FREQUENCY SETTING "Frequency Reached"

Factory Setting: 0.00 Hz. F008 sets the frequency at which the Multifunction Open Collector Output (Terminals 10, 11) will change state when F061 is set to a specific operation mode. See Section IX, Function F061, on page 67.

Programmable Range: 0.00 - 400.0 Hz

F009 BANDWIDTH SETTING

Factory Setting: 0.00 Hz. F009 sets the bandwidth of the operation of F008.

Programmable Range: 0.00 - 30.00 Hz

F010 START/STOP CONTROL

Factory Setting: 0000. F010 sets either Keypad Operation or External Start/Stop Control

F010 = 0000: Keypad Operation
0001: External Run/Stop Contacts (See F003)

Note: *If F010 is set to "0001" [External Contacts], the Stop Function on the keypad (RUN/STOP key) remains operational.*

F011 FREQUENCY CONTROL METHOD

Factory Setting: 0000. F011 sets the drive for either keypad control or external signal input control (speed potentiometer, 0 - 5 VDC, 0 - 10 VDC, 0 - 20 mA DC, or 4 - 20 mA DC).

F011 = 0000: Keypad
0001: Potentiometer on Keypad
0002: External Analog Signal Input or Remote Potentiometer
0003: Up/Down Frequency Control Using Multifunction Input Terminals 6, 7 (or 8)

Note: *For Up/Down Frequency Control Using Multifunction Input Terminals "6", "7" (or "8"), see Section V-B-4-a, on page 22.*

F012 TRIP PREVENTION

Factory Setting: 0000. F012 sets the condition at which the Trip Prevention will operate. The drive contains Trip Prevention circuitry which will prevent tripping when drive operation exceeds normal operating parameters.

F012 = xxx0: Enable Trip Prevention During Acceleration
xxx1: Disable Trip Prevention During Acceleration
xx0x: Enable Trip Prevention During Deceleration
xx1x: Disable Trip Prevention During Deceleration
x0xx: Enable Trip Prevention During Run Mode
x1xx: Disable Trip Prevention During Run Mode
0xxx: Trip Prevention Deceleration Time Set by F002 (Deceleration Time #1)
1xxx: Trip Prevention Deceleration Time Set by F015 (Trip Prevention Deceleration Time)

F013 TRIP PREVENTION LEVEL DURING ACCELERATION

Factory Setting: 110 %. F013 sets the level at which the Trip Prevention is activated while accelerating. In this mode, the actual acceleration time will increase if the set acceleration time is too short for the inertia of the load being accelerated.

Programmable Range: 30 - 200%

F014 TRIP PREVENTION LEVEL WHILE IN RUN MODE

Factory Setting: 160%. F014 sets the overcurrent level at which the Trip Prevention is activated while in Run Mode. In this mode, the set output frequency will momentarily decrease in order to attempt to reduce drive current due to transient overload. F012 must be set to “x0xx” [Enable Trip Prevention While In Run Mode] (factory setting).

Programmable Range: 30 - 200 %

F015 TRIP PREVENTION DECELERATION TIME

Factory Setting: 3.0 Seconds. F015 sets an alternate deceleration time when Trip Prevention is activated during the Run Mode (F014). Function F012 must be set to “1xxx”.

Programmable Range: 0.1 - 3600 Seconds

F016 AUTO AC LINE START, RESET, START/STOP SIGNAL VERIFICATION SCAN TIME

Factory Setting: 0000. Function F016 is used to control the AC line start and reset operation modes. In addition, it is used to set the Start/Stop signal scan time.

Start/Stop-Forward/Reverse Terminals “3”, “4”, and “5” are scanned electronically in order to verify the existence of a command. The scan time is factory set so that each terminal is scanned every 20 mS. For shorter scan times, use Function F016.

F016 = xxx0: Enable Auto AC Line Start when External Run Command is On
xxx1: Disable Auto AC Line Start when External Run Command is On
xx0x: Enable Reset Only when Run Command is Off
xx1x: Enable Reset Whether External Run Command is On or Off

Note: *For rapidly changing command signals, the scan time may have to be reduced.*

00xx: Scan Time: 20 mS
01xx: Scan Time: 10 mS
10xx: Scan Time: 6 mS
11xx: Scan Time: 2 mS

F017 - F023 PRESET SPEEDS # 1 - 7 FREQUENCY SETTING

Factory Setting: See Table 19. F017 - F023 set the frequency for each of the seven preset speeds. See Section V-B-4-b, on page 23. See Table 19.

Programmable Range: 0.00 - 400.0 Hz

TABLE 19 – PRESET SPEED # 1 - 7

Preset Speed	Factory Setting	Function Number to Set Frequency
1	5.00 Hz	F017
2	10.00 Hz	F018
3	20.00 Hz	F019
4	30.00 Hz	F020
5	40.00 Hz	F021
6	50.00 Hz	F022
7	60.00 Hz	F023

F024 JOG FREQUENCY

Factory Setting: 2.00 Hz. F024 sets the Jog Frequency. Jog is activated by using one of the Multifunction Input Terminals. See Section V-B-4-c, on page 24.

Programmable Range: 0.00 - 400.0 Hz

F025 KEYPAD FREQUENCY

Factory Setting: 5.00 Hz. The frequency set by the keypad is stored in F025. The keypad frequency may be set directly by F025. See Section VIII-B-1, on page 29.

Programmable Range: 0.00 - 400.0 Hz

F026 ANALOG INPUT FREQUENCY OFFSET

Factory Setting: 0.00 Hz. F026 sets the offset of the Analog Input Signal. See section VIII-D-4-a on page 35.

Programmable Range: 0.00 - 400.0 Hz

Note: *When an external signal is used, Function F007 is still operational. Either function can be used to set the Output Frequency Lower Limit.*

F027 ANALOG INPUT SIGNAL REFERENCE RATIO

Factory Setting: 0.0 %. F027 sets the Analog Input Signal Reference Ratio. To calculate the signal reference ratio value to enter in Function F027, use the following formula. See Section VIII-D-4-b on page 35.

F027 = (Minimum Input Signal Value ÷ Maximum Input Signal Value) X 100

Programmable Range: 0.0 - 100.0 %

F028 ANALOG INPUT SCALING REFERENCE RATIO

Factory Setting: 100.0 %. F028 sets the Analog Input Signal Scaling Reference Ratio. F028 is factory set to "100.0", which will provide 100% scaling of the ratio of the analog input signal to the drive signal input setting. See Section VIII-D-4-c on page 36.

Programmable Range: 0.00 - 100.0 %

F029 ANALOG INPUT SIGNAL SLOPE (Low-to-High / High-to-Low)

Factory Setting: 0000. F029 sets the drive to run the motor with a low-to-high or high-to-low signal input. See Section VIII-D-4-d, on page 37.

F029 = 0000: Low-to-High (Positive Slope)
0001: High-to-Low (Negative Slope)

F030 AC LINE INPUT VOLTAGE

Factory Setting: 220.0 Volts AC (208/230 VAC Models) and 460.0 Volts AC (308/460 VAC Models). F030 sets the drive for the actual AC line input voltage being applied.

Programmable Range: 180.0 - 528.0 Volts AC

F031 AC POWER LOSS RIDE-THROUGH TIME

Factory Setting: 0.5 Seconds. F031 sets the amount of time of AC power loss allowed before the drive trips.

Programmable Range: 0.0 - 2.0 Seconds

F032 AUTOMATIC AC LINE START

Factory Setting: 0000. When F032 is used in conjunction with other functions, the drive can be set for Automatic Restart with the AC line. See Section VIII-5-c, on page 38.

F032 = 0000: Disable Automatic AC Line Start
0001: Enable Automatic AC Line Start

F033 ANALOG SIGNAL INPUT SCAN TIME

Factory Setting: 100 (200 mS) F033 sets the amount of time that Terminal 13 will be scanned for presence of a signal (in 2 mS increments). This is the minimum amount of time that the drive requires for the signal to be present. If the signal is not present during the time specified, the drive will treat the signal as "zero" and will not respond.

Programmable Range: 1 - 100 (mS x 2)

Note: *Reduced scan time will eliminate noise on slow charging input signals.*

F034 AUTO RESTART DELAY TIME

Factory Setting: 0.00 Seconds. F034 sets the time between automatic restart attempts for all faults except Automatic AC Line Start.

Programmable Range: 0.0 - 800.0 Seconds

WARNING! Use caution when setting restart delay times, since machinery may restart unexpectedly.

F035 NUMBER OF AUTO RESTART ATTEMPTS

Factory Setting: 0 Auto Restart Attempts. F035 sets the number of Auto Restart Attempts that will be performed after a fault has cleared. If the number of restart attempts exceeds the setting in Function F035, the drive will need to be manually restarted.

Programmable Range: 0 - 10 Auto Restart Attempts

F036 NUMBER OF MOTOR POLES

Factory Setting: 4 Poles. F036 sets the number of motor poles. This function is required when the drive is programmed to display Motor RPM using Function F051 (F051 = "0001"). If the number of motor poles is not known, use the following formula:

Number of Motor Poles =
(Motor Nameplate Rated Frequency X 120) ÷ Motor Rated RPM

Example – If using a 60 Hz, 1725 RPM motor, calculate the number of motor poles as follows.

F036 = (60 X 120) ÷ 1725 = 7200 ÷ 1725 = 4.17. Set F036 to "0004" (4 motor poles).

Programmable Range: 2 - 72 Poles

F037 VOLTS/Hz PATTERN MAXIMUM FREQUENCY

Factory Setting: 60.00 Hz. F037 sets the Volts/Hz Pattern Maximum Frequency when using a custom Volts/Hz pattern (F005 = "0018"). See Figure 22, on page 44.

Programmable Range: 50.00 - 400.0 Hz

F038 VOLTS/Hz PATTERN VOLTAGE RATIO

Factory Setting: 100.0 %. F038 sets the Volts/Hz Pattern Voltage Ratio when using a custom Volts/Hz pattern (F005 = "0018"). See Figure 22, on page 44.

Programmable Range: 0.00 - 100.0 %

F039 VOLTS/Hz PATTERN MID FREQUENCY

Factory Setting: 3.00 Hz. F039 sets the Volts/Hz Pattern Mid Frequency when using a custom Volts/Hz pattern (F005 = "0018"). See Figure 22, on page 44.

Programmable Range: 0.11 - 400.0 Hz

F040 VOLTS/Hz PATTERN MID VOLTAGE RATIO

Factory Setting: 7.5%. F040 sets the Volts/Hz Pattern Mid Voltage Ratio when using a custom Volts/Hz pattern (F005 = "0018"). See Figure 22, on page 44.

Programmable Range: 0.0 - 100.0%

F041 VOLTS/Hz PATTERN VOLTAGE RATIO AT 0.1 Hz

Factory Setting: 7.5%. F041 sets the Volts/Hz Pattern Voltage Ratio at 0.1 Hz when using a custom volts/Hz pattern (F005 = "0018"). See Figure 22, on page 44.

Programmable Range: 0.0 - 100.0 %

F042 START FREQUENCY

Factory Setting: 1.00 Hz. F042 sets the minimum Start Frequency of the drive. Although the drive will start at the frequency set by F042, it will still have a controlled range down to 0.1 Hz.

Programmable Range: 0.10 - 10.00 Hz

F043 SWITCHING FREQUENCY (Code)

Factory Setting: 0014. F043 sets the Switching Frequency (Code). F043 is factory set to "0014", which operates the drive at 10 kHz and provides low motor noise and good motor torque. Increasing the switching frequency to the maximum of 12 kHz will further reduce motor noise. However, increased radio frequency interference will result as well as 10% derating of the maximum output current. Reducing the switching frequency will provide increased motor torque. However, the audible noise will also increase.

F043 =	0000: 1.0 kHz	0004: 2.4 kHz	0008: 4.8 kHz	0012: 8.0 kHz
	0001: 1.2 kHz	0005: 3.0 kHz	0009: 5.0 kHz	0013: 9.0 kHz
	0002: 1.8 kHz	0006: 3.6 kHz	0010: 6.0 kHz	0014: 10 kHz
	0003: 2.0 kHz	0007: 4.0 kHz	0011: 7.2 kHz	0014: 12 kHz

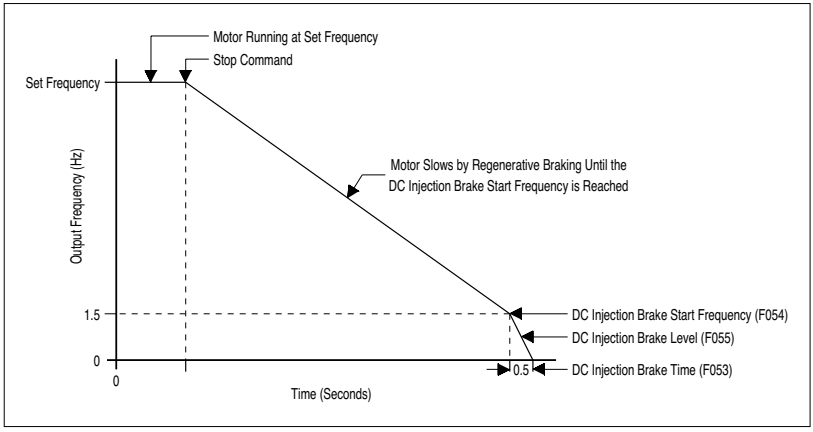
F044 STOP METHOD

Factory Setting: 0000. F044 sets either controlled deceleration-to-stop or coast-to-stop when a stop command is given. The controlled deceleration function uses a combination of regeneration and DC injection braking to stop the motor. The factory setting utilizes regeneration as the primary method of braking. When the Stop Command is given, the motor will decelerate in accordance to the deceleration time set by F002 [Deceleration Time # 1]. When the output frequency reaches 1.5 Hz, the injection braking begins to take effect. For high inertial loads, the optional Brake Resistor may be required (available for models through 10 HP). See Figure 28, on page 62 and Section IX, Functions F053, F054, and F055, on page 65.

F044 = 0000: Controlled Deceleration-to-Stop with DC Injection Braking (Rapid Stop)
0001: Coast-to-Stop

Application Note – Controlled Deceleration-to-Stop with Injection Braking (Rapid Stop) can also be activated with a Multifunction Input Terminal set to code "0005". Coast-to-Stop can also be activated with a Multifunction Input Terminal set to code "0006". If the drive is stopped, as per above, it must be restarted with the RUN/STOP key, if the drive is set to Keypad Control, or it must be restarted by opening and closing the Run contact, if the drive is set for External Start/Stop Contacts.

FIGURE 28 – CONTROLLED DECELERATION-TO-STOP WITH DC INJECTION BRAKING (RAPID STOP) (F044 SET TO "0000")

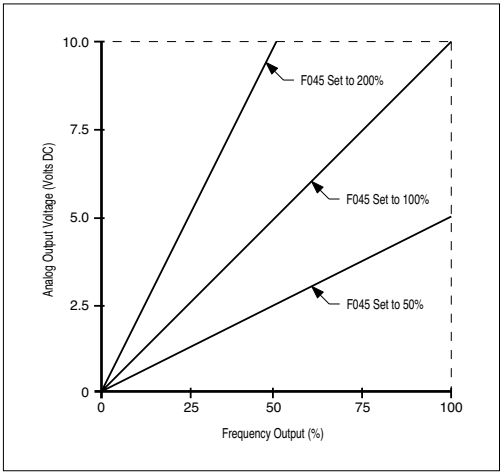


F045 ANALOG OUTPUT VOLTAGE GAIN

Factory Setting: 100 %. F045 sets the Analog Output Voltage Gain. See Figure 29.

Programmable Range: 0 - 200 % Figure 29 - Analog Output Voltage Gain

FIGURE 29 – ANALOG OUTPUT VOLTAGE GAIN



F046 MULTIFUNCTION ANALOG OUTPUT VOLTAGE MODE

Factory Setting: 0000 – F046 sets the operation of the Multifunction Analog Output Voltage (Terminals 14, 15). Provides a linear DC output voltage (0 - 10 Volts DC) proportional to the mode setting.

F046 = 0000: Output Frequency
0001: Set Frequency
0002: Drive Output Voltage
0003: Bus Voltage

F047 DISPLAY MODE (Volt., Curr.)

Factory Setting: 0000 – F047 sets the Display Mode. The display is factory programmed to show Drive Output Frequency (see F051). The respective "status" indicator will illuminate when the specific parameter is displayed.

F047 = xxx0: Disable Motor Voltage Display
xxx1: Enable Motor Voltage Display
xx0x: Disable Bus Voltage Display
xx1x: Enable Bus Voltage Display
x0xx: Disable Motor Current Display
x1xx: Enable Motor Current Display

Notes: 1. *The drive is factory programmed to alternately display Drive Output Frequency and Function Number when the DSP/FUN key is pressed. If F047 is set to "0111", pressing the DSP/FUN key repeatedly will toggle the display to show Motor Set Frequency (Hz), Function Number, Motor Voltage (Volts AC), Bus Voltage (Volts DC), and Motor Current (Amps AC).* ***2.*** *The digital display will distinguish between Motor Voltage and Bus Voltage by displaying a small "u" for Motor Voltage and a large "U" for Bus Voltage.*

F048 DYNAMIC BRAKE, STOP PRIORITY, SPIN-START, AUTOMATIC VOLTAGE REGULATOR

Factory Setting: 0000 – F048 sets the Dynamic Brake, Stop Priority, Spin-Start, and Automatic Voltage Regulator.

F048 = xxx0: Enhanced Braking
xxx1: Standard Braking
xx0x: Enable STOP key with External Contacts (F010 = 0001)
xx1x: Disable STOP key is with External Contacts (F010 = 0001)
x0xx: Spin-Start Controlled by Multifunction Input Terminals
x1xx: Enable Spin-Start when the Drive is in Run Mode
0xxx: Enable Automatic Voltage Regulator
1xxx: Disable Automatic Voltage Regulator

F049 ACCELERATION TIME # 2

Factory Setting: 10.00 Seconds – F049 sets Acceleration Time # 2. The acceleration time is the time it takes for the drive output to reach full speed as set in F006 [Output Frequency Upper Limit]. The acceleration time is based on zero speed to full speed. Acceleration Time # 2 is activated by programming one of the three multifunction input terminals "6", "7", or "8" to "0004" (or "0020") using F056, F057, or F058.

If the drive is set to less than full speed, the acceleration time will be proportionally decreased. In order to prevent an overcurrent trip, when accelerating high inertial loads, the acceleration time may be automatically extended and the current limit circuit may activate.

Programmable Range: 0.1 - 3600 Seconds

F050 DECELERATION TIME # 2

Factory Setting: 10.00 Seconds. F050 sets Deceleration Time # 2. The deceleration time is the time it takes for the drive output setting to reach zero speed, as set in F007 [Minimum Output Frequency], after a stop or zero speed command is given. The deceleration time is based on full speed to zero speed. Deceleration Time # 2 is activated by programming one of the three multifunction input terminals "6", "7", or "8" to "0004" (or "0020") using F056, F057, or F058.

If the drive is initially set to other than full speed, the deceleration time will be proportionally less. Also, when decelerating high inertial loads, the automatic regeneration protection circuit may activate. This circuit will extend the deceleration time to prevent the drive from tripping, due to overcharging the bus capacitors.

Programmable Range: 0.1 - 3600 Seconds

F051 DISPLAY MODE (FREQ., RPM, LINE SPEED DECIMAL PLACE)

Factory Setting: 0000. F051 sets the Digital Display Mode.

F051 = 0000: Drive Output Frequency is Displayed
0001: Motor RPM is Displayed (See F036)
0002: Line Speed Displayed in Whole Numbers (xxxx)
0003: Line Speed Displayed with One Decimal Place (xxx.x)
0004: Line Speed Displayed with Two Decimal Places (xx.xx)
0005: Line Speed Displayed with Three Decimal Places (x.xxx)

Notes: 1. *When F051 is set to "0001" the display will indicate motor RPM instead of Drive Output Frequency. F036 must be set to the correct number of motor poles for the RPM readout to be correct.* ***2.*** *When F051 is set to "0002" - "0005", line speed will be displayed instead of Drive Output Frequency or RPM.*

F052 LINE SPEED DISPLAY (CUSTOM UNITS)

Factory Setting: 1800. F052 sets Line Speed or Custom Units for a specific process output. Enter the significant digits in F052 and use F051 to set the decimal place.

Example – If a conveyor operates at 36 ft/min at full speed (set by F006) and the readout is desired with 2 decimal places, enter "3600" in F052 and "0004" in F051. Readout at full speed will be "36.00".

Programmable Range: 0 - 9999

F053 DC INJECTION BRAKE TIME

Factory Setting: 0.5 Seconds. F053 sets the DC Injection Brake Time. The brake time should not exceed the actual time to stop the load since it may cause overheating of the motor. See Figure 28, on page 62.

Programmable Range: 0 - 25.5 Seconds

F054 DC INJECTION BRAKE START FREQUENCY

Factory Setting: 1.5 Hz. F054 sets the frequency at which the DC injection brake begins. See Figure 28, on page 62.

Programmable Range: 1 - 10 Hz

F055 DC INJECTION BRAKE LEVEL

Factory Setting: 8.0 %. F17 sets the DC injection brake level, as a percent of bus voltage. See Figure 28, on page 62.

Programmable Range: 0 - 20%

Note: *Do not increase the DC Injection Brake Level beyond what is necessary to stop the motor since motor overheating may occur.*

F056 MULTIFUNCTION INPUT TERMINAL "6" (SP1)

Factory Setting: 0000. F056 sets the operation of Terminal 6 of Terminal Block TM2. See Notes – Multifunction Input Terminal Codes, on page 66.

	Close Contact to Activate (Norm. Open)	Open Contact to Activate (Norm. Closed)
F056 =	0000: Preset Speed # 1[1]	0016: Preset Speed # 1[1]
	0001: Preset Speed # 2[1]	0017: Preset Speed # 2[1]
	0002: Preset Speed # 4[1]	0018: Preset Speed # 4[1]
	0003: Jog[2]	0019: Jog[2]
	0004: Accel/Decel # 2[3]	0020: Accel/Decel # 2[3]
	0005: Rapid Stop (E.S.)[4,5]	0021: Rapid Stop (E.S.)[4,5]
	0006: Coast-to-Stop (b.b.)[5]	0022: Coast-to-Stop (b.b.)[5]
	0007: Spin-Start[6]	0023: Spin-Start[6]
	0008: Energy Saving[7]	0024: Energy Saving[7]
	0009: Remote Signal Operation[8]	0025: Remote Signal Operation[8]
	0010: Communication Selection[9]	0026: Communication Selection[9]
	0011: Frequency Hold During Accel/Decel[10]	0027: Frequency Hold During Accel/Decel[10]
	0012: Up Command[11]	0028: Up Command[11]
	0013: Down Command[11]	0029: Down Command[11]
	0014: Sequence Control[12]	0030: Sequence Control[12]
	0015: Master/Auxiliary Speed[13]	0031: Master/Auxiliary Speed[13]

F057 MULTIFUNCTION INPUT TERMINAL "7" (SP2)

Factory Setting: 0001. F057 sets the operation of Terminal 7 of Terminal Block TM2.

Close Contact to Activate (Norm. Open*)

F057 =

0000: Preset Speed # 1[1]
0001: Preset Speed # 2[1]
0002: Preset Speed # 4[1]
0003: Jog[2]
0004: Accel/Decel # 2[3]
0005: Rapid Stop (E.S.)[4, 5]
0006: Coast-to-Stop (b.b.)[5]
0007: Spin-Start[6]
0008: Energy Saving[7]
0009: Remote Signal Operation[8]
0010: Communication Selection[9]
0011: Frequency Hold During Accel/Decel[10]
0012: Up Command[11]
0013: Down Command[11]
0014: Sequence Control[12]
0015: Master/Auxiliary Speed[13]

F058 MULTIFUNCTION INPUT TERMINAL "8" (SP3)

Factory Setting: 0002. F058 sets the operation of Terminal 8 of Terminal Block TM2.

Close Contact to Activate (Norm. Open*)

F058 =

0000: Preset Speed # 1[1]
0001: Preset Speed # 2[1]
0002: Preset Speed # 4[1]
0003: Jog[2]
0004: Accel/Decel # 2[3]
0005: Rapid Stop (E.S.)[4, 5]
0006: Coast-to-Stop (b.b.)[5]
0007: Spin-Start[6]
0008: Energy Saving[7]
0009: Remote Signal Operation[8]
0010: Communication Selection[9]
0011: Frequency Hold During Accel/Decel[10]
0012: Up Command[11]
0013: Down Command[11]
0014: Sequence Control[12]
0015: Master/Auxiliary Speed[13]

**For Norm. Closed contacts use Function Codes "0016" - "0031". See F056 on page 65.*

Notes - *Multifunction Input Terminal Codes (Refer to the Following for Additional Information):*

1. *Section V-B-4-b, Preset Speed Operation, on page 23.* ***2.*** *Section V-B-4-c, Jog Speed Operation, on page 24.* ***3.*** *Functions F049 and F050, Accel/Decel Time # 2, on pages 49 and 50.* ***4.*** *The drive will stop by using Regenerative and Injection Braking. See Function F044, Stop Method, on page 61, and Figure 28, on page 62. Also see related Functions F053 - F055, DC Injection Brake, on pages 64 and 65.* ***5.*** *To restart the drive, open and close the Run Contacts. If Start/Stop is set for Keypad Operation (F010 = 0000), press the RUN/STOP key to restart the drive.* ***6.*** *Section VIII-D-5-c, Spin-Start Application Note, on page 39.* ***7.*** *Functions F082 and F083, Energy Saving, on page 71.* ***8.*** *Drive operation will change from Keypad Control to External Start/Stop (Terminals "3", "4", and "5", of Terminal Block TM2) and External Frequency Control (Terminals "13" and "14", of Terminal Block TM2).* ***9.*** *Disables operation by communications except for reading of drive function settings and operational status.* ***10.*** *The drive ceases to accelerate or decelerate and will remain at "hold" frequency.* ***11.*** *Section V-B-4-a, External Up/Down Frequency Control, on page 22.* ***12.*** *Section V-B-4-b, Preset Speed Operation and Notes 1-5, Sequence Control, on page 23. Also see Function 84, Process Timer Operation Mode, on page 71.* ***13.*** *Exchanges frequency command between the keypad potentiometer and external signals (or remote potentiometer) on Terminals "12" and "14", of Terminal Block TM2.*

F059 & F060 ARE RESERVED

F061 MULTIFUNCTION OUTPUT TERMINALS 10, 11 (Open Collector)

Factory Setting: 0000 – F061 sets the operation of Multifunction Output Terminals 10 and 11, which will change state when the drive operates as programmed in F061. F061 is factory set to "0000" [Run], which will make the Multifunction Open Collector Output Terminal change state when the drive is in the Run Mode.

F061 = 0000: Run
0001: Frequency Reached (Drive is at set frequency)
0002: Set Frequency (F008 ± F009)
0003: Frequency Greater than Target Frequency (F008)
0004: Frequency Less than Target Frequency (F008)
0005: Trip Due to Overload
0006: Change 0000 (Run) from Normally Open to Normally Closed

Note: *If the open collector output is used with a relay, a clamping diode must be used, as shown in Figure 14, on page 24.*

F062, F063 & F064 ARE RESERVED

F065 SKIP FREQUENCY # 1

Factory Setting: 0.00 Hz – F065 sets Skip Frequency # 1.

Programmable Range: 0.00 - 400.0 Hz

Note: *Skip frequencies are used to eliminate mechanical vibration or resonance at certain speeds.*

F066 SKIP FREQUENCY # 2

Factory Setting: 0.00 Hz. F066 sets Skip Frequency # 2.

Programmable Range: 0.00 - 400.0 Hz

F067 SKIP FREQUENCY # 3

Factory Setting: 0.00 Hz. F067 sets Skip Frequency # 3.

Programmable Range: 0.00 - 400.0 Hz

F068 SKIP FREQUENCY BANDWIDTH

Factory Setting: 0.00 Hz. F068 sets the Skip Frequency Bandwidth.

Programmable Range: 0.00 - 10.00 Hz

Example – If F065 is set to 10.00 Hz, F066 is set to 20.00 Hz, F067 is set to 30.00 Hz, and F068 is set to 2.00 Hz, the frequencies that will be skipped are 8 - 12 Hz, 18 - 22 Hz, and 28 - 32 Hz.

F069 ELECTRONIC MOTOR OVERLOAD PROTECTION (I^2t) OPERATION MODE

Factory Setting: 0000 – F069 sets the Electronic Motor Overload Protection (I^2t) Operation Mode.

F069 = xxx0: Enable Electronic Motor Overload Protection
xxx1: Disable Electronic Motor Overload Protection
xx0x: Electronic Motor Overload Protection Set for Non Inverter Duty Motor
xx1x: Electronic Motor Overload Protection Set for Inverter Duty Motor
x0xx: Constant Torque (OL = 103%) (150% for 1 Minute)
x1xx: Variable Torque (OL = 113%) (123% for 1 Minute)
0xxx: Coast-to-Stop after Overload Protection is Activated
1xxx: Drive will Not Trip when Overload Protection is Activated ("OL1" will be Displayed)

F070 MOTOR RATED CURRENT

Factory Setting: See Table 20. F070 sets the motor nameplate rated current. Enter the motor nameplate rated current, as described in Section VIII-C-1, on page 31. See Table 20. For most applications, the motor current will not have to be changed.

TABLE 20 – DRIVE MODEL AND FACTORY SETTING OF MOTOR RATED CURRENT

Model No.	Part No.	Drive Rating		F070 Factory Current Setting (Amps Ac)
		HP	kW	
KBN2-2250-1	12000	.50	.37	1.9
KBN2-2201-1	12010	1	.75	3.4
KBN2-2202-1	12020	2	1.5	6.1
KBN2-2203-1	12030	3	2.2	8.7
KBN2-2305-1	12040	5	3.7	13.5
KBN2-2307-1	12050	7.5	5.6	20.1
KBN2-2310-1	12060	10	7.5	25.1
KBN2-2315-1	12070	15	11	36.7
KBN2-2320-1	12080	20	15	50.3
KBN2-2330-1	12090	30	22	72.9
KBN2-4301-1	12100	1	.75	1.7
KBN2-4302-1	12110	2	1.5	3.1
KBN2-4303-1	12120	3	2.2	4.4
KBN2-4305-1	12130	5	3.7	6.8
KBN2-4307-1	12140	7.5	5.6	10.1
KBN2-4310-1	12150	10	7.5	12.6
KBN2-4315-1	12160	15	11	18.4
KBN2-4320-1	12170	20	15	25.2
KBN2-4330-1	12180	30	22	36.5

F071 DRIVE OVERLOAD PROTECTION ENABLE/DISABLE AND TORQUE BOOST MODE

Factory Setting: 0000. F071 enables or disables Drive Overload Protection and Torque Boost Mode.

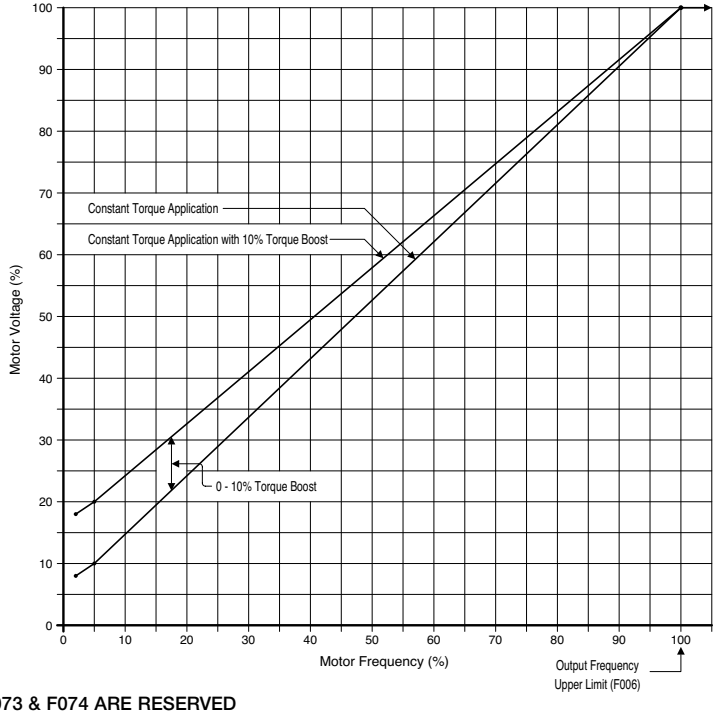
F071 = xxx0: Enable Drive Overload Protection x0xx: Enable F072
xxx1: Disable Drive Overload Protection x1xx: Disable F072

F072 VOLTS/Hz CURVE MODIFICATION (TORQUE BOOST)

Factory Setting: 0.0 %. F072 sets the percent of torque boost that will be applied to the motor by modifying the Volts/Hz patterns set by F005 for 60 Hz Motors (or F009 for 50 Hz Motors), as shown in Figure 30.

Programmable Range: 0.0 - 10.0 %

FIGURE 30 – VOLTS/Hz CURVE MODIFICATION (Torque Boost)



F073 & F074 ARE RESERVED

F075 MOTOR NO LOAD CURRENT

Factory Setting: See Table 21, on page 70 . F075 sets the no load motor current which is used for Slip Compensation. Enter the no load motor current, as described in Section VIII-D-6-b-3-a, on page 34.

F076 MOTOR RATED SLIP

Factory Setting: 0.00 Hz. F076 sets the Motor Rated Slip. This function is required if Slip Compensation is used. The motor rated slip must be entered in frequency (Hz). To calculate the Motor Rated Slip, use the following formula:

$$\text{Motor Slip (Hz)} = \text{Asynchronous Motor Frequency (60 Hz or 50 Hz)} - \frac{\text{Nameplate Rated Motor RPM} \times \text{Number of Motor Poles}}{120}$$

TABLE 21 – DRIVE MODEL AND FACTORY SETTING OF MOTOR NO LOAD CURRENT

Model No.	Part No.	Drive Rating		F075 Factory Current Setting (Amps AC)
		HP	kW	
KBN2-2250-1	12000	.50	.37	.6
KBN2-2201-1	12010	1	.75	1.1
KBN2-2202-1	12020	2	1.5	2.0
KBN2-2203-1	12030	3	2.2	2.9
KBN2-2305-1	12040	5	3.7	4.5
KBN2-2307-1	12050	7.5	5.6	6.7
KBN2-2310-1	12060	10	7.5	8.4
KBN2-2315-1	12070	15	11	12.2
KBN2-2320-1	12080	20	15	16.8
KBN2-2330-1	12090	30	22	24.3
KBN2-4301-1	12100	1	.75	.6
KBN2-4302-1	12110	2	1.5	1
KBN2-4303-1	12120	3	2.2	1.5
KBN2-4305-1	12130	5	3.7	2.3
KBN2-4307-1	12140	7.5	5.6	3.4
KBN2-4310-1	12150	10	7.5	4.2
KBN2-4315-1	12160	15	11	6.1
KBN2-4320-1	12170	20	15	8.4
KBN2-4330-1	12180	30	22	12.2

F077 OVERTORQUE CONTROL

Factory Setting: 0000. F077 sets the Overtorque Control.

F077 = xxx0: Overtorque Control Disabled
xxx1: Overtorque Control Operational
xx0x: Overtorque Control Operational Only at Set Frequency
xx1x: Overtorque Control Operational while the Drive is in Run Mode
x0xx: Drive will Continue to Operate After Overtorque is Detected
x1xx: Coast-to-Stop After Overtorque is Detected

F078 OVERTORQUE DETECTION LEVEL

Factory Setting: 160 %. F078 sets the Overtorque Detection Level as a percent of the full load rating of the motor.

Programmable Range: 30 - 200 %

F079 OVERTORQUE DETECTION TIME

Factory Setting: 0.1 Seconds. F079 sets the allowable time that the load can be in "overtorque" before the overtorque circuit activates.

Programmable Range: 0.0 - 25.0 Seconds

F080 ACCEL/DECEL S-CURVE TIME # 1

Factory Setting: 0.2 Seconds. F080 sets the Accel/Decel S-Curve Time # 1.

Programmable Range: 0.0 - 4.0 Seconds

Note: *Accel/Decel S-Curve Tiime # 1 is added to Accel/Decel Time # 1 (F001/F002).*

F081 ACCEL/DECEL S-CURVE TIME # 2

Factory Setting: 0.2 Seconds – F081 sets the Accel/Decel S-Curve Time # 2

Programmable Range: 0.0 - 4.0 Seconds

Note: *Accel/Decel S-Curve Tiime # 2 is added to Accel/Decel Time # 2 (F049/F050).*

F082 ENERGY SAVING MODE

Factory Setting: 0000. F082 sets the Energy Saving Mode.

F082 = xx00: Disable Energy Saving
xx01: Energy Saving Controlled by Multifunction Input Terminals

F083 ENERGY SAVING GAIN

Factory Setting: 80 %. F083 sets the Energy Saving Gain.

Programmable Range: 0 - 100 %

Note: *Multifunction Input Terminals "6", "7", or "8" must be programmed to "0008" or "0024", and the respective terminal activated, to enable Energy Saving Mode. Also, Function F082 must be set to "xx01".*

F084 PROCESS TIMER OPERATION MODE

Factory Setting: 0000. F084 sets the Process Timer Operation Mode.

F084 = xxx0: Disable Process Timer
xxx1: Enable Process Timer
xx0x: Set Frequency Output After Process Timer Completes
xx1x: Zero Speed Output After Process Timer Completes
x1xx: Automatically Repeat Process Timer Operation

F085 - F091 PROCESS TIMER # 1 - 7 TIME

Factory Setting: 0.0 Seconds. F085 - F091 set Process Timer # 1 - 7 times. Process Timers #1-7 operate at the Preset Speed #1-7 frequency settings.

Programmable Range: 0.0 - 3600 Seconds

F092 VIBRATION CONTROL TIME

Factory Setting: 5. F092 sets the number of times the equipment will tolerate vibration.

Programmable Range: 1 - 100

F093 VIBRATION CONTROL GAIN

Factory Setting: 0.0 %. F093 sets the Vibration Control Gain.

Programmable Range: 0.0 - 100.0 %

F094 VIBRATION CONTROL BIAS

Factory Setting: 0 %. F094 sets the Vibration Control Bias.

Programmable Range: 0 - 30 %

F095 & F096 FACTORY SETTING ONLY

F097 MULTIFUNCTION OUTPUT RELAY

The output relay can be programmed in a variety of ways in accordance with the functions listed beleow. The output relay is factory programmed to activate due to the following faults: OC-S, OC-A, OC-C, OC-d, OC-b, OU-C, LU-C, OH-C.

Factory Setting: 0000. F097 sets the operation of the Multifunction Output Relay. See Function F098.

Relay Operation

F097 = xxx0: Disabled in Auto Restart Mode
xxx1: Operational In Auto Restart Mode (See Function F016, on page 57)
xx0x: Disabled During Momentary Power Loss
xx1x: Operational During Momentary Power Loss (See Function F032 on page 59.
x0xx: Disabled in Rapid Stop* Mode
x1xx: Operation in Rapid Stop* Mode (See Functions F056-F058, on pages 65 and 66).
0xxx: Disabled in Coast-to-Stop* Mode
1xxx: Operation in Coast-to-Stop* Mode (See Functions F056-F058, on pages 65 and 66).

*Rapid Stop and Coast-to-Stop are activate by using the Multifunction Input Terminals (“6”, “7”, or “8”).

Note: *The Output Relay contacts are rated 1 Amp at 30 Volts DC or 250 Volts AC.*

F098 MULTIFUNCTION OUTPUT RELAY (Cont.)

Factory Setting: 0000. F098 sets the operation of the Multifunction Output Relay. See Function F097.

Relay Operation

F098 = xxx0: Disabled when Overtorque Control is Activated
xxx1: Operational when Overtorque Control is Activated (See Function F077, on page 70).

xx0x: Disabled when Electronic Motor Overload Protection is Activated
xx1x: Operational when Electronic Motor Overload Protection is Activated. (See Function F069 on page 68).
x0xx: Contacts are Normally Open
x1xx: Contacts are Normally Closed*
0xxx: Disabled when Drive Overload Protection is Activated
1xxx: Operational when Drive Overload Protection is Activated (See Function F071, on page 68).

Notes: 1. *When Function F098 is set to "0000" (factory setting), the Multifunction Output Relay is not operational and will not indicate the faults Overtorque, Electronic Motor Overload, or Drive Overload.* ***2.*** *The relay contacts are rated 1Amp at 30 Volts DC or 250 Volts AC.*

***Application Note –** To sense an AC power loss, the contacts must be set to normally closed (F098 = "x1xx").

F099 RESERVED

F100 COMMUNICATION IDENTIFICATION NUMBER

Factory Setting: 1. F100 sets the Communication Identification Number. This feature is used when programming multiple drives.

Programmable Range: 1 - 32

F101 COMMUNICATION BAUD RATE

Factory Setting: 0001. F101 sets the Communication Baud Rate.

F101 = 0000: 4800 bps 0002: 19200 bps
0001: 9600 bps 0003: 38400 bps

F102 COMMUNICATION PARAMETERS

Factory Setting: 1100. F102 sets the Communication Parameters.

F102 = xxx0: 1 Stop Bit 0xxx: 8-Bit Data x1xx: With Parity
xx0x: Even Parity xxx1: 2 Stop Bits 1xxx: 7-Bit Data
x0xx: Without Parity xx1x: Odd Parity

F103, F104, F105 & F106 FACTORY SETTINGS ONLY

F107 – F122 ARE RESERVED

F123 RESET DRIVE TO FACTORY SETTINGS

Factory Setting: 0000. F123 resets the drive to factory settings.

F123 = 1110: Reset for 50 Hz Motor Operation
1111: Reset for 60 Hz Motor Operation

F124 CPU PROGRAM

Factory Setting Only – F124 identifies the CPU Program.

F125 LOGS LAST 3 FAULTS THAT OCCURRED

F125 logs the last three faults that occurred and cannot be reprogrammed. See Table 22. The faults are logged in chronological order. Press the ▲ or ▼ key to display the logged faults. The number in the display indicates the chronological occurrence of the fault ("1.xxx" indicates the latest fault that occurred, "2.xxx" indicates the previous fault that occurred, and "3.xxx" indicates the first fault that occurred). Press the </RESET key to erase all three faults ("1.- - -", "2.- - -", and "3.- - -" will be displayed).

TABLE 22 – FAULT CODES AND CORRECTIVE ACTIONS

Fault Code	Description	Probable Cause	Corrective Actions
CPF	Program error.	Noise Interference.	Add appropriate filtering.
EPR	EEPROM error.	EEPROM defective.	Return the drive for repair.
-OU-	AC line input voltage is too high.	Incorrect AC line voltage.	Correct the line voltage.
		Detection circuit is defective.	Return the drive for repair.
-LU-	AC line input voltage is too low.	Incorrect AC line voltage.	Correct the line voltage.
		Detection circuit is defective.	Return the drive for repair.
-OH-	Overtemperature while the drive is in Stop Mode.	Ambient temperature is too high.	Improve ventilation to reduce the ambient temperature.
		Detection circuit is defective.	Return the drive for repair.
OH1*	Brake resistor overload. (On models thru 10 HP when brake resistor is installed.)	Deceleration time is too short.	Increase the Deceleration Time setting (F002).
		Frequent Run/Stop operations.	Decrease the Run/Stop operations.
		Excessive load.	Use higher rated drive.
-OC-	Overload while the drive is in Stop Mode.	Detection circuit is defective.	Return the drive for repair.
OL1	Motor overload.	Electronic Motor Overload Protection is set too low.	Change F069 or F070 setting.
		Incorrect Volts/Hz Pattern setting.	Change the Volts /Hz Pattern setting (F005).
		Load exceeds motor rating.	Replace with an appropriately rated motor.
OL2	Drive overload.	Incorrect Volts/Hz Pattern setting.	Change Volts/Hz Pattern setting (F005).
		Load exceeds drive rating.	Replace with an appropriately rated drive.
OL3	Overtorque.	Excessive loading.	Replace with an appropriately rated drive.
		Incorrect Volts/Hz Pattern setting.	Change Volts/Hz Pattern setting (F005).
		F078 and/or F079 are set too low.	Increase setting of F078 and/or F079.
OC-S	Transient overcurrent.	Motor bearing or equipment.	Check the motor and/or equipment.
		Transistor module is defective.	Return the drive for repair.
OC-A	Overcurrent during acceleration.	Acceleration Time setting too short.	Increase the Acceleration Time setting (F001).
		Incorrect Volts/Hz Pattern setting.	Change the Volts/Hz Pattern setting (F005).
		Motor load capacity exceeds drive rating.	Replace with an appropriately rated drive.

TABLE 22 – FAULT CODES AND CORRECTIVE ACTIONS (CONTINUED)

Fault Code	Description	Probable Cause	Corrective Action
OC-C	Overcurrent at set speed.	Transient overloading.	Check the load for excessive friction.
		Transient power surge.	Install a line reactor at the AC line input.
OC-d	Overcurrent during deceleration.	Deceleration Time setting too short.	Increase the Deceleration Time setting (F002).
OC-b	Overcurrent during braking.	Incorrect DC Injection Brake Time setting.	Change the DC Injection Brake Time setting (F053).
		Incorrect DC Injection Brake Start Frequency setting.	Change the DC Injection Brake Start Frequency setting (F054).
		Incorrect DC Injection Brake Level setting.	Change the DC Injection Brake Level setting (F055).
OU-C	Overvoltage at set speed or deceleration.	Deceleration time is set too low.	Increase the Deceleration Time setting (F002).
		AC line input voltage variation.	Install a transformer at the AC line input.
LU-C	Low AC line voltage at set speed.	Wiring impedance too great.	Check the AC line voltage at source. Rewire with proper gauge wire.
		Drive AC line input voltage not set correctly.	Set F030 to the actual AC line input voltage.
		Low line voltage.	Install a transformer at the AC line.
OH-C	Heat sink overtemperature at set speed.	Load Current exceeds the drive rating.	Replace with an appropriately rated drive.
		Ambient temperature is too high.	Improve ventilation to reduce the ambient temperature.
E.S.	Rapid Stop.	When the external stop signal is activated from a Multifunction Input Terminal, the motor will decelerate and stop. The display will flash “E.S.” after the motor stops.	Open and close the Run contact to restart the drive.
b. b.	Coast-to-Stop.	When the external stop signal is activated from a Multifunction Input Terminal, the motor will coast-to-stop. The display will flash “b.b.”.	Open and close the Run contact to restart the drive.
LOC	Motor direction locked.	Attempting to reverse motor direction when F003 is set to “x1xx”.	Change setting of F003 to “x0xx”.
		Attempting to change the output frequency when F004 = “xxx1” or “xx1x”.	Change setting of F004 to “xxx0” or “xx0x”.
Err1	Operation error.	Attempting to change the output frequency with the ▲ or ▼ key when F011 is set to “0001”, “0002”, or “0003”.	Set F011 to “0000”.
		Attempting to reprogram a factory setting.	Factory setting cannot be reprogrammed.
		Attempting to change functions which cannot be changed while the drive is in Run Mode.	“Stop” the drive to change the function.
Err2	Setting error.	F007 is in the range of F065 ±F068 or F066 ± F068 or F067 ± F068.	Change setting of F065 - F068 or F066 - F068 or F067 - F068 or F007.
		The setting of F006 is less than or equal to the setting of F007.	Change the setting of F006 to be greater than the setting of F007.
		The setting of F027 is greater than or equal to the setting of F028.	Change the setting of F027 to be less than the setting of F028.

TABLE 22 – FAULT CODES AND CORRECTIVE ACTIONS (CONTINUED)

Fault Code	Description	Probable Cause	Corrective Action
Err3	Setting error.	Volts/Hz curve is set too steep when F005 is set to "0018".	(F038 - F040) ÷ (F037 - F039) ≤ 65 or (F040 - F041) ÷ (F039 - 0.1) ≤ 65.
		Analog signal input is set too steep.	
Err4	Setting error (Volts/Hz Pattern).	Incorrect setting of F037.	F037 > F039 > 0.1 Hz.
		Incorrect setting of F041.	F038 ≥ F040 ≥ F041.
Err5	Parameter setting error.	Parameters setting is disabled.	Enable parameter setting.
		Attempting to change settings of F101 or F102 during communication.	Set F101 and F102 before initiating communication.
Err6	Communication error.	Connection error.	Check connection.
		Incorrect communication parameters settings.	Check settings of F101 and F102.
		Checksum error.	Check communication agreement.
		Agreement error.	Check communication.
Err7	Bus voltage error.	Bus voltage is not within tolerance.	Check the AC line input voltage or the bus voltage.

** When the braking circuit is overloaded during deceleration, the drive will stop braking and display "OH1. When the braking circuit temperature returns to a safe level, "OH1" will no longer be displayed and the drive will resume normal braking operation.*

TABLE 23 – DISPLAY STATUS WHEN THE DRIVE IS IN EXTERNAL START/STOP MODE (F010 = 0001)

Display Indication	Description
StP0	The drive has been set to Zero Frequency using the keypad or External frequency command
StP1	The drive is in Stop Mode due to an interruption and resumption of the AC power. To restart the drive, open and close the Start/Stop contact. ***Note:*** *F016 is set to "xxx1" [Disable Auto AC Line Start when External Command is On]*
StP2	The RUN/STOP key is pressed while the drive is in Run Mode

Note: *When the drive is stopped by external contacts, a stop code (StP0, StP1, StP2) will be displayed, as described in Table 23.*

X. OPTIONAL ACCESSORIES

Complete instructions and connection diagrams are supplied with all accessories to facilitate installation.

A. RFI Filters – Provide RFI noise suppression to meet CE and C-Tick requirements. See Table 24 on page 78, and Figure 31 on page 77. The recommended maximum wiring distance between drive and filter is 12" (30 cm). If motor wires exceed 12" (30 cm), a shielded cable must be used. On Some applications, an additional Motor Choke may have to be used.

FIGURE 31 – RECOMMENDED RFI FILTER CONNECTION

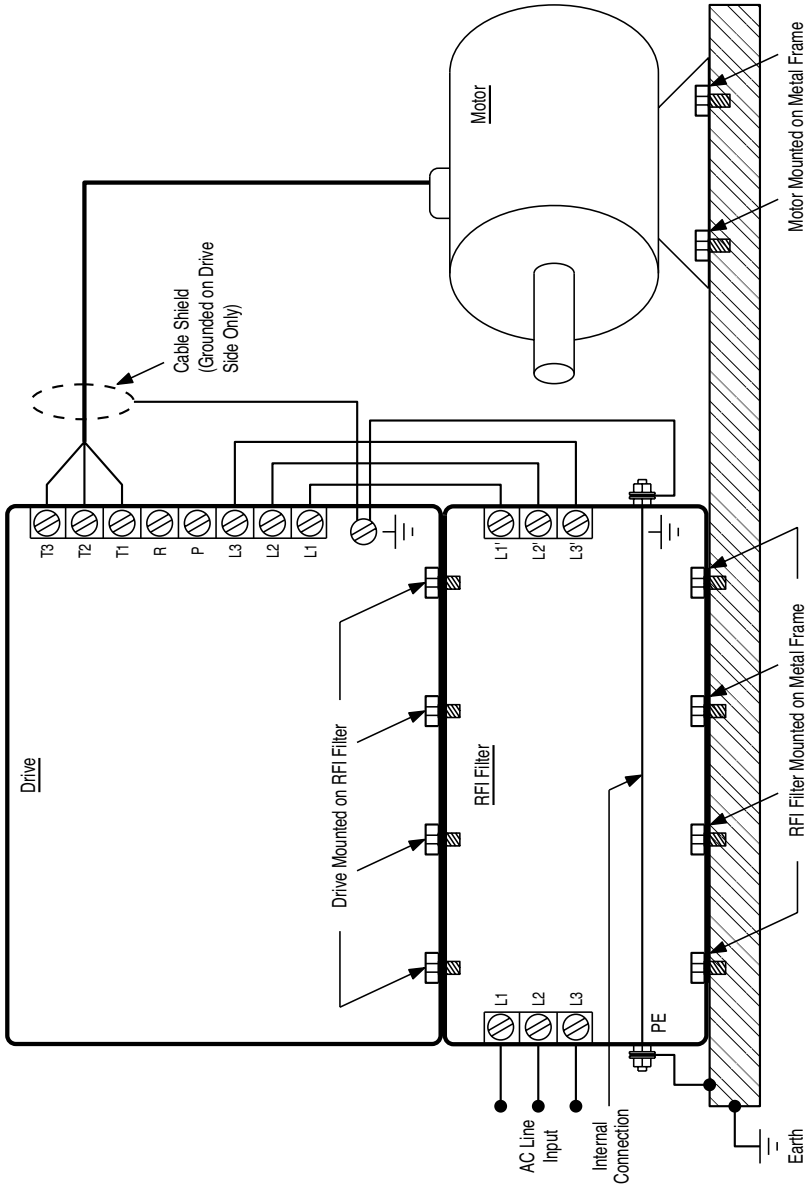


TABLE 24 – RFI FILTERS

Drive Model	Class	Input Phases (ϕ)	Rating		KB Model No.	KB Part No.	Dimensions (W x H x D)	
			Amps AC	Volts AC			Inches	mm
KBN2-2250-1	B	1	10	230	KBN2-EMI-2102	14020	4.49 x 7.83 x 1.18	114 x 199 x 30
KBN2-2201-1								
KBN2-2202-1	B	1	20	230	KBN2-EMI-2202A	14030	6.26 x 8.98 x 1.97	159 x 228 x 50
KBN2-2203-1					KBN2-EMI-2202B	14040	7.68 x 10.43 x 1.97	195 x 265 x 50
KBN2-4301-1	B	3	10	460	KBN2-EMI-4103A	14050	6.26 x 8.98 x 1.97	159 x 228 x 45
KBN2-4302-1								
KBN2-4303-1	B	3	10	460	KBN2-EMI-4103B	14060	7.68 x 10.43 x 1.97	195 x 265 x 45
KBN2-4305-1								
KBN2-4307-1	B	3	20	460	KBN2-EMI-4203	14070	8.27 x 14.17 x 2.76	210 x 360 x 70
KBN2-4310-1	A							
KBN2-4315-1	A	3	60	460	KBN2-EMI-4603	14080	10.24 x 18.11 x 3.94	260 x 460 x 100
KBN2-4320-1								
KBN2-4330-1								

Note: *Class A RFI Filter complies with Industrial Standard and Class B RFI Filter complies with Residential Standard.*

B. Brake Resistor Kit – Provides quicker stopping with high inertial loads. This option is only available for Models KBN2-2250-1, 2201-1, 2202-1, 2203-1, 2305-1, 2307-1, 2310-1, 4301-1, 4302-1, 4303-1, 4305-1, 4307-1, 4310-1. See Table 25.

TABLE 25 – BRAKE RESISTORS

Drive Model No.	Motor HP (kw)	Braking Torque (%)	Brake Resistor				
			Part No.	Ω	W	Dimensions (W x H x L)	
						Inches	mm
KBN2-2250-1	.5 (.37)	220	14170	200	60	1.57 x 0.79 x 4.53	40 x 20 x 115
KBN2-2201-1	1 (.75)	220	14170	200	60	1.57 x 0.79 x 4.53	40 x 20 x 115
KBN2-2202-1	2 (1.5)	120	14180	100	150	1.57 x 0.79 x 8.46	40 x 20 x 215
KBN2-2203-1	3 (2.2)	115	14190	70	200	2.36 x 1.18 x 6.49	60 x 30 x 165
KBN2-2305-1	5 (3.7)	120	14200	40	300	2.36 x 1.18 x 8.46	60 x 30 x 215
KBN2-2307-1	7.5 (5.6)	125	14210	25	500	2.36 x 1.18 x 13.19	60 x 30 x 335
KBN2-2310-1	10 (7.5)	120	14220	20	600	2.36 x 1.18 x 13.19	60 x 30 x 335
KBN2-4301-1	1 (0.75)	125	14230	750	60	1.57 x 0.79 x 4.53	40 x 20 x 115
KBN2-4302-1	2 (1.5)	120	14240	400	150	1.57 x 0.79 x 8.46	40 x 20 x 215
KBN2-4303-1	3 (2.2.)	130	14250	250	200	2.36 x 1.18 x 6.49	60 x 30 x 165
KBN2-4305-1	5 (3.7)	130	14260	150	300	2.36 x 1.18 x 8.46	60 x 30 x 215
KBN2-4307-1	7.5 (5.6)	125	14270	100	500	2.36 x 1.18 x 13.19	60 x 30 x 335
KBN2-4310-1	10 (7.5)	120	14280	80	600	2.36 x 1.18 x 13.19	60 x 30 x 335

C. Digital Keypad Extension Cable Kit – 3 Ft. (1m) and 10 Ft. (3m) extension cables provide remote mounting of the digital keypad. See Table 26, on page 79.

TABLE 26 – EXTENSION CABLES

Drive Model No	Extension Cable Kit Part No.		
	3 Ft. (1m)	6 Ft. (2 m)	10 Ft. (3 m)
KBN2-2250-1	14090	14100	14110
KBN2-2201-1			
KBN2-2202-1			
KBN2-2203-1			
KBN2-2305-1			
KBN2-2307-1	14120	14130	14140
KBN2-2310-1			
KBN2-2315-1			
KBN2-2320-1			
KBN2-2330-1			

Drive Model No	Extension Cable Kit Part No.		
	3 Ft. (1 m)	6 Ft. (2 m)	10 Ft. (3 m)
KBN2-4301-1	14090	14100	14110
KBN2-4302-1			
KBN2-4303-1			
KBN2-4305-1			
KBN2-4307-1	14120	14130	14140
KBN2-4310-1			
KBN2-4315-1			
KBN2-4320-1			
KBN2-4330-1			

D. External Speed Potentiometer Kit (Part No. 9111) – Provides remote mounting of the speed potentiometer to control motor speed. Kit includes a linear 5 kΩ potentiometer, mounting hardware, and panel insulator.

E. RS-232 Communication Kit (Part No. 14150) and RS-485 Communication Kit (Part No. 14160) – Provides PC Windows® based RS-232/485 DriveLink™ software communications to facilitate programming.

F. DownLoad Module™ (DLM) (Part No. 14145) – Handheld programming device uploads and downloads drive programs.

XI. LIMITED WARRANTY

For a period of 18 months from the date of original purchase, KB Electronics, Inc. will repair or replace, without charge, devices which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The foregoing is in lieu of any other warranty or guarantee, expressed or implied. KB Electronics, Inc. is not responsible for any expense, including installation and removal, inconvenience, or consequential damage, including injury to any person, caused by items of our manufacture or sale. Some states do not allow certain exclusions or limitations found in this warranty and therefore they may not apply to you. In any event, the total liability of KB Electronics, Inc., under any circumstance, shall not exceed the full purchase price of this product. (rev 2/2000)

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