Configuring Drive Parameters

3

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Choosing a Programming Device

Introduction

Hitachi variable frequency drives (inverters) use the latest electronics technology for getting the right AC waveform to the motor at the right time. The benefits are many, including energy savings and higher machine output or productivity. The flexibility required to handle a broad range of applications has required ever more configurable options and parameters—inverters are now a complex industrial automation component. And this can make a product seem difficult to use, but the goal of this chapter is to make this easier for you.

As the powerup test in Chapter 2 demonstrated, you do not have to program very many parameters to run the motor. In fact, most applications would benefit only from programming just a few, specific parameters. This chapter will explain the purpose of each set of parameters, and help you choose the ones that are important to your application.

If you are developing a new application for the inverter and a motor, finding the right parameters to change is mostly an exercise in optimization. Therefore, it is okay to begin running the motor with a loosely tuned system. By making specific, individual changes and observing their effects, you can achieve a finely tuned system. And, the SJ100 Series inverters have a built-in auto-tuning algorithm to set certain motor parameters.

Introduction to Inverter Programming

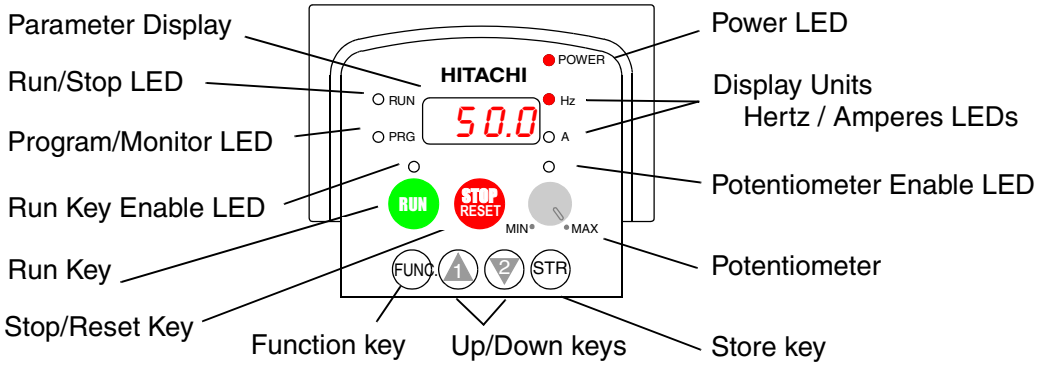
The front panel keypad is the first and best way to get to know the inverter's capabilities. Every function or programmable parameter is accessible from the keypad. The other devices simply imitate the keypad's layout and inverter access, while adding another valuable aspect to the system. For example, the Copy Unit can transfer one inverter's parameter settings to another inverter, while still providing standard operator keypad control. In this way, you can use a variety of programming devices with basically the same keypad skills. The following table shows various programming options, the features unique to each device, and the cables required.

Device	Part Number	Parameter Access	Parameter setting storage	Cables (choose one)	
				Part number	Length
Inverter keypad	—	Monitor and program	EEPROM in inverter	—	—
DOP Professional Software (for PC)	DOP–PRO	Monitor and program	PC hard drive or diskette	(Included with software)	2 meters
Digital Operator/ Copy Unit	SRW–0EX	Monitor and program	EEPROM in operator panel	ICS–1	1 meter
				ICS–3	3 meters
Operator Monitor	OPE–J	Monitor only	none on operator monitor	ICJ–1L	1 meter
				ICJ–3L	3 meters

Using Keypad Devices

Inverter Front Panel Keypad

The SJ100 Series inverter front keypad contains all the elements for both monitoring and programming parameters. The keypad layout is pictured below. All other programming devices for the inverter have a similar key arrangement and function.

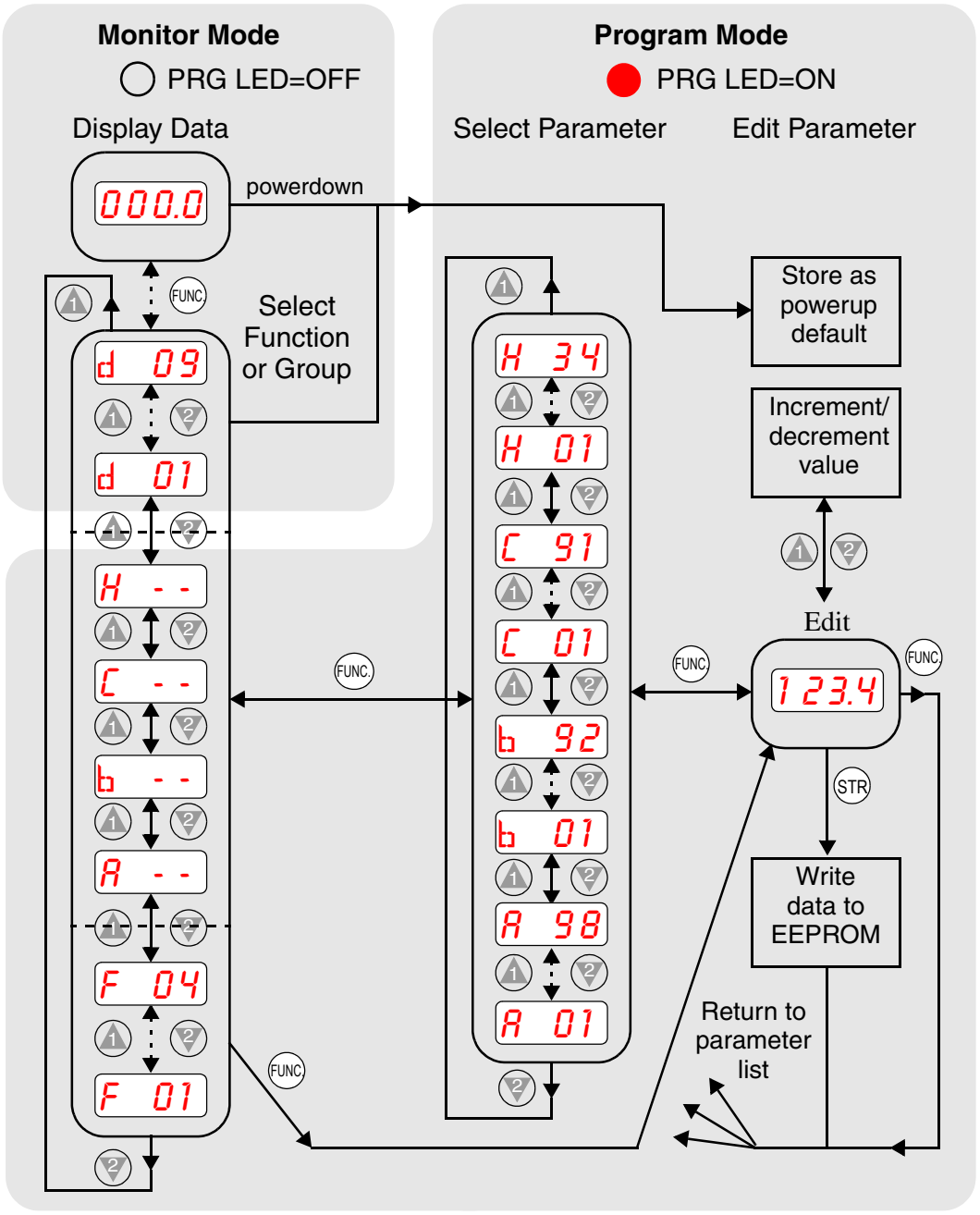


Key and Indicator Legend

- **Run/Stop LED** - ON when the inverter output is ON and the motor is developing torque (Run Mode), and OFF when the inverter output is OFF (Stop Mode).
- **Program/Monitor LED** - This LED is ON when the inverter is ready for parameter editing (Program Mode). It is OFF when the parameter display is monitoring data (Monitor Mode).
- **Run Key Enable LED** - is ON when the inverter is ready to respond to the Run key, OFF when the Run key is disabled.
- **Run Key** - Press this key to run the motor (the Run Enable LED must be ON first). Parameter F_04, Keypad Run Key Routing, determines whether the Run key generates a Run FWD or Run REV command.
- **Stop/Reset Key** - Press this key to stop the motor when it is running (uses the programmed deceleration rate). This key will also reset an alarm that has tripped.
- **Potentiometer** - Allows an operator to directly set the motor speed when the potentiometer is enabled for output frequency control.
- **Potentiometer Enable LED** - ON when the potentiometer is enabled for value entry.
- **Parameter Display** - A 4-digit, 7-segment display for parameters and function codes.
- **Display Units, Hertz/Amperes** - One of these LEDs will be ON to indicate the units associated with the parameter display.
- **Power LED** - This LED is ON when the power input to the inverter is ON.
- **Function Key** - This key is used to navigate through the lists of parameters and functions for setting and monitoring parameter values.
- **Up/Down (▲1, ▼2) Keys** - Use these keys alternately to move up or down the lists of parameter and functions shown in the display, and increment/decrement values.
- **Store (STR) Key** - When the unit is in Program Mode and you have edited a parameter value, press the Store key to write the new value to the EEPROM.

Keypad Navigational Map

You can use the inverter's front panel keypad to navigate to any parameter or function. The diagram below shows the basic navigational map to access these items.

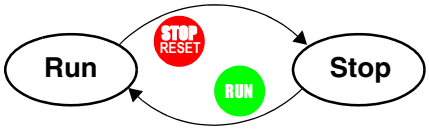


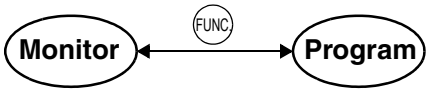
NOTE: The inverter 7-segment display shows lower case "b" and "d," meaning the same as the upper case letters "B" and "D" used in this manual (for uniformity "A to F").

NOTE: The Store Key saves the edited parameter (shown in the display) to the inverter's EEPROM. Upload or download of parameters to/from external devices is accomplished through a different command—do not confuse *Store* with *Download* or *Upload*.

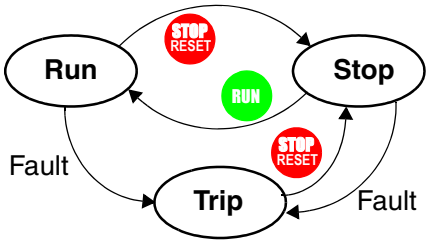
Operational Modes

The RUN and PGM LEDs tell just part of the story; Run Mode and Program Modes are independent modes, not opposite modes. In the state diagram to the right, Run alternates with Stop, and Program Mode alternates with Monitor Mode. This is a very important ability, for it shows that a technician can approach a running machine and change some parameters without shutting down the machine.





The occurrence of a fault during operation will cause the inverter to enter the Trip Mode as shown. An event such as an output overload will cause the inverter to exit the Run Mode and turn OFF its output to the motor. In the Trip Mode, any request to run the motor is ignored. You must clear the error by pressing the Stop/Reset switch. See "Monitoring Trip Events, History, & Conditions" on page 6–5.



Run Mode Edits

The inverter can be in Run Mode (inverter output is controlling motor) and still allow you to edit certain parameters. This is useful in applications that must run continuously, yet need some inverter parameter adjustment.

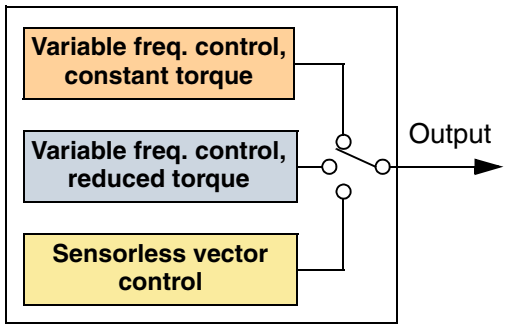
The parameter tables in this chapter have a column titled "Run Mode Edit." An Ex mark ✘ means the parameter cannot be edited; a Check mark ✔ means the parameter can be edited. The Software Lock Setting (parameter B_31) determines when the Run Mode access permission is in effect and access permission in other conditions, as well. It is the responsibility of the user to choose a useful and safe software lock setting for the inverter operating conditions and personnel. Please refer to "Software Lock Mode" on page 3–28 for more information.

	Run Mode Edit	
	✘	
	✔	

Control Algorithms

The motor control program in the SJ100 inverter has three sinusoidal PWM switching algorithms. The intent is that you select the best algorithm for the motor characteristics in your application. Each algorithm generates the frequency output in a unique way. Once configured, the algorithm is the basis for other parameter settings as well (see "Torque Control Algorithms" on page 3–13). Therefore, choose the best algorithm early in your application design process.

Inverter Control Algorithms

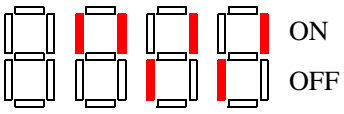
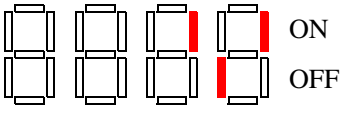


"D" Group: Monitoring Functions

Parameter Monitoring Functions

You can access important system parameter values with the "D" Group monitoring functions, whether the inverter is in Run Mode or Stop Mode. After selecting the function code number for the parameter you want to monitor, press the Function key once to show the value on the display. In Functions D_05 and D_06, the intelligent terminals use individual segments of the display to show ON/OFF status.

If the inverter display is set to monitor a parameter and powerdown occurs, the inverter stores the present monitor function setting. For your convenience, the display automatically returns to the previously monitored parameter upon the next powerup.

"D" Function			Run Mode Edit	Range and Units
Func. Code	**Name / SRW Display**	**Description**		
D_01	Output frequency monitor FM 0000.00Hz	Real-time display of output frequency to motor, from 0.0 to 360.0 Hz	—	0.0 to 360.0 Hz
D_02	Output current monitor Im 0.0A 0.0%	Filtered display of output current to motor (100 ms internal filter time constant)	—	A
D_03	Rotation direction monitor Dir STOP	Three different indications: "F"..... Forward "l l" .. Stop "r"..... Reverse	—	—
D_04	Process variable (PV), PID feedback monitor PID-FB 0000.00%	Displays the scaled PID process variable (feedback) value (A_75 is scale factor)	—	—
D_05	Intelligent input terminal status TERM LLL LLLLLL	Displays the state of the intelligent input terminals:  ON OFF 6 5 4 3 2 1 Terminal numbers	—	—
D_06	Intelligent output terminal status TERM LLL LLLLLL	Displays the state of the intelligent output terminals:  ON OFF AL 12 11 Terminal numbers	—	—

Configuring Drive Parameters

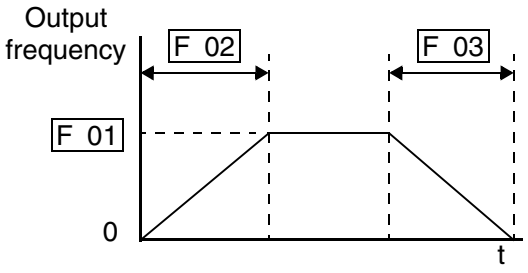
"D" Function			Run Mode Edit	Range and Units
Func. Code	**Name / SRW Display**	**Description**		
D_07	Scaled output frequency monitor /Hz01.0 0.00	Displays the output frequency scaled by the constant in B_86. Decimal point indicates range: XX.XX 0.01 to 99.99 XXX.X 100.0 to 999.9 XXXX. 1000 to 9999 XXXX 10000 to 99990	—	Hz

Trip Event and History Monitoring

The trip event and history monitoring feature lets you cycle through related information using the keypad. See "Monitoring Trip Events, History, & Conditions" on page 6–5 for more details.

"D" Function			Run Mode Edit	Range and Units
Func. Code	**Name / SRW Display**	**Description**		
D_08	Trip event monitor ERR1 EEPROM ERR1 0.0Hz ERR1 0.0A ERR1 324.3Vdc ERR1 RUN 000000H	Displays the current trip event. information.	—	—
D_09	Trip history monitor ERR2 EEPROM ERR2 0.0Hz ERR2 0.0A ERR2 330.0Vdc ERR2 RUN 000000H ERR3 EEPROM ERR3 0.0Hz ERR3 0.0A ERR3 328.7Vdc ERR3 RUN 000000H	Displays the previous two events and their causes.	—	—
—	Cumulative operation RUN time monitor RUN 000000H	Displays total time the inverter has been in RUN mode in hours.	—	hours
—	Trip count ERROR COUNT 009	Displays cumulative number of trip events.	—	trips

"F" Group: Main Profile Parameters



The basic frequency (speed) profile is defined by parameters contained in the "F" Group as shown to the right. The set running frequency is in Hz, but acceleration and deceleration are specified in the time duration of the ramp (from zero to maximum frequency, or from maximum frequency to zero). The motor direction parameter determines whether the keypad Run key produces a FWD or REV command. This parameter does not affect the intelligent terminal [FWD] and [REV] functions, which you configure separately.

Acceleration 1 and Deceleration 1 are the standard default accel and decel values for the main profile. Accel and decel values for an alternative profile are specified by using parameters Ax92 through Ax93. The motor direction selection (F_04) determines the direction of rotation as commanded only from the keypad. This setting applies to any motor profile (1st or 2nd) in use at a particular time

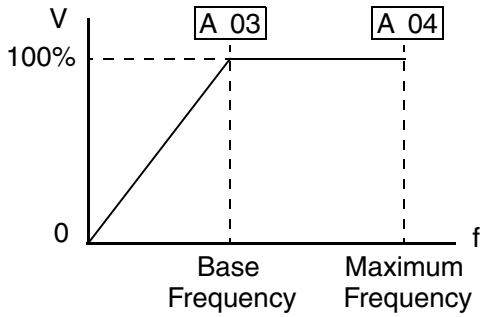
"F" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
F_01	Output frequency setting TM 000.0 0.0Hz	Standard default target frequency that determines constant motor speed, range is 0 to 360 Hz	✔	0.0	0.0	0.0	Hz
F_02	Acceleration (1) time setting ACC 1 0010.0s	Standard default acceleration, range is 0.1 to 3000 sec.	✔	10.0	10.0	10.0	sec.
F202	Acceleration (1) time setting, 2nd motor 2ACC1 0010.0s	Standard default acceleration, 2nd motor, range is 0.1 to 3000 sec.	✔	10.0	10.0	10.0	sec.
F_03	Deceleration (1) time setting DEC 1 0010.0s	Standard default deceleration, range is 0.1 to 3000 sec.	✔	10.0	10.0	10.0	sec.
F203	Deceleration (1) time setting, 2nd motor 2DEC1 0010.0s	Standard default deceleration, 2nd motor, range is 0.1 to 3000 sec.	✔	10.0	10.0	10.0	sec.
F_04	Keypad Run key routing INIT DOPE FWD	Two options; select codes: 00...Forward 01...Reverse	✘	00	00	00	—

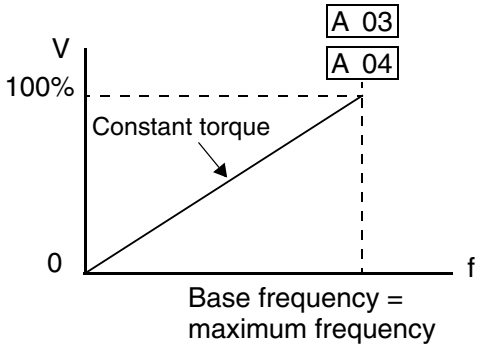
"A" Group: Standard Functions

Basic Parameter Settings

These settings affect the most fundamental behavior of the inverter—the outputs to the motor. The frequency of the inverter's AC output determines the motor speed. You may select from three different sources for the reference speed. During application development you may prefer using the potentiometer, but you may switch to an external source (control terminal setting) in the finished application, for example.

The base frequency and maximum frequency settings interact according to the graph below (left). The inverter output operation follows the constant V/f curve until it reaches the full-scale output voltage. This initial straight line is the constant-torque part of the operating characteristic. The horizontal line over to the maximum frequency serves to let the motor run faster, but at a reduced torque. If you want the motor to output constant torque over its entire operating range (limited to the motor nameplate voltage and frequency rating), then set the base frequency and maximum frequency equal as shown (below right).





NOTE: The "2nd motor" settings in the tables in this chapter store an alternate set of parameters for a second motor. The inverter can use the 1st set or 2nd set of parameters to generate the output frequency to the motor. See "Configuring the Inverter for Multiple Motors" on page 4–40.

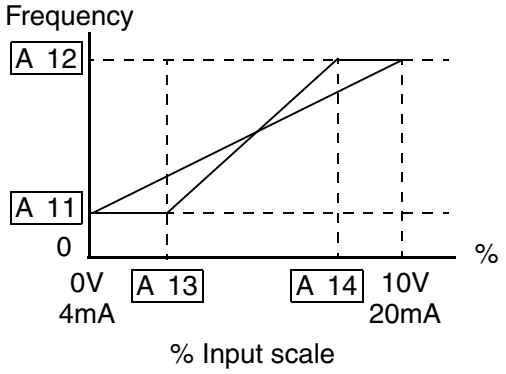
"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_01	Frequency source setting F-SET-SELECT TRM	Three options; select codes: 00... Keypad potentiometer 01... Control terminal 02... Function F_01 setting	✘	01	01	02	—
A_02	Run command source setting F/R SELECT TRM	Two options; select codes: 01... Control terminal 02... Run key on keypad, or digital operator	✘	01	01	02	—
A_03	Base frequency setting F-BASE 060Hz	Settable from 50 Hz to the maximum frequency	✘	50.0	60.0	60.0	Hz

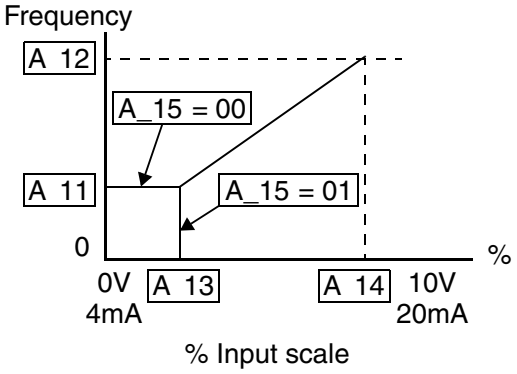
"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A203	Base frequency setting, 2nd motor	Settable from 50 Hz to the maximum frequency	✘	50.0	60.0	60.0	Hz
	2F-BASE 060Hz						
A_04	Maximum frequency setting	Settable from the base frequency up to 360 Hz	✘	50.0	60.0	60.0	Hz
	F-MAX 060Hz						
A204	Maximum frequency setting, 2nd motor	Settable from the base frequency up to 360 Hz	✘	50.0	60.0	60.0	Hz
	2F-MAX 060Hz						

Analog Input Settings

The inverter has the capability to accept an external analog input that can command the output frequency to the motor. Voltage input (0 –10V) and current input (4–20mA) are available on separate terminals ([O] and [OI], respectively). Terminal [L] serves as signal ground for the two analog inputs. The analog input settings adjust the curve characteristics between the analog input and the frequency output.

In the graph below (left), A_13 and A_14 select the active portion of the input voltage or current range. The parameters A_11 and A_12 select the start and end frequency of the converted output frequency range, respectively. Together, these four parameters define a line segment as shown (below, right). When the line does not begin at the origin, A_15 defines whether the inverter outputs 0Hz or the A_11 frequency when the analog input value is less than the A_13 setting (determines the non-linear part of the translation).





"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_11	O–L input active range start frequency IN EXS 000.0Hz	The output frequency corresponding to the analog input range starting point	✘	0	0	0	Hz
A_12	O–L input active range end frequency IN EXE 000.0Hz	The output frequency corresponding to the analog input range ending point	✘	0	0	0	Hz
A_13	O–L input active range start voltage IN EX%S 000%	The starting point (offset) for the active analog input range	✘	0	0	0	%
A_14	O–L input active range end voltage IN EX%E 100%	The ending point (offset) for the active analog input range	✘	100	100	100	%
A_15	O–L input start frequency enable IN LEVEL 0Hz	Two options; select codes: 00... Use offset (A_11 value) 01... Use 0 Hz	✘	01	01	01	—
A_16	External frequency filter time constant IN F-SAMP 8	Range n = 1 to 8, where n = number of samples for avg.	✘	8	8	8	Samples

Multi-speed and Jog Frequency Setting

The SJ100 inverter has the capability to store and output up to 16 preset frequencies to the motor (A_20 to A_35). As in traditional motion terminology, we call this *multi-speed profile* capability. These preset frequencies are selected by means of digital inputs to the inverter. The inverter applies the current acceleration or deceleration setting to change from the current output frequency to the new one. The first multi-speed setting is duplicated for the second motor settings (the remaining 15 multi-speeds apply only to the first motor).

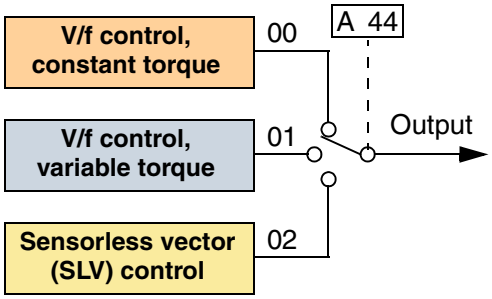
The jog speed setting is used whenever the Jog command is active. The jog speed setting range is arbitrarily limited to 10 Hz, to provide safety during manual operation. The acceleration to the jog frequency is instantaneous, but you can choose from three modes for the best method for stopping the jog operation.

"A" Function			Run Mode Edit	Defaults			
Func. Code	**Name / SRW Display**	**Description**		**–FE (CE)**	**–FU (UL)**	**–FR (Jpn)**	**Units**
A_20	Multi-speed frequency setting SPD FS 000.0Hz	Defines the first speed of a multi-speed profile, range is 0 to 360 Hz A_20 = Speed 0 (1st motor)	✔	0	0	0	Hz
A220	Multi-speed frequency setting, 2nd motor SPD 2FS 000.0Hz	Defines the first speed of a multi-speed profile for 2nd motor, range is 0 to 360 Hz A_20 = Speed 0 (2nd motor)	✔	0	0	0	Hz
A_21 to A_35	Multi-speed frequency settings (for both motors)	Defines 15 more speeds, range is 0 to 360 Hz. A_21= Speed 1... A_35 = Speed 15	✔	see next row	see next row	see next row	Hz
	SPD 1 000.0Hz	A_21		0	0	5	
	SPD 2 000.0Hz	A_22		0	0	10	
	SPD 3 000.0Hz	A_23		0	0	15	
	SPD 4 000.0Hz	A_24		0	0	20	
	SPD 5 000.0Hz	A_25		0	0	30	
	SPD 6 000.0Hz	A_26		0	0	40	
	SPD 7 000.0Hz	A_27		0	0	50	
	SPD 8 000.0Hz	A_28		0	0	60	
	SPD 9 000.0Hz	A_29		0	0	0	
	SPD 10 000.0Hz	A_30		0	0	0	
	SPD 11 000.0Hz	A_31		0	0	0	
	SPD 12 000.0Hz	A_32		0	0	0	
	SPD 13 000.0Hz	A_33		0	0	0	
	SPD 14 000.0Hz	A_34		0	0	0	
	SPD 15 000.0Hz	A_35		0	0	0	
A_38	Jog frequency setting Jogging 01.00Hz	Defines limited speed for jog, range is 0.5 to 9.99 Hz	✔	1.0	1.0	1.0	Hz
A_39	Jog stop mode Jog Mode 0	Define how end of jog stops the motor; three options: 00... Free-run stop 01... Controlled deceleration 02... DC braking to stop	✘	00	00	00	—

Torque Control Algorithms

The inverter generates the motor output according to the V/f algorithm or the sensorless vector control algorithm. Parameter A_44 selects the inverter algorithm for generating the frequency output, as shown in the diagram to the right (A244 for 2nd motor). The factory default is 02 (sensorless vector control).

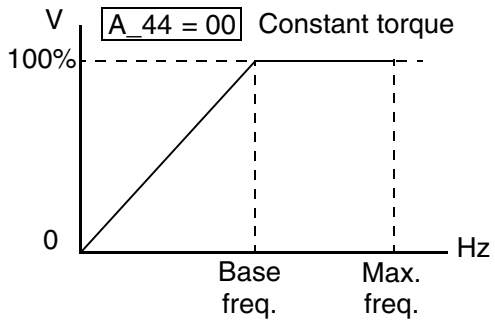
Inverter Torque Control Algorithms

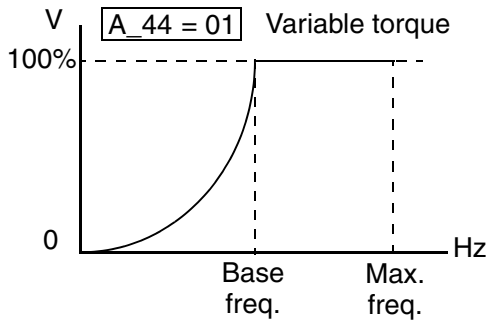


Review the following descriptions to help you choose the best torque control algorithm for your application.

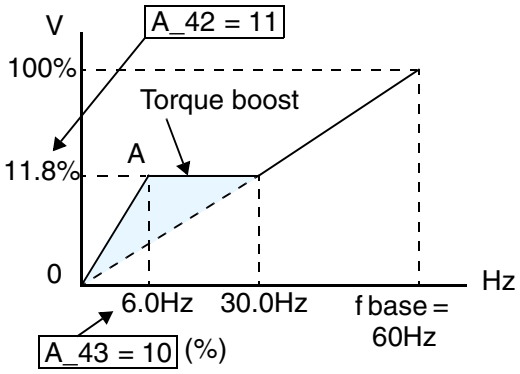
- The built-in V/f curves are oriented toward developing constant torque or variable torque characteristics (see graphs below).
- Sensorless vector control calculates an ideal torque vector based on current motor position, winding currents, and so on. It is a more robust control method than the V/f control methods. However, it is more dependent on actual motor parameters and will require you to set these values carefully or perform the auto-tuning procedure (see "Auto-tuning for Sensorless Vector Control" on page 4–35).

Constant and Variable (Reduced) Torque – The graph below (left) shows the constant torque characteristic from 0Hz to the base frequency A_03. The voltage remains constant for output frequencies higher than the base frequency. The graph below (right) shows the general variable (reduced) torque curve. The range from 0Hz to the base frequency is the variable characteristic.





Torque Boost – The Constant and Variable Torque algorithms feature an adjustable *torque boost* curve. When the motor load has a lot of inertia or starting friction, you may need to increase the low frequency starting torque characteristics by boosting the voltage above the normal V/f ratio (shown at right). The boost is applied from zero to 1/2 the base frequency. You set the breakpoint of the boost (point A on the graph) by using



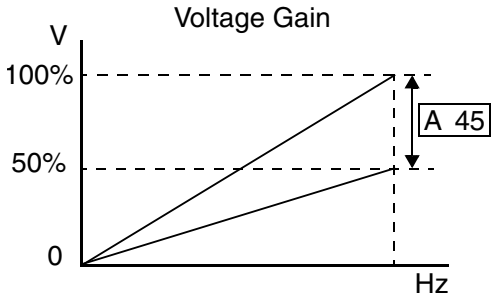
parameters A_42 and A_43. The manual boost is calculated as an addition to the standard straight V/f line (constant torque curve).

NOTE: Manual torque boost is not operational when sensorless vector control is in use.

Be aware that running the motor at a low speed for a long time can cause motor overheating. This is particularly true when manual torque boost is ON, or if the motor relies on a built-in fan for cooling.

NOTE: Manual torque boost applies only to constant torque (A_44=00) and variable torque (A_44=01) V/f control.

Voltage Gain – Using parameter A_45 you can modify the voltage gain of the inverter (see graph at right). This is specified as a percentage of the full scale setting (Automatic Voltage Regulation) AVR level in parameter F_03. The gain can be set from 50% to 100%. It should be adjusted in accordance with the motor specifications.



Sensorless Vector Control (SLV) – This advanced torque control algorithm improves torque performance at very low speeds—down to 0.5 Hz. Set parameter A_44=02 to select SLV operation. The SLV algorithm must be tuned to match the characteristics of the particular motor connected to your inverter. Simply using the default motor parameters in the inverter will not work satisfactorily for these control methods. Chapter 4 discusses motor/inverter size selection and how to set the motor parameters either manually or by using the built-in auto-tuning. Before using the sensorless vector control methods, please refer to "Auto-tuning for Sensorless Vector Control" on page 4–35.

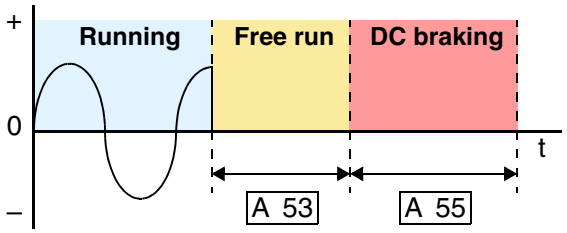
NOTE: When the inverter is in SLV (sensorless vector) mode, use B_83 to set the carrier frequency greater than 2.1 kHz for proper operation.

NOTE: You must disable sensorless vector operation when two or more motors are connected (parallel operation) to the inverter.

The following table shows the methods of torque control selection.

"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_41	Torque boost method selection V-Boost Mode 0	Two options: 00... Manual torque boost 01... Automatic torque boost	✘	00	00	00	—
A241	Torque boost method selection, 2nd motor 2V-Boost Mode 0	Two options (for 2nd motor): 00... Manual torque boost 01... Automatic torque boost	✘	00	00	00	—
A_42	Manual torque boost value V-Boost code 11	Can boost starting torque between 0 and 99% above normal V/f curve, from 0 to 1/2 base frequency	✔	11	11	11	—
A242	Manual torque boost value, 2nd motor 2V-Boost code 11	Can boost starting torque between 0 and 99% above normal V/f curve, from 0 to 1/2 base frequency	✔	11	11	11	—
A_43	Manual torque boost frequency adjustment V-Boost F 10.0%	Sets the frequency of the V/f breakpoint A in graph (top of previous page) for torque boost	✔	10.0	10.0	10.0	%
A243	Manual torque boost frequency adjustment, 2nd motor 2V-Boost F 10.0%	Sets the frequency of the V/f breakpoint A in graph (top of previous page) for torque boost	✔	10.0	10.0	10.0	%
A_44	V/f characteristic curve selection CONTROL SLV	Two available V/f curves; three select codes: 00... Constant torque 01... Reduced torque 02... Sensorless vector control	✘	02	02	02	—
A244	V/f characteristic curve selection, 2nd motor 2CONTROL SLV	Two available V/f curves; three select codes: 00... Constant torque 01... Reduced torque 02... Sensorless vector control	✘	02	02	02	—
A_45	V/f gain setting V-Gain 100%	Sets voltage gain of the inverter from 50 to 100%	✔	100	100	100	%

DC Braking Settings



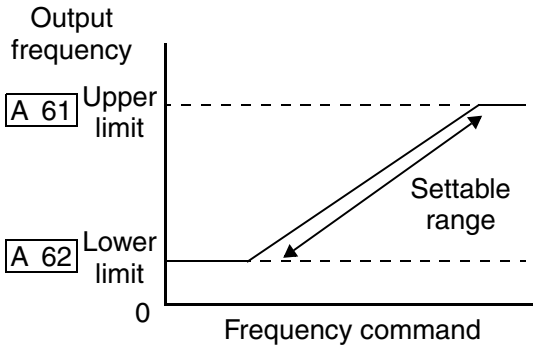
The DC braking feature can provide additional stopping torque when compared to a normal deceleration to a stop. DC braking is particularly useful at low speeds when normal deceleration torque is minimal. When you enable DC braking, the inverter injects a DC voltage into the motor windings during deceleration below a frequency you can specify (A_52). The braking power (A_54) and duration (A_55) can both be set. You can optionally specify a wait time before DC braking (A_53), during which the motor will free run (coast).

CAUTION: Be careful to avoid specifying a braking time that is long enough to cause motor overheating. If you use DC braking, we recommend using a motor with a built-in thermistor, and wiring it to the inverter's thermistor input (see "Thermistor Thermal Protection" on page 4–22). Also refer to the motor manufacturer's specifications for duty-cycle recommendations during DC braking.

"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_51	DC braking enable DCB SW OFF	Two options; select codes: 00...Disable 01...Enable	✘	00	00	00	—
A_52	DC braking frequency setting DCB F 00.5Hz	The frequency at which DC braking occurs, range is 0.5 to 10 Hz	✘	0.5	0.5	0.5	Hz
A_53	DC braking wait time DCB WAIT 0.0s	The delay from the end of Run command to start of DC braking (motor free runs until DC braking begins)	✘	0.0	0.0	0.0	sec.
A_54	DC braking during deceleration DCB V 000	Applied level of DC braking force, settable from 0 to 100%	✘	0	0	0	%
A_55	DC braking time for deceleration DCB T 00.0s	Sets the duration for DC braking, range is 0.1 to 60.0 seconds	✘	0.0	0.0	0.0	sec.

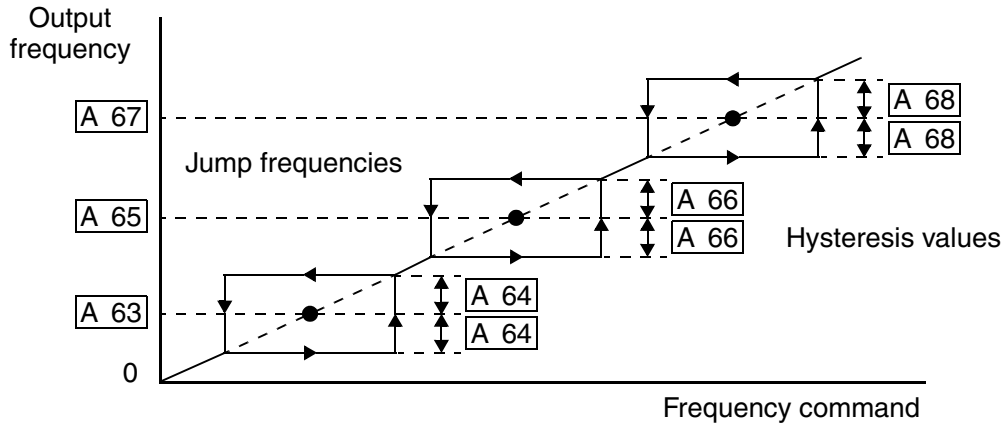
Frequency-related Functions

Frequency Limits – Upper and lower limits can be imposed on the inverter output frequency. These limits will apply regardless of the source of the speed reference. You can configure the lower frequency limit to be greater than zero as shown in the graph. The upper limit must not exceed the rating of the motor or capability of the machinery.



"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_61	Frequency upper limit setting LIMIT H 000.0Hz	Sets a limit on output frequency less than the maximum frequency (A_04) Range is 0.5 to 360.0 Hz 0.0.. setting is disabled >0.1 setting is enabled	✘	0.0	0.0	0.0	Hz
A_62	Frequency lower limit setting LIMIT L 000.0Hz	Sets a limit on output frequency greater than zero Range is 0.5 to 360.0 Hz 0.0.. setting is disabled >0.1 setting is enabled	✘	0.0	0.0	0.0	Hz

Jump Frequencies – Some motors or machines exhibit resonances at particular speed(s), which can be destructive for prolonged running at those speeds. The inverter has up to three *jump frequencies* as shown in the graph. The hysteresis around the jump frequencies causes the inverter output to skip around the sensitive frequency values.



"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_63, A_65, A_67	Jump (center) frequency setting JUMP F1 000.0Hz JUMP F2 000.0Hz JUMP F3 000.0Hz	Up to 3 output frequencies can be defined for the output to jump past to avoid motor resonances (center frequency) Range is 0.0 to 360.0 Hz	✘	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	Hz
A_64, A_66, A_68	Jump (hysteresis) frequency width setting JUMP W1 00.50Hz JUMP W2 00.50Hz JUMP W3 00.50Hz	Defines the distance from the center frequency at which the jump around occurs Range is 0.0 to 10.0 Hz	✘	0.5 0.5 0.5	0.5 0.5 0.5	0.5 0.5 0.5	Hz

PID Control

When enabled, the built-in PID loop calculates an ideal inverter output value to cause a loop feedback process variable (PV) to move closer in value to the setpoint (SP). The current frequency command serves as the SP. The PID loop algorithm will read the analog input for the process variable (you specify the current or voltage input) and calculate the output.

- A scale factor in A_75 lets you multiply the PV by a factor, converting it into engineering units for the process.
- Proportional, integral, and derivative gains are all adjustable.
- See "PID Loop Operation" on page 4–39 for more information.

"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_71	PID Enable PID SW OFF	Enables PID function, two option codes: 00... PID Disable 01... PID Enable	✘	00	00	00	—
A_72	PID proportional gain PID P 1.0	Proportional gain has a range of 0.2 to 5.0	✘	1.0	1.0	1.0	—
A_73	PID integral time constant PID I 001.0s	Integral time constant has a range of 0.0 to 150 seconds	✘	1.0	1.0	1.0	sec.
A_74	PID derivative time constant PID D 00.0	Derivative time constant has a range of 0.0 to 100 seconds	✘	0.0	0.0	0.0	sec.
A_75	PV scale conversion PID CONV 01.00	Process Variable (PV) scale factor (multiplier), range of 0.01 to 99.99	✘	1.00	1.00	1.00	—
A_76	PV source setting PID INPT CUR	Selects source of Process Variable (PV), option codes: 00... [OI] terminal (current in) 01... [O] terminal (voltage in)	✘	00	00	00	—

NOTE: The setting A_73 for the integrator is the integrator's time constant Ti, not the gain. The integrator gain Ki = 1/Ti. When you set A_73 = 0, the integrator is disabled.

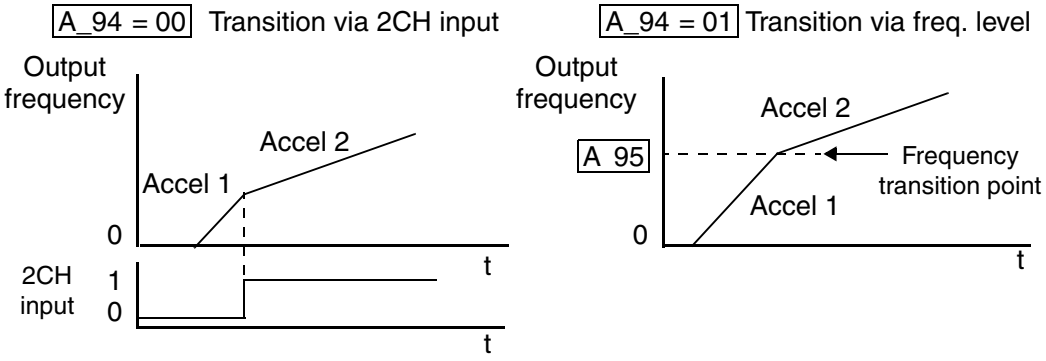
Automatic Voltage Regulation (AVR) Function

The automatic voltage regulation (AVR) feature keeps the inverter output waveform at a relatively constant amplitude during power input fluctuations. This can be useful if the installation is subject to input voltage fluctuations. However, the inverter cannot boost its motor output to a voltage higher than the power input voltage. If you enable this feature, be sure to select the proper voltage class setting for your motor.

"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_81	AVR function select AVR MODE DOFF	Automatic (output) voltage regulation, selects from three type of AVR functions, three option codes: 00... AVR enabled 01... AVR disabled 02... AVR enabled except during deceleration	✘	02	00	02	—
A_82	AVR voltage select AVR AC 230V	200V class inverter settings: ..... 200/220/230/240 400V class inverter settings: 380/400/415/440/460	✘	230/ 400	230/ 460	200/ 400	V

Second Acceleration and Deceleration Functions

The SJ100 inverter features two-stage acceleration and deceleration ramps. This gives flexibility in the profile shape. You can specify the frequency transition point, the point at which the standard acceleration (F_02) or deceleration (F_03) changes to the second acceleration (A_92) or deceleration (A_93). These profile options are also available for the second motor settings. Select a transition frequency method via A_94 as depicted below. Be careful not to confuse the *second acceleration/deceleration settings* with settings for the *second motor*!



"A" Function			Run Mode Edit	Defaults			
Func. Code	**Name / SRW Display**	**Description**		**–FE (CE)**	**–FU (UL)**	**–FR (Jpn)**	**Units**
A_92	Acceleration (2) time setting ACC 2 0015.0s	Duration of 2nd segment of acceleration, range is: 0.1 to 3000 sec.	✔	15.0	15.0	15.0	sec.
A292	Acceleration (2) time setting, (2nd motor) 2ACC2 0015.0s	Duration of 2nd segment of acceleration, 2nd motor, range is: 0.1 to 3000 sec.	✔	15.0	15.0	15.0	sec.
A_93	Deceleration (2) time setting DEC 2 0015.0s	Duration of 2nd segment of deceleration, range is: 0.1 to 3000 sec.	✔	15.0	15.0	15.0	sec.
A293	Deceleration (2) time setting, (2nd motor) 2DEC2 0015.0s	Duration of 2nd segment of deceleration, 2nd motor, range is: 0.1 to 3000 sec.	✔	15.0	15.0	15.0	sec.
A_94	Select method to switch to Acc2/Dec2 profile ACC CHG TM	Two options for switching from 1st to 2nd accel/decel: 00... 2CH input from terminal 01... transition frequency	✘	00	00	00	—
A294	Select method to switch to Acc2/Dec2 profile, 2nd motor 2ACCCHG TM	Two options for switching from 1st to 2nd accel/decel: 00... 2CH input from terminal 01... transition frequency (2nd motor)	✘	00	00	00	—

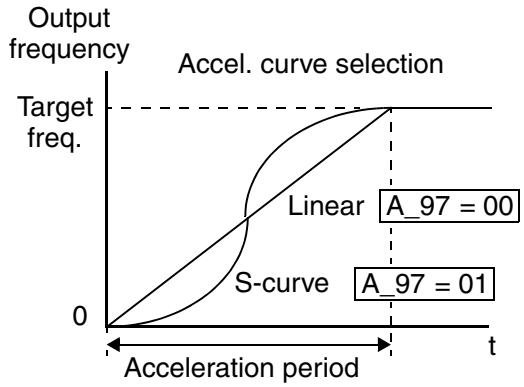
"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_95	Acc1 to Acc2 frequency transition point ACC CHFr 000.0Hz	Output frequency at which Accel1 switches to Accel2, range is 0.0 to 360.0 Hz	✘	0.0	0.0	0.0	Hz
A295	Acc1 to Acc2 frequency transition point, 2nd motor 2ACCCHFr 000.0Hz	Output frequency at which Accel1 switches to Accel2, range is 0.0 to 360.0 Hz (2nd motor)	✘	0.0	0.0	0.0	Hz
A_96	Dec1 to Dec2 frequency transition point DEC CHFr 000.0Hz	Output frequency at which Decel1 switches to Decel2, range is 0.0 to 360.0 Hz	✘	0.0	0.0	0.0	Hz
A296	Dec1 to Dec2 frequency transition point, 2nd motor 2DECCHFr 000.0Hz	Output frequency at which Decel1 switches to Decel2, range is 0.0 to 360.0 Hz (2nd motor)	✘	0.0	0.0	0.0	Hz

NOTE: For A_95 and A_96 (and for 2nd motor settings), if you set a very rapid Acc1 or Dec1 time (less than 1.0 second), the inverter may not be able to change rates to Acc2 or Dec2 before reaching the target frequency. In that case, the inverter decreases the rate of Acc1 or Dec1 in order to achieve the second ramp to the target frequency.

Accel/Decel

Standard acceleration and deceleration is linear. The inverter CPU can also calculate an S-curve acceleration or deceleration curve as shown. This profile is useful for favoring the load characteristics in particular applications.

Curve settings for acceleration and deceleration are independently selected. To enable the S-curve, use function A_97 (acceleration) and A_98 (deceleration).



"A" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
A_97	Acceleration curve selection ACCEL LINE L	Set the characteristic curve of Acc1 and Acc2, two options: 00... linear 01... S-curve	✘	00	00	00	—
A_98	Deceleration curve selection DEC LINE L	Set the characteristic curve of Acc1 and Acc2, two options: 00... linear 01... S-curve	✘	00	00	00	—

"B" Group: Fine Tuning Functions

The "B" Group of functions and parameters adjust some of the more subtle but useful aspects of motor control and system configuration.

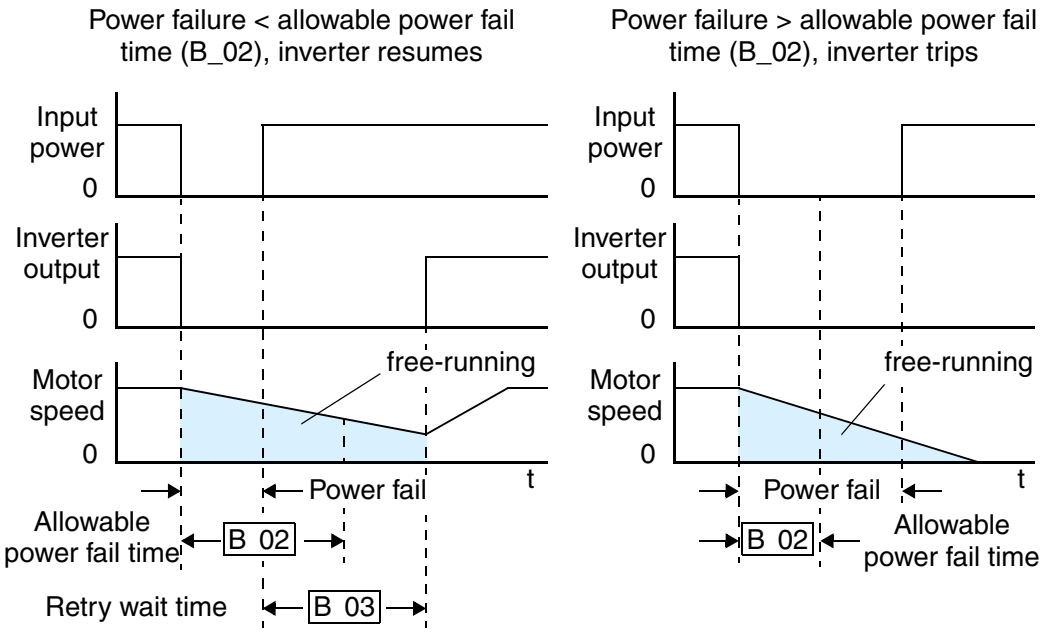
Automatic Restart Mode

The restart mode determines how the inverter will resume operation after a fault causes a trip event. The four options provide advantages for various situations. Frequency matching allows the inverter to read the motor speed by virtue of its residual magnetic flux and restart the output at the corresponding frequency. The inverter can attempt a restart a certain number of times depending on the particular trip event:

- Over-current trip, restart up to 3 times
- Over-voltage trip, restart up to 3 times
- Under-voltage trip, restart up to 16 times

When the inverter reaches the maximum number of restarts (3 or 16), you must power-cycle the inverter to reset its operation.

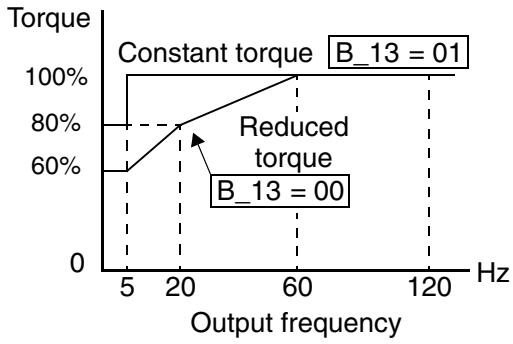
Other parameters specify the allowable under-voltage level and the delay time before restarting. The proper settings depend on the typical fault conditions for your application, the necessity of restarting the process in unattended situations, and whether restarting is always safe.



"B" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
B_01	Selection of automatic restart mode IPS POWR ALM	Select inverter restart method, four option codes: 00... Alarm output after trip, no automatic restart 01... Restart at 0Hz 02... Resume operation after frequency matching 03... Resume previous freq. after freq. matching, then decelerate to stop and display trip info.	✘	00	00	00	—
B_02	Allowable under-voltage power failure time IPS UVTIME 01.0s	The amount of time a power input under-voltage can occur without tripping the power failure alarm. Range is 0.3 to 25 sec. If under-voltage exists longer than this time, the inverter trips, even if the restart mode is selected.	✘	1.0	1.0	1.0	sec.
B_03	Retry wait time before motor restart IPS WAIT 001.0s	Time delay after under-voltage condition goes away, before the inverter runs motor again. Range is 0.3 to 100 seconds.	✘	1.0	1.0	1.0	sec.

Electronic Thermal Overload Alarm Setting

The thermal overload detection protects the inverter and motor from overheating due to an excessive load. It uses a current/inverse time curve to determine the trip point.



First, use B_13 to select the torque characteristic that matches your load. This allows the inverter to utilize the best thermal overload characteristic for your application.

The torque developed in a motor is directly proportional to the current in the windings, which is also proportional to the heat generated (and temperature, over time). Therefore, you must set the thermal overload threshold in terms of current (amperes) for parameter B_12. The range is 50% to 120% of the rated current for each inverter model. If the current exceeds the level you specify, the inverter will trip and log an event (error E05) in the history table. The inverter turns the motor output OFF when tripped. Separate settings are available for the second motor (if applicable) as shown in the following table.

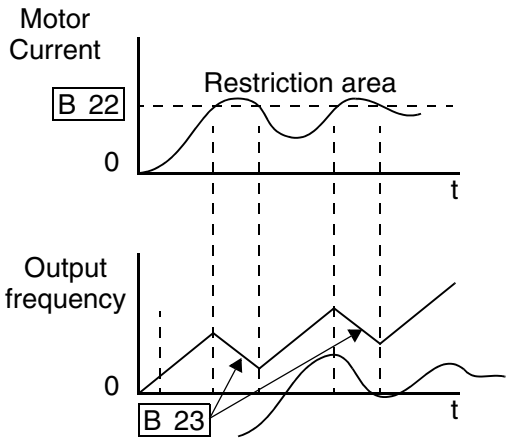
"B" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
B_12	Level of electronic thermal setting E-THM LVL 03.00A	Set a level between 50% and 120% for the rated inverter current.	✘	Rated current for each inverter model *See note			A
B212	Level of electronic thermal setting, 2nd motor 2E-THMLVL 03.00A	Set a level between 50% and 120% for the rated inverter current.	✘	Rated current for each inverter model *See note			A
B_13	Electronic thermal characteristic E-THM CHAR CRT	Select from two curves, option codes: 00...Reduced torque 01...Constant torque	✘	01	01	00	—
B213	Electronic thermal characteristic, 2nd motor 2E-THMCHAR CRT	Select from two curves, option codes: 00...Reduced torque 01...Constant torque	✘	01	01	00	—

WARNING: When parameter B_12, level of electronic thermal setting, is set to device FLA rating (Full Load Ampere nameplate rating), the device provides solid state motor overload protection at 115% of device FLA or equivalent. Parameter B_12, level of electronic thermal setting, is a variable parameter.

NOTE: For inverter models 005NFE, 011NFE, and 030HFE, the thermal value is less than the rated amperes (is the same as models 004NFE, 007NFE, and 040HFE respectively). Therefore, be sure to set the electronic thermal overload according to the actual motor driven by the particular inverter.

Overload Restriction

If the inverter's output current exceeds a preset current level you specify during acceleration or constant speed, the overload restriction feature automatically reduces the output frequency to restrict the overload. This feature does not generate an alarm or trip event. You can instruct the inverter to apply overload restriction only during constant speed, thus allowing higher currents for acceleration. Or, you may use the same threshold for both acceleration and constant speed. In the case of controlled deceleration, the inverter monitors both output current and DC bus voltage. The inverter will increase output frequency to try to avoid a trip due to over-current or over-voltage (due to regeneration).



When the inverter detects an overload, it must decelerate the motor to reduce the current until it is less than the threshold. You can choose the rate of deceleration that the inverter uses to lower the output current.

"B" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
B_21	Overload restriction operation mode OLOAD MODE ON	Select the operating mode during overload conditions, three options, option codes: 00... Disabled 01... Enabled for acceleration and constant speed 02... Enabled for constant speed only	✘	01	01	01	—
B_22	Overload restriction setting OLOAD LVL 03.75A	Sets the level for overload restriction, between 50% and 150% of the rated current of the inverter, setting resolution is 1% of rated current	✘	Rated current x 1.25			A
B_23	Deceleration rate at overload restriction OLOAD CONST 01.0	Sets the deceleration rate when inverter detects overload, range is 0.1 to 30.0, resolution is 0.1.	✘	1.0	1.0	1.0	—

Software Lock Mode

The software lock function keeps personnel from accidentally changing parameters in the inverter memory. Use B_31 to select from various protection levels.

The table below lists all combinations of B_31 option codes and the ON/OFF state of the [SFT] input. Each Check ✔ or Ex ✘ indicates whether the corresponding parameter(s) can be edited. The Standard Parameters column below shows access is permitted for some lock modes. These refer to the parameter tables throughout this chapter, each of which includes a column titled *Run Mode Edit* as shown to the right. The marks (Check ✔ or Ex ✘) under the "Run Mode Edit" column title indicate whether access applies to each parameter as defined in the table below. In some lock modes, you can edit only F_01 and the Multi-speed parameter group that includes A_20, A220, A_21–A_35, and A_38 (Jog). However, it does not include A_19, Multi-speed operation selection. The editing access to B_31 itself is unique, and is specified in the right-most two columns below.

	Run Mode Edit	
	✘	
	✔	

B_31 Lock Mode	[SFT] Intelligent Input	Standard Parameters		F_01 and Multi-Speed	B_31	
		Stop	Run	Stop & Run	Stop	Run
00	OFF	✔	Run mode edit access	✔	✔	✘
	ON	✘	✘	✘	✔	✘
01	OFF	✔	Run mode edit access	✔	✔	✘
	ON	✘	✘	✔	✔	✘
02	(ignored)	✘	✘	✘	✔	✘
03	(ignored)	✘	✘	✔	✔	✘

NOTE: Since the software lock function B_31 is always accessible, this feature is not the same as password protection used in other industrial control devices.

"B" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
B_31	Software lock mode selection S-LOCK MD1	Prevents parameter changes, in four options, option codes: 00... all parameters except B_31 are locked when [SFT] terminal is ON 01... all parameters except B_31 and output frequency F_01 when [SFT] terminal is ON 02... all parameters except B_31 are locked 03... all parameters except B_31 and output frequency F_01 setting are locked	✘	01	01	01	—

NOTE: To disable parameter editing when using B_31 lock modes 00 and 01, assign the [SFT] function to one of the intelligent input terminals.
See "Software Lock" on page 4–19.

Miscellaneous Settings

The miscellaneous settings include scaling factors, initialization modes, and others. this section covers some of the most important settings you may need to configure.

B_83: Carrier frequency adjustment – The internal *switching frequency* of the inverter circuitry (also called the *chopper frequency*). It is called the carrier frequency because the lower AC output frequency of the inverter "rides" the carrier. The faint, high-pitched sound you hear when the inverter is in Run Mode is characteristic of switching power supplies in general. The carrier frequency is adjustable from 500 Hz to 16 kHz. The audible sound decreases at the higher frequencies, but RFI noise and leakage current may be increased. Refer to the specification derating curves in Chapter 1 to determine the maximum allowable carrier frequency setting for your particular inverter and environmental conditions.

NOTE: When DC braking is performed, the inverter automatically holds the carrier frequency at 1 kHz.

NOTE: When the inverter is in sensorless vector mode, use B_83 to set the carrier frequency greater than 2.1 kHz for proper operation.

NOTE: The carrier frequency setting must stay within specified limits for inverter-motor applications that must comply with particular regulatory agencies. For example, a European CE-approved application requires the inverter carrier to be less than 5 kHz.

B_84, B_85: Initialization codes – These functions allow you to restore the factory default settings. Please refer to "Restoring Factory Default Settings" on page 6–8.

B_86: Frequency display scaling – You can convert the output frequency monitor on D_01 to a scaled number (engineering units) monitored at function D_07. For example, the motor may run a conveyor that is monitored in feet per minute. Use this formula:

$$\text{Scaled output frequency (D\_07)} = \text{Output frequency (D\_01)} \times \text{Factor (B\_86)}$$

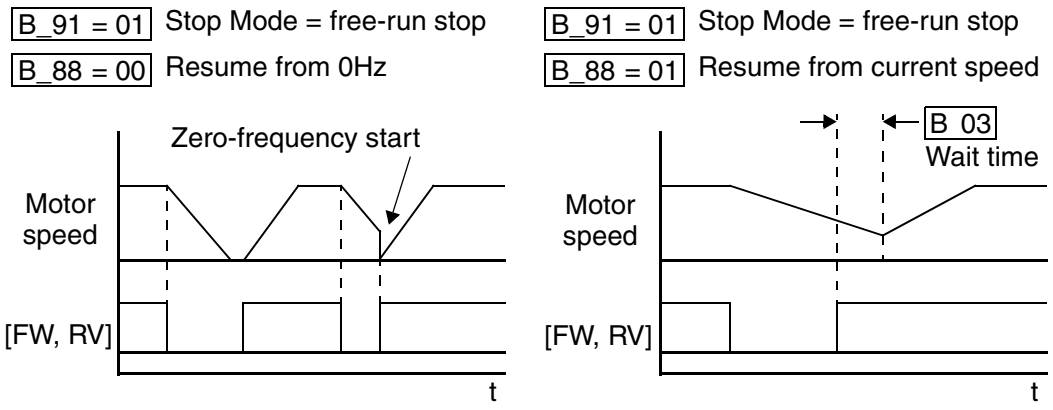
"B" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
B_81	[FM] terminal analog meter adjustment ADJ 080	Adjust 8-bit gain to analog meter connected to terminal [FM], range is 0 to 255	✔	80	80	80	—
B_82	Start frequency adjustment Fmin 0.5Hz	Sets the starting frequency for the inverter output, range is 0.5 to 9.9 Hz	✘	0.5	0.5	0.5	Hz
B_83	Carrier frequency setting CARRIER 05.0kHz	Sets the PWM carrier (internal switching frequency), range is 0.5 to 16.0 kHz	✘	5.0	5.0	12.0	kHz
B_84	Initialization mode (parameters or trip history) INIT MODE TRP	Select the type of initialization to occur, two option codes: 00... Trip history clear 01... Parameter initialization	✘	00			—
B_85	Country code for initialization INIT SEL USA	Select default parameter values for country on initialization, four options, option codes: 00... Japan version 01... Europe version 02... US version 03... reserved (do not set)	✘	01	02	00	—
B_86	Frequency scaling conversion factor /Hz01.0 0.00	Specify a constant to scale the displayed frequency for D_07 monitor, range is 0.1 to 99.9	✘	1.0	1.0	1.0	—
B_87	STOP key enable STOP-SW ON	Select whether the STOP key on the keypad is enabled, two option codes: 00... enabled 01... disabled	✘	00	00	00	—

B_91/B_88: Stop Mode / Restart Mode Configuration – You can configure how the inverter performs a standard stop (each time Run FWD and REV signals turn OFF). Setting B_91 determines whether the inverter will control the deceleration, or whether it will perform a free-run stop (coast to a stop). When using the free-run stop selection, it is imperative to also configure how you want the inverter to resume control of motor speed. Setting B_88 determines whether the inverter will ensure the motor always resumes at 0 Hz, or whether the motor resumes from its current coasting speed (also called *frequency matching*). The Run command may turn OFF briefly, allowing the motor to coast to a slower speed from which normal operation can resume.

In most applications a controlled deceleration is desirable, corresponding to B_91=00. However, applications such as HVAC fan control will often use a free-run stop (B_91=01). This practice decreases dynamic stress on system components, prolonging system life. In this case, you will typically set B_88=01 in order to resume from the current speed after a free-run stop (see diagram below, right). Note that using the default setting, B_88=00, can cause trip events when the inverter attempts to force the load quickly to zero speed.

NOTE: Other events can cause (or be configured to cause) a free-run stop, such as power loss (see "Automatic Restart Mode" on page 3–24), or an intelligent input terminal [FRS] signal. If all free-run stop behavior is important to your application (such as HVAC), be sure to configure each event accordingly.

An additional parameter further configures all instances of a free-run stop. Parameter B_03, Retry Wait Time Before Motor Restart, sets the minimum time the inverter will free-run. For example, if B_03 = 4 seconds (and B_91=01) and the cause of the free-run-stop lasts 10 seconds, the inverter will free-run (coast) for a total of 14 seconds before driving the motor again.



"B" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
B_88	Restart mode after FRS RUN FRS ZST	Selects how the inverter resumes operation when the free-run stop (FRS) is cancelled, two options: 00... Restart from 0Hz 01... Restart from frequency detected from real speed of motor (frequency matching)	✘	00	00	00	—
B_89	Data select for digital operator OPE-J PANEL d01	Select the monitoring data to send to the optional remote hand-held digital operator, seven option codes: 01... Output frequency (D_01) 02... Output current (D_02) 03... Motor direction (D_03) 04... PID PV feedback (D_04) 05... Input states for input terminals (D_05) 06... Output states for output terminals (D_06) 07... Scaled output frequency (D_07)	✔	01	01	01	—
B_90	Dynamic braking usage ratio BRD-%ED 000.0%	Selects the rate of use (in %) of the regenerative braking resistor per 100 sec. intervals, range is 0.0 to 100.0% 0% . Dynamic braking disabled >0% Enabled, per value	✘	0.0	0.0	0.0	%
B_91	Stop mode selection RUN STP DEC	Selects how the inverter stops the motor, two option codes: 00... DEC (decelerate and stop) 01... FRS (free run to stop)	✘	00	00	00	—
B_92	Cooling fan control INIT FAN-CTL OFF	Selects when the fan is ON per inverter operation, two options: 00... Fan is always ON 01... Fan is ON during run, OFF during stop	✘	00	00	00	—

B_90: Dynamic braking usage ratio – This parameter limits the amount of time the inverter can use the dynamic braking accessory device without entering the Trip Mode. Please refer to "Dynamic Braking" on page 5–5 for more information on dynamic braking accessories.

"C" Group: Intelligent Terminal Functions

The six input terminals **[1]**, **[2]**, **[3]**, **[4]**, **[5]**, and **[6]** can be configured for any of 19 different functions. The next two tables show how to configure the six terminals. The inputs are logical, in that they are either OFF or ON. We define these states as OFF=0, and ON=1.

The inverter comes with default options for the six terminals. These default settings are initially unique, each one having its own setting. Note that European and US versions have different default settings. You can use any option on any terminal, and even use the same option twice to create a logical OR (though usually not required).

NOTE: Terminal **[5]** has the ability to be a logical input, and to be an analog input for a thermistor device when the PTC function (option code 19) is assigned to that terminal.

Input Terminal Configuration

Functions and Options –The *function codes* in the following table let you assign one of nineteen options to any of the six logic inputs for the SJ100 inverters. The functions C_01through C_06 configure the terminals [1] through [6] respectively. The "value" of these particular parameters is not a scalar value, but it is a discrete number that selects one option from many available *options*.

For example, if you set function C_01=00, you have assigned option 00 (Forward Run) to terminal [1]. The option codes and the specifics of how each one works are in Chapter 4.

"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_01	Terminal [1] function IN-TM 1 FW	Select function for terminal [1] 18 options (see next section)	✘	00 [FW]	00 [FW]	00 [FW]	—
C_02	Terminal [2] function IN-TM 2 RV	Select function for terminal [2] 18 options (see next section)	✘	01 [RV]	01 [RV]	01 [RV]	—
C_03	Terminal [3] function IN-TM 3 AT	Select function for terminal [3] 18 options (see next section)	✘	02 [CF1]	16 [AT]	02 [CF1]	—
C_04	Terminal [4] function IN-TM 4 USP	Select function for terminal [4] 18 options (see next section)	✘	03 [CF2]	13 [USP]	03 [CF2]	—
C_05	Terminal [5] function IN-TM 5 2CH	Select function for terminal [5] 19 options (see next section)	✘	18 [RS]	09 [2CH]	09 [2CH]	—
C_06	Terminal [6] function IN-TM 6 RS	Select function for terminal [6] 18 options (see next section)	✘	09 [2CH]	18 [RS]	18 [RS]	—

The input logic convention is programmable for each of the six inputs. Most inputs default to normally open (active high), but you can select normally closed (active low) in order to invert the sense of the logic.

"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_11	Terminal [1] active state IN-TM O/C-1 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	00	00	00	—
C_12	Terminal [2] active state IN-TM O/C-2 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	00	00	00	—
C_13	Terminal [3] active state IN-TM O/C-3 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	00	00	00	—
C_14	Terminal [4] active state IN-TM O/C-4 NC	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	00	01	00	—
C_15	Terminal [5] active state IN-TM O/C-5 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	00	00	00	—
C_16	Terminal [6] active state IN-TM O/C-6 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	00	00	00	—

NOTE: An input terminal configured for option code 18 ([RS] Reset command) cannot be configured for normally closed operation.

Intelligent Input Terminal Overview

Each of the six intelligent terminals may be assigned any of the options in the following table. When you program one of the option codes for terminal assignments C_01 to C_06, the respective terminal assumes the function role of that option code. The terminal functions have a symbol or abbreviation that we use to label a terminal using that function. For example the "Forward Run" command is [FW]. The physical label on the terminal block connector is simply **1**, **2**, **3**, **4**, **5**, or **6**. However, schematic examples in this manual also use the terminal symbol (such as [FW]) to show the assigned option. The option codes for C_11 to C_16 determines the active state of the logical input (active high or active low).

Input Function Summary Table – This table shows all nineteen intelligent input functions at a glance. Detailed descriptions of these functions, related parameters and settings, and example wiring diagrams are in "Using Intelligent Input Terminals" on page 4–8.

Input Function Summary Table				
Option Code	**Terminal Symbol**	**Function Name**	**Description**	
00	FW	Forward Run/Stop	ON	Inverter is in Run Mode, motor runs forward
			OFF	Inverter is in Stop Mode, motor stops
01	RV	Reverse Run/Stop	ON	Inverter is in Run Mode, motor runs reverse
			OFF	Inverter is in Stop Mode, motor stops
02	CF1	Multi-speed Select, Bit 0 (LSB)	ON	Binary encoded speed select, Bit 0, logical 1
			OFF	Binary encoded speed select, Bit 0, logical 0
03	CF2	Multi-speed Select, Bit 1	ON	Binary encoded speed select, Bit 1, logical 1
			OFF	Binary encoded speed select, Bit 1, logical 0
04	CF3	Multi-speed Select, Bit 2	ON	Binary encoded speed select, Bit 2, logical 1
			OFF	Binary encoded speed select, Bit 2, logical 0
05	CF4	Multi-speed Select, Bit 3 (MSB)	ON	Binary encoded speed select, Bit 3, logical 1
			OFF	Binary encoded speed select, Bit 3, logical 0
06	JG	Jogging	ON	Inverter is in Run Mode, output to motor runs at jog parameter frequency
			OFF	Inverter is in Stop Mode
07	DB	External DC Braking	ON	DC braking will be applied during deceleration
			OFF	DC braking will not be applied
08	SET	Set (select) 2nd Motor Data	ON	The inverter uses 2nd motor parameters for generating frequency output to motor
			OFF	The inverter uses 1st (main) motor parameters for generating frequency output to motor
09	2CH	2-stage Acceleration and Deceleration	ON	Frequency output uses 2nd-stage acceleration and deceleration values
			OFF	Frequency output uses standard acceleration and deceleration values
11	FRS	Free-run Stop	ON	Causes output to turn OFF, allowing motor to free run (coast) to stop
			OFF	Output operates normally, so controlled deceleration stops motor
12	EXT	External Trip	ON	When assigned input transitions OFF to ON, inverter latches trip event and displays E12
			OFF	No trip event for ON to OFF, any recorded trip events remain in history until Reset

Input Function Summary Table				
Option Code	**Terminal Symbol**	**Function Name**	**Description**	
13	USP	Unattended Start Protection	ON	On powerup, the inverter will not resume a Run command (mostly used in the US)
			OFF	On powerup, the inverter will resume a Run command that was active before power loss
15	SFT	Software Lock	ON	The keypad and remote programming devices are prevented from changing parameters
			OFF	The parameters may be edited and stored
16	AT	Analog Input Voltage/current Select	ON	Terminal [OI] is enabled for current input (uses terminal [L] for power supply return)
			OFF	Terminal [O] is enabled for voltage input (uses terminal [L] for power supply return)
18	RS	Reset Inverter	ON	The trip condition is reset, the motor output is turned OFF, and powerup reset is asserted
			OFF	Normal power-ON operation
19	PTC	PTC Thermistor Thermal Protection	ANLG	When a thermistor is connected to terminals [5] and [L], the inverter checks for over-temperature and will cause trip event and turn OFF output to motor
			OPEN	A disconnect of the thermistor causes a trip event, and the inverter turns OFF the motor
27	UP	Remote Control UP Function (motorized speed pot.)	ON	Accelerates (increases output frequency) motor from current frequency
			OFF	Output to motor operates normally
28	DWN	Remote Control DOWN Function (motorized speed pot.)	ON	Decelerates (decreases output frequency) motor from current frequency
			OFF	Output to motor operates normally

Output Terminal Configuration

The inverter provides configuration for logic (discrete) and analog outputs, shown in the table below.

"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_21	Terminal [11] function OUT-TM 1 FA1	Select function for terminal [11], 6 options (see next section)	✘	01 [FA1]	01 [FA1]	01 [FA1]	—
C_22	Terminal [12] function OUT-TM 2 RUN	Select function for terminal [12], 6 options (see next section)	✘	00 [RUN]	00 [RUN]	00 [RUN]	—
C_23	[FM] signal selection MONITOR A-F	Select function for terminal [FM], 3 options (see next section)	✘	00 [A–F]	00 [A–F]	00 [A–F]	—
C_24	Alarm relay terminal function OUT-TM RY AL	Select function for alarm terminals, 6 options (see next section)	✘	05 [AL]	05 [AL]	05 [AL]	—

The output logic convention is programmable for terminals [11], [12], and the alarm relay terminals. The open-collector output terminals [11] and [12] default to normally open (active low), but you can select normally closed (active high) for these terminals in order to invert the sense of the logic. You can invert the logical sense of the alarm relay output as well.

"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_31	Terminal [11] active state (–FU) OUT-TM O/C-1 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	—	00	—	—
	Reserved (–FE / –FR) (not displayed)	(reserved) DO NOT EDIT	✘	00	—	00	—
C_32	Terminal [12] active state (–FU) OUT-TM O/C-2 NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	—	00	—	—
	Terminal [11] active state (–FE / –FR) OUT-TM O/C-1 NO	(reserved) DO NOT EDIT	✘	00	—	00	—

"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_33	Alarm relay active state OUT-TM O/C-RY NO	Select logic convention, two option codes: 00... normally open [NO] 01... normally closed [NC]	✘	01	01	01	—

Output Function Summary Table – This table shows all six functions for the logical outputs (terminals [11], [12]) at a glance. Detailed descriptions of these functions, related parameters and settings, and example wiring diagrams are in "Using Intelligent Output Terminals" on page 4–24.

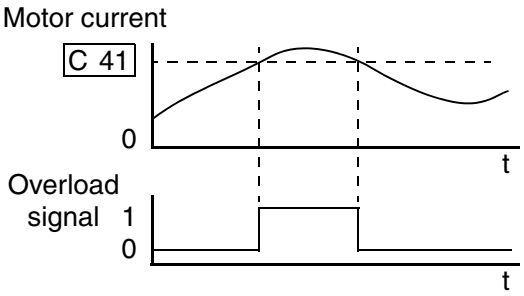
Output Function Summary Table				
Option Code	Terminal Symbol	Function Name	Description	
00	RUN	Run Signal	ON	when inverter is in Run Mode
			OFF	when inverter is in Stop Mode
01	FA1	Frequency Arrival Type 1 – Constant Speed	ON	when output to motor is at the set frequency
			OFF	when output to motor is OFF, or in any acceleration or deceleration ramp
02	FA2	Frequency Arrival Type 2 – Over-frequency	ON	when output to motor is at or above the set frequency, even if in accel. or decel. ramps
			OFF	when output to motor is OFF, or at a level below the set frequency
03	OL	Overload Advance Notice Signal	ON	when output current is more than the set threshold for the overload signal
			OFF	when output current is less than the set threshold for the overload signal
04	OD	Output Deviation for PID Control	ON	when PID error is more than the set threshold for the deviation signal
			OFF	when PID error is less than the set threshold for the deviation signal
05	AL	Alarm Signal	ON	when an alarm signal has occurred and has not been cleared
			OFF	when no alarm has occurred since the last clearing of alarm(s)

Analog Function Summary Table – This table shows all three functions for the analog output [FM] (frequency meter) terminal. Detailed descriptions, related parameters and settings, and example wiring diagrams are in "Analog and Digital Monitor Output" on page 4–33.

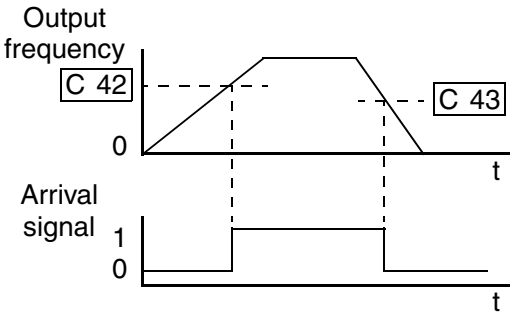
Analog Function Summary Table		
Option Code	**Function Name**	**Description**
00	Analog Frequency Monitor	PWM (pulse-width-modulated) voltage output that has a duty cycle proportional to the inverter output frequency
01	Analog Current Output Monitor	PWM (pulse-width-modulated) voltage output that has a duty cycle proportional to the inverter output current to the motor. It reaches 100% duty cycle when the output reaches 200% of the rated inverter current.
02	Digital Frequency Output Monitor	FM (frequency-modulated) voltage output with a constant 50% duty cycle. Its frequency = inverter output frequency.

Output Function Adjustment Parameters

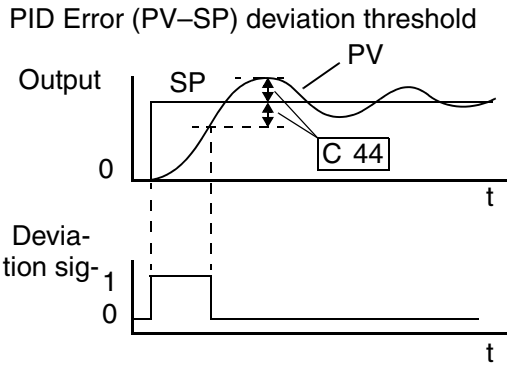
The following parameters work in conjunction with the intelligent output function, when configured. The overload level parameter (C_41) sets the motor current level at which the overload signal [OD] turns ON. The range of settings is from 0% to 200% of the rated current for the inverter. This function is for generating an early warning logic output, without causing either a trip event or a restriction of the motor current (those effects are available on other functions).



The frequency arrival signal, [FA1] or [FA2], is intended to indicate when the inverter output has reached (arrived at) the target frequency. You can adjust the timing of the leading and trailing edges of the signal via two parameters specific to acceleration and deceleration ramps, C_42 and C_43.



The Error for the PID loop is the magnitude (absolute value) of the difference between the Setpoint (desired value) and Process Variable (actual value). The PID output deviation signal [OD] (output terminal function option code 04) indicates when the error magnitude has exceeded a magnitude you define.



"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_41	Overload level setting OV Load 03.00A	Sets the overload signal level between 0% and 200% (from 0 to two times the rated current of the inverter)	✘	Rated current for each inverter model			
C_42	Frequency arrival setting for acceleration ARV ACC 000.0Hz	Sets the frequency arrival setting threshold for the output frequency during acceleration	✘	0.0	0.0	0.0	Hz

"C" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
C_43	Arrival frequency setting for deceleration ARV DEC 000.0Hz	Sets the frequency arrival setting threshold for the output frequency during deceleration	✘	0.0	0.0	0.0	Hz
C_44	PID deviation level setting OV PID 003.0%	Sets the allowable PID loop error magnitude (absolute value), SP - PV, range is 0.0 to 100%, resolution is 0.1%	✘	3.0	3.0	3.0	%
C_81	O input span calibration ADJ-O 082	Scale factor between the external frequency command on terminals L – O (voltage input) and the frequency output	✘	Factory-calibrated			—
C_82	OI input span calibration ADJ-OI 066	Scale factor between the external frequency command on terminals L – OI (current input) and the frequency output	✘	Factory-calibrated			—
C_91	Debug mode enable INIT DEBG OFF	(Reserved) DO NOT EDIT	✘	00	00	00	—
C_92	Core monitor address (not displayed)	(Reserved) DO NOT EDIT	✘	0000	0000	0000	—
C_93	Core monitor date (not displayed)	(Reserved) DO NOT EDIT	✘	—	—	—	—
C_94	Core set address (not displayed)	(Reserved) DO NOT EDIT	✘	D_01	D_01	D_01	—
C_95	Core set date (not displayed)	(Reserved) DO NOT EDIT	✘	00	00	00	—

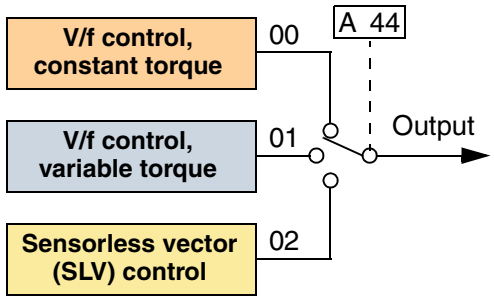
NOTE: Settings C_81 and C_82 are factory-calibrated for each inverter. Do not change these settings unless absolutely necessary. Note that if you restore factory defaults for all parameters, these settings will not change.

“H” Group: Motor Constants Functions

Introduction

The “H” Group parameters configure the inverter for the motor characteristics. You must manually set H_03 and H_04 values to match the motor. The remaining parameters are related to sensorless vector control (SLV), and are in use only when function A_44 is set for SLV as shown in the diagram. The procedure in “Auto-tuning for Sensorless Vector Control” on page 4–35 automatically sets all the parameters related to SLV. If you configure the inverter to use SLV, we highly recommend letting the auto-tuning procedure derive the values for you. If you want to reset the parameters to the factory default settings, use the procedure in “Restoring Factory Default Settings” on page 6–8.

Inverter Torque Control Algorithms



NOTE: The auto-tuning procedure and related warning messages are in “Auto-tuning for Sensorless Vector Control” on page 4–35. Please read these before trying to auto-tune the motor parameters.

“H” Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
H_01	Auto-tuning Setting AUX AUTO NOR	Three states for auto-tuning function, option codes: 00... Auto-tuning OFF 01... Auto-tune (rotate motor) 02... Auto-tune (measure motor resistance and inductance, without rotating)	✘	00	00	00	—
H_02	Motor data selection AUX DATA NOR	Two selections, option codes: 00... Use standard motor data 01... Use auto-tuning data	✘	00	00	00	—
H202	Motor data selection, 2nd motor 2AUXDATA NOR	Two selections, option codes: 00... Use standard motor data 01... Use auto-tuning data	✘	00	00	00	—
H_03	Motor capacity AUX K 0.4 kW	Nine selections: 0.2 / 0.4 / 0.75 / 1.5 / 2.2 / 3.7 5.5 / 7.5 / 11	✘	Specified by the capacity of each inverter model			kW
H203	Motor capacity, 2nd setting 2AUXK 0.4 kW	Nine selections: 0.2 / 0.4 / 0.75 / 1.5 / 2.2 / 3.7 5.5 / 7.5 / 11	✘	Specified by the capacity of each inverter model			—
H_04	Motor poles setting AUX P 4P	Four selections: 2 / 4 / 6 / 8	✘	4	4	4	poles

"H" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
H204	Motor poles setting, 2nd motor 2AUXP 4P	Four selections: 2 / 4 / 6 / 8	✘	4	4	4	poles
H_05	Motor speed constant AUX KP 20	Motor proportional gain constant (factory set), range is 0 to 99	✘	20	20	20	—
H205	Motor speed constant, 2nd motor 2AUXKP 20	Motor proportional gain constant (factory set) range is 0 to 99	✘	20	20	20	—
H_06	Motor stabilization constant AUX KCD 100	Motor constant (factory set), range is 0 to 255	✘	100	100	100	—
H206	Motor stabilization constant, 2nd motor 2AUXKCD 100	Motor constant (factory set), range is 0 to 255	✘	100	100	100	—
H_20	Motor constant R1 AUX R1 05.700*	Range is 0.000 to 65.53, 0.000 to 9.999 10.00 to 65.53	✘	Factory set according to inverter model			Ohms
H220	Motor constant R1, 2nd motor 2AUXR1 05.700*	Range is 0.000 to 65.53, 0.000 to 9.999 10.00 to 65.53	✘	Factory set according to inverter model			Ohms
H_21	Motor constant R2 AUX R2 02.773	Range is 0.000 to 65.53, 0.000 to 9.999 10.00 to 65.53	✘	Factory set according to inverter model			Ohms
H221	Motor constant R2, 2nd motor 2AUXR2 02.773	Range is 0.000 to 65.53, 0.000 to 9.999 10.00 to 65.53	✘	Factory set according to inverter model			Ohms
H_22	Motor constant L AUX L 045.70mH	Range is 0.00 - 655.3 mH, 0.00 to 99.99 100.0 - 655.3	✘	Factory set according to inverter model			mH
H222	Motor constant L, 2nd motor 2AUXL 045.70mH	Range is 0.00 - 655.3 mH, 0.00 to 99.99 100.0 - 655.3	✘	Factory set according to inverter model			mH
H_23	Motor constant I_o AUX I0 001.50A	Range is 0.00 to 655.3 Amps, 0.00 to 99.99 100.0 - 655.3	✘	Factory set according to inverter model			Arms
H223	Motor constant I_o, 2nd motor 2AUXI0 001.50A	Range is 0.00 to 655.3 Amps, 0.00 to 99.99 100.0 - 655.3	✘	Factory set according to inverter model			Arms

"H" Function			Run Mode Edit	Defaults			
Func. Code	Name / SRW Display	Description		–FE (CE)	–FU (UL)	–FR (Jpn)	Units
H_24	Motor Constant J AUX J 0020.0	Ratio (unit-less), range is 1.0 to 1000	✘	Factory set according to inverter model			—
H224	Motor constant J, 2nd motor 2AUXJ 0020.0	Ratio (unit-less), range is 1.0 to 1000	✘	Factory set according to inverter model			—
H_30	Auto-tuned motor constant R1 (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H230	Auto-tuned motor constant R1, 2nd motor (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H_31	Auto-tuned motor constant R2 (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H231	Motor constant R2, 2nd motor (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H_32	Auto-tuned motor constant L (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H232	Auto-tuned motor constant L, 2nd motor (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H_33	Auto-tuned motor constant I_o (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H233	Auto-tuned motor constant I_o, 2nd motor (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H_34	Auto-tuned motor constant J (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—
H234	Auto-tuned motor constant J, 2nd motor (not displayed)	Auto-tuning data (do not edit)	✘	Factory set according to inverter model			—