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G7/H7 Applications Workbook

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G7 Applications Workbook

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Configuring Local / Remote operations

Introduction

Local/Remote Key – Toggles between the **Local** and **Remote** modes. The LED is on when the system is in the **Local** mode.

The **Local** mode allows the **Command** and **Frequency** control functions to be carried out via the **EOI**.

The **Remote** mode enables the **Command** and **Frequency** control functions to be carried out via the **Control Terminal Strip, LED Keypad, RS232/485, Communication card** or **Pulse Input.**

The availablity of the Local mode of operation may be disabled via *Program ⇒ EOI Option Setup ⇒ **Local/Remote Key***. Here you have the option of selecting **Command Mode** or **Frequency Mode**. The availability of the **Local** mode of operation may be reinstated by changing this setting, performing a **Reset**, or powering down.

EOI

Command Mode Selection *Program ⇒ Fundamental Parameters ⇒ Standard Mode Set*

Direct Access Number – **F003**
Parameter Type – **Selection List**
Factory Default – **Use Control Terminal Strip**
Changeable During Run – **No**

The **Command Mode selection** establishes the source of the command inputs. Command inputs include **Run, Stop, Forward**, etc.

If the **LCD** or **LED keypad** is selected, the **Local / Remote** key is enabled to select either the **Keypad** (local) or the **Control Terminal Strip** (remote) as the command source.

If the Control Terminal Strip (remote) is selected, it may be programmed to select any of the following as a source of the command signal:

- Use RR *(Factory Default)*
- Use LED Keypad (option)
- Use Common (TTL)
- Use RS232/485
- Use Communication Card (option)

Frequency Mode #1 *Program ⇒ Fundamental Parameters ⇒ Standard Mode Set*

Direct Access Number – **F004**
Parameter Type – **Selection List**
Factory Default – **Use RR**
Changeable During Run – **No**

The **Frequency Mode #1** determines the source of the frequency command or the torque command (when operating in the torque control mode) of the G7.

If the **LCD** or **LED keypad** is selected, the **Local / Remote** key is enabled to select either the **Keypad** (local) or the **Control Terminal Strip** (remote) as the command source.

Selections are

- Use Vi/II
- Use RR
- Use RX
- Use RX2 (Option Card)
- Use LED Keypad (option)
- Use Binary/BCD Input
- Use LCD Keypad
- Use RS232/485
- Use Communication Card (Option)
- Use MOP Function Simulation
- Use Pulse Input Option

Frequency Mode #2 *Program ⇒ Fundamental Parameters ⇒ Standard Mode Set*

Direct Access Number – **F207**
Parameter Type – **Selection List**
Factory Default – **VI/II**
Changeable During Run – **Yes**

This parameter selects the source of the frequency command signal to be used as **Frequency Mode #2** in the event that **Frequency Mode#1** is disabled or **Frequency Mode #2** is set up as the primary control parameter.

Selections are

- Use Vi/II
- Use RR
- Use RX
- Use RX2 (Option Card)
- Use LED Keypad (option)
- Use Binary/BCD Input
- Use LCD Keypad
- Use RS232/485
- Use Communication Card (Option)
- Use MOP Function Simulation
- Use Pulse Input Option

Lockout of Local/Remote

Lockout of the Local/Remote can be done by *Program ⇒ EOI Setup ⇒ Lockout ⇒ Lockout Local/Remote.*

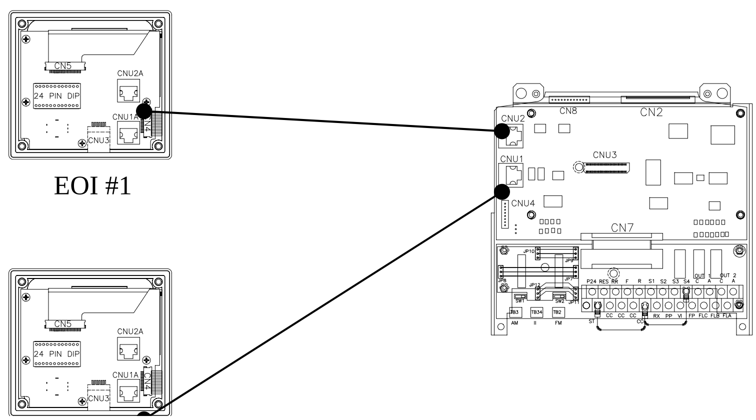
Operating the G7 with two installed EOIs

Required Equipment

One 120V G7 Demo with simulator terminal strip and two EOIs

Connections

Connect one EOI using the TTL port on the EOI and on the G7
Connect the second EOI using the RS485 port on the EOI and the RS232/485 port on the G7



Programming

EOI Number One (Functionality Start/Stop, Frequency Control, No Programming, No monitoring)

Direct Access	Path	Parameter Name	Comments
NA	EOI Setup Options/Local Remote Key	Command Selection	Selected (default)
NA	EOI Setup Options/Local Remote Key	Frequency Selection	Selected (default)
NA	EOI Setup Options/Lockout	Lockout Reset	Selected
NA	EOI Setup Options/Lockout	Lockout Monitor	Selected
NA	EOI Setup Options/Lockout	Lockout Parameter Access	Selected
NA	EOI Setup Options/Lockout/Password	Enable Password	Select Enable Password and set password to 999

EOI Number Two (Functionality: Run/Stop, No Frequency Control, Full Programming and Monitoring)

Direct Access	Path	Parameter Name	Comments
NA	EOI Setup Options/Local Remote Key	Command Selection	Selected (default)
NA	EOI Setup Options/Local Remote Key	Frequency Selection	**NOT** Selected

Instructions

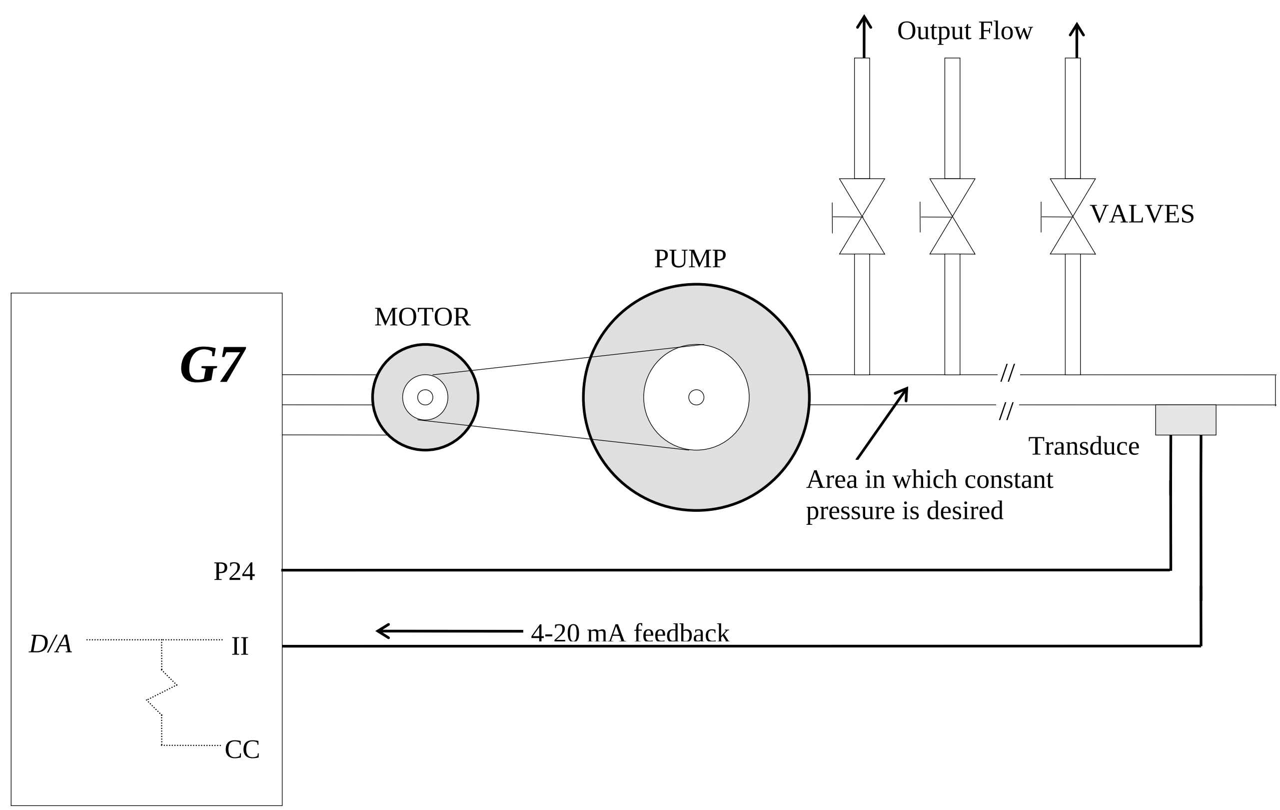
This demonstration makes obvious the ability to use multiple EOIs with one G7 drive. Each EOI may have different functionality and privileges. This is often desirable when an EOI is mounted at the drive to facilitate programming, troubleshooting, and monitoring while an additional EOI may be mounted remotely for use by an operator.

PID Control

Introduction

The built-in PID of the G7 can be used to maintain a constant process variable such as flow, pressure, temperature, and level. In the example below, the drive is used to vary the speed of the motor/pump to maintain a constant pressure at the output of the pump. As the valves on the output of the pump are opened, the pressure goes low. The drive senses this via a 4-20 mA feedback signal and speeds up to increase pressure up to the desired level. The drive will slow the motor/pump down as the valves close. The rate at which the drive responds to changes is adjustable via three parameters (Proportional Gain, Integral Time, and Differential Time) and will have to be field-tuned. Later in this guideline, PID applications will be discussed in general.

Connections



Check your transducer's schematic for connection information. The above diagram is typical for a loop-powered transducer. Separately powered *isolated* transducers feed into the 'II' and "CC" terminals. If your transducer is not isolated, order an isolated input board. The inputs to the standard G7 are not isolated; *do not* connect the 'CC' terminal to ground.

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Programming

Direct Access	Parameter Path	Parameter Name	Comments
F012	Program➔Fundamental Parameters➔Frequency Setting	Upper Limit	Set to 60
F011	Program➔Fundamental Parameters➔Frequency Setting	Maximum Frequency	Set to 60
F009	Program➔Fundamental Parameters➔Standard Mode Selection	Accel #1	Set to 5
F010	Program➔Fundamental Parameters➔Standard Mode Selection	Decel #1	Set to 5
F201	Program➔Frequency Setting Parameters➔Speed Reference Setpoints	VI/II	Set 0 hz at 20% Set 60 hz at 100%
F360	Program➔Feedback Parameters➔Feedback Settings	Input Selection	Set to VI/II for the PID feedback signal

The above programming assumes a system in which an increase in 4-20 mA feedback signal causes the drive to reduce output frequency. If the system is such that increasing feedback should cause an increase in output frequency, the 'II' terminal should be reversed by programming the following:

Direct Access	Parameter Path	Parameter Name	Comments
F201	Program➔Frequency Setting Parameters➔Speed Reference Setpoints	VI/II	Set 60 hz at 20% Set 0 hz at 100%

Setting the Setpoint

In general, the setpoint is set by adjusting the setpoint to whatever level (frequency) is necessary to yield the desired process variable setting. The commanded frequency and actual output frequency will most likely not be the same; it is only the process variable's (pressure, temperature, etc.) value that is of concern. It is the ratio of Frequency Command to Maximum Output Frequency that the drive uses to determine the feedback value it is trying to maintain (the setpoint).

Setpoint via keypad (Local Mode)

Press LOCAL/REMOTE button to illuminate the panel's green LED. Hit RUN and adjust the keypad pot to whatever value it takes to develop the desired process variable value. If you still need to setup the setpoing via the keypad but need to Start/Stop from terminal, then set the F004 Frequency Mode #1 to Use Common (TTL).

Setpoint via pot on RR terminal (Remote Mode)

Press LOCAL/REMOTE button to turn green LED off. Make F-CC OR R-CC. Adjust RR pot to whatever setting it takes to generate the desired process variable value.

How to find your set point in Local Mode:

You need to know what the range of your transducer is in order to solve for the set point in the drive. Here is an example:

Transducer range: 4 to 20mA
Pressure range of transducer: 0 to 5 inches
Range of Drive: 0 to 60 (Maximum Frequency set at 60 hz)
Desired set point: 1.5 inches

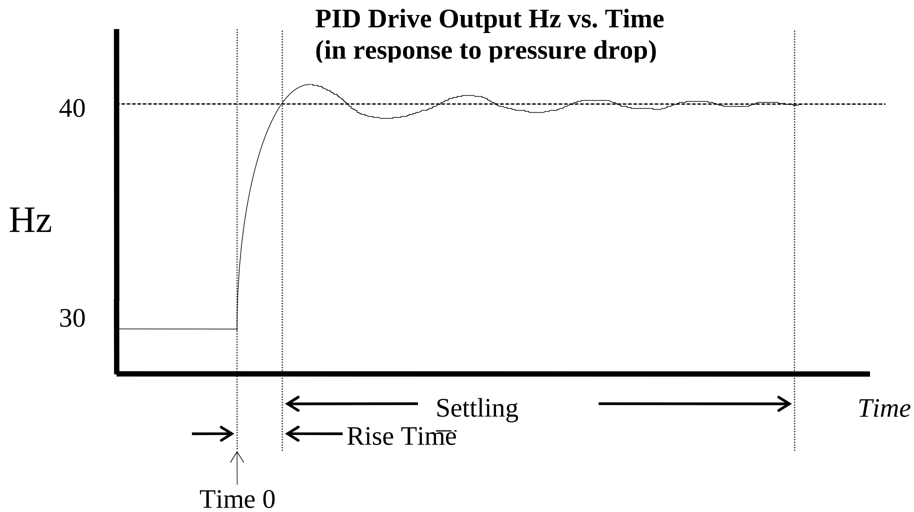
Set point entered in the drive $\frac{desired\_setpiont\_pressure}{(pressureat20mA - pressureat4mA)} \times 60$

$$= \frac{1.5inches}{5inches - 0inches} \times 60 = 18$$

So for this example you would enter 18 as your set point in the drive.

Tuning the PID

The idea when tuning this PID is to get fast enough response from the drive that the pressure doesn't drop or increase very much. One problem with this is that if the response is too quick, the drive can actually overshoot (put out a higher frequency than necessary), and in extreme cases, oscillations can occur. The object then when tuning a PID loop is to **minimize the rise and settling times.**

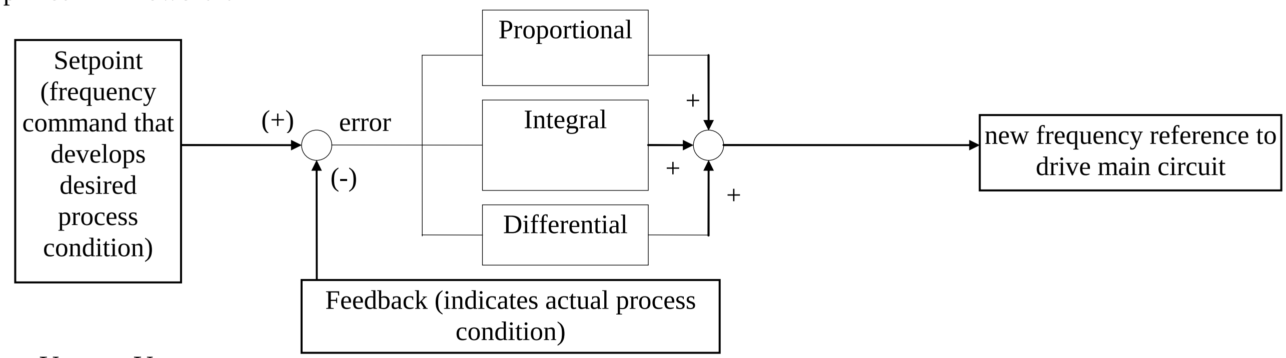


The above figure illustrates what is meant by the rise and settling times. Suppose that a G7 is running at 30 Hz. At Time 0, all of the valves in the example system open. Suppose also that the drive now needs to speed up to 40 Hz to maintain the desired pressure. The rise time, is the time it takes to go from Time 0 (pressure change) to the needed Hz (for the first time). As seen in the above graph, there can be some oscillations that (hopefully) settle out after a time called the Settling Time. Remember that as the output frequency changes, so does the pressure. **THE USER MUST DECIDE WHAT ARE ACCEPTABLE RISE AND SETTLING TIMES.** The rise time, settling time, and overshoot are dependent on the system and can be adjusted by changing three of the parameters in the table programming above: Proportional Gain, Integral Time, and Differential Time.

Some recommended PID values based on application type:

Process Variable	Proportional Gain	Integral Gain (seconds/repeat)	Differential Gain (seconds)
Flow	0.3	0.6	0.0
Levels: fast	1.0	8.0	0.0
Levels: slow	0.25	16.0	0.0
Pressure: fast	2.0	0.5	0.0
Pressure: slow	1.0	2.0	0.0
Temperature: fast	1.0	2.0	0.0
Temperature: slow	1.0	16.0	0.25
Temperature: furnace	0.8	8.0	0.125
Compressor speed	1.0	2.0	0.0

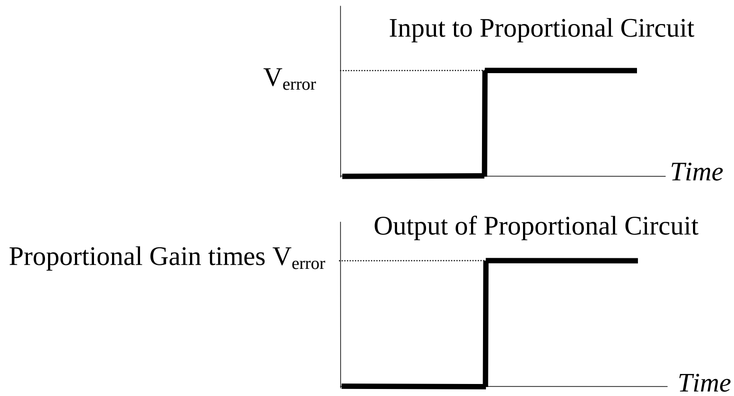
Simplified PID flowchart



$V_{error} = V_{setpoint} - V_{feedback}$

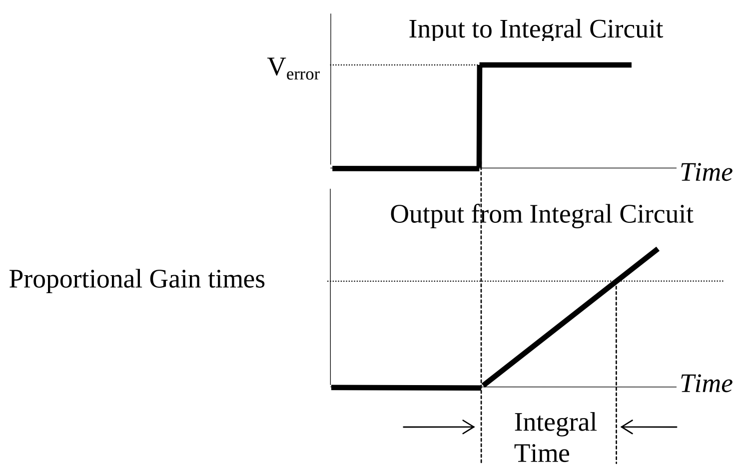
PROPORTIONAL GAIN

Note that PIDs for quickly-changing process variables have higher proportional gains than do their counterparts for slowly-changing process variables. The higher the proportional gain, the smaller the rise time. With increased proportional gain usually comes increased overshoot and increased chance of oscillation.



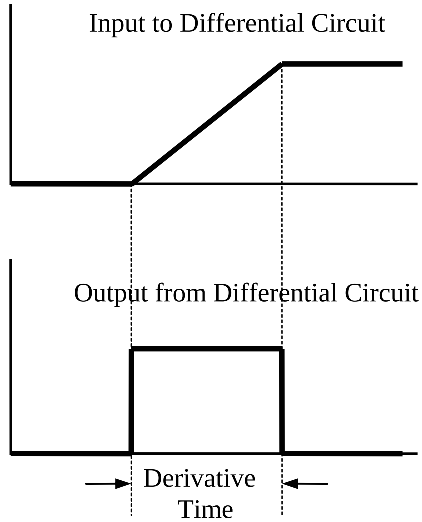
INTEGRAL GAIN

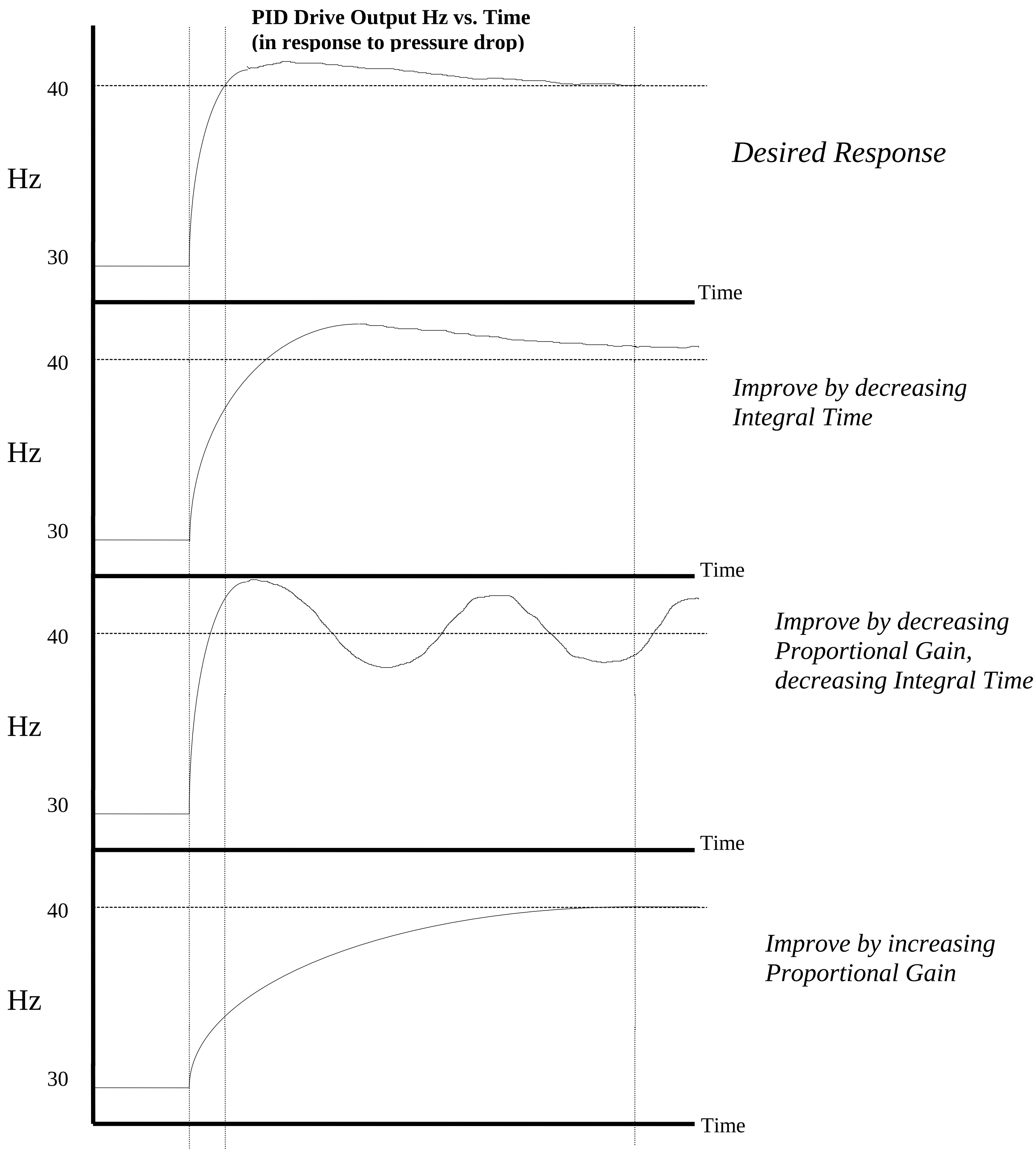
Also known as reset, integral gain is not really a gain at all, but a time. The integral time (units seconds per repeat) defines how long it takes the integral circuit output to go from zero to the level set by the output of the proportional circuit. The integral action is therefore influenced by the proportional action. The output of the integral circuit represents the area under the V_{error} vs. time graph. In the below example, if V_{error} were to remain at the level shown, the output of the integral circuit would continue to increase linearly with time (integral output is proportional to area of the rectangle = Proportional gain times V_{error} times time). **The shorter the integral time, the stronger the effect of the integral action**. If you have a system that never quite gets to the setpoint (there is steady-state error), decrease the integral time.



DIFFERENTIAL GAIN

Also known as anti-hunting gain or rate, differential gain is really not a gain, but a time. Differential gain is seldom used, but it helps to stop oscillations on slowly changing variables (temperature). Any high frequency changes in the system variable (including noise, if present) are picked up by the differential circuit and could lead to instability. **The longer the differential time, the stronger the differential action**.




PID Drive Output Hz vs. Time
(in response to pressure drop)
40
Hz
30
Time
Desired Response
40
Hz
30
Time
Improve by decreasing Integral Time
40
Hz
30
Time
Improve by decreasing Proportional Gain, decreasing Integral Time
40
Hz
30
Time
Improve by increasing Proportional Gain

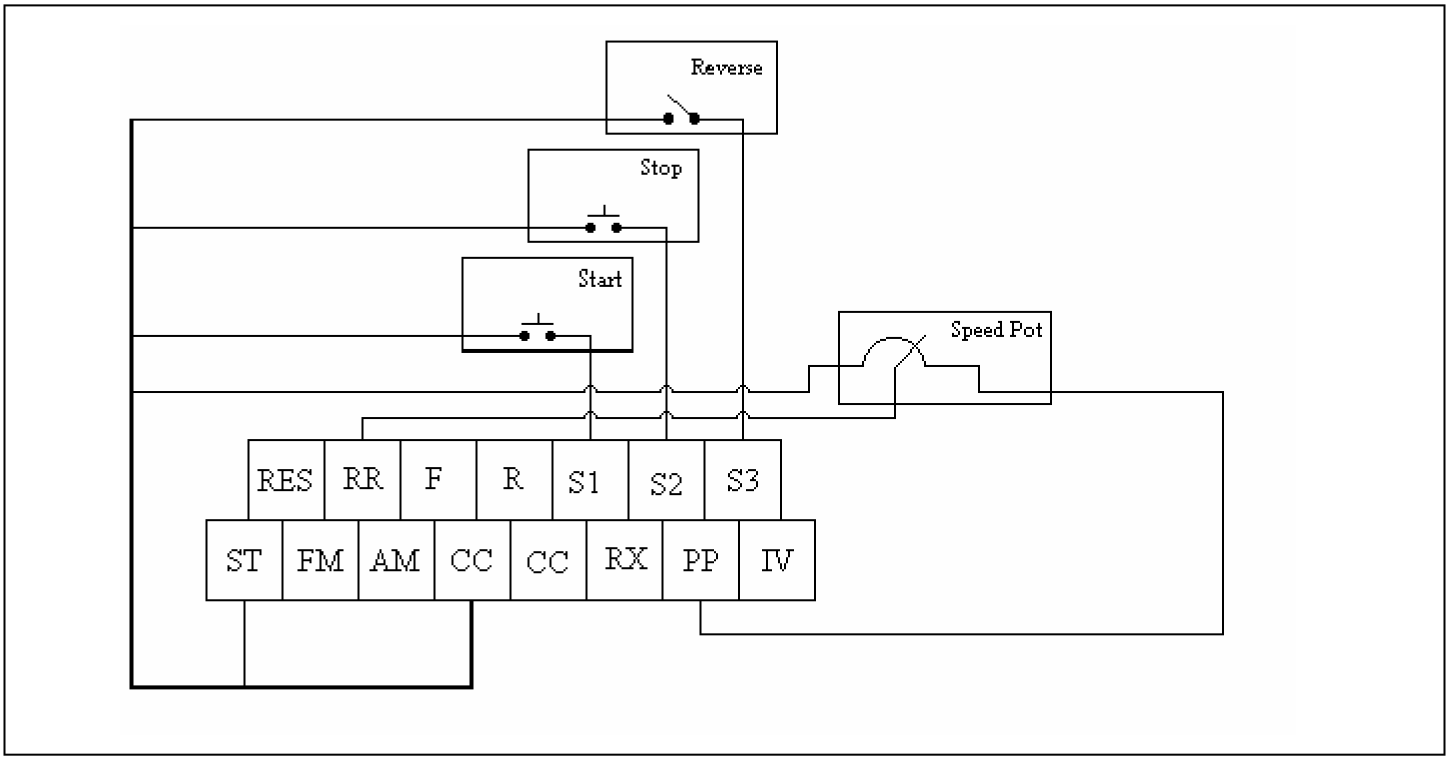
More PID parameters:

- Feedback Source Delay Filter determines the drive reaction time. **Decrease Filter Constant to improve drive reaction to process variable change.** Too long of a filter time can result in under/overshoot.
- When PID is turned on, Lower Limit and Upper Limit frequency are both effective in setting the setpoing and the output frequency in Local Mode, but in Remote mode it only affects the output frequency.
- Use PID Deviation Limits to limit the amplitude of the error signal. The values entered here are in percent of Maximum Output Frequency. Use on systems that change quickly and drastically. Feedback Settings Lower Deviation Limits applies to the error when the feedback is less than the setpoint. Feedback Settings Upper Deviation Limits applies to the error when the feedback is greater than the setpoint. Discrete output 1 or 2 can be programmed to be function 19 so that when the deviation is exceeded, the output will be closed for indication.

PID can be turned ON/OFF **remotely** by programming one of the input terminal's functions to "18" and opening/closing it to 'CC' respectively. Feedback source selection must still be set with a feedback source. The drive's stop/start command must be coming from the terminal strip for the **remote** PID ON/OFF to work (a frequency reference can come from keypad if desired). PID can be turned ON/OFF in this way while the motor is turning.

Three Wire Control

Introduction



The G7 can be programmed to allow three-wire start/stop functionality without the use of an external relay. Note that the pushbuttons utilized are momentary. The switch "S3" determines direction. When S3 is closed, it is in reverse direction, when opened, forward direction.

The following programming example will demonstrate how to set up a G7 to function as a three-wire control operator.

Programming

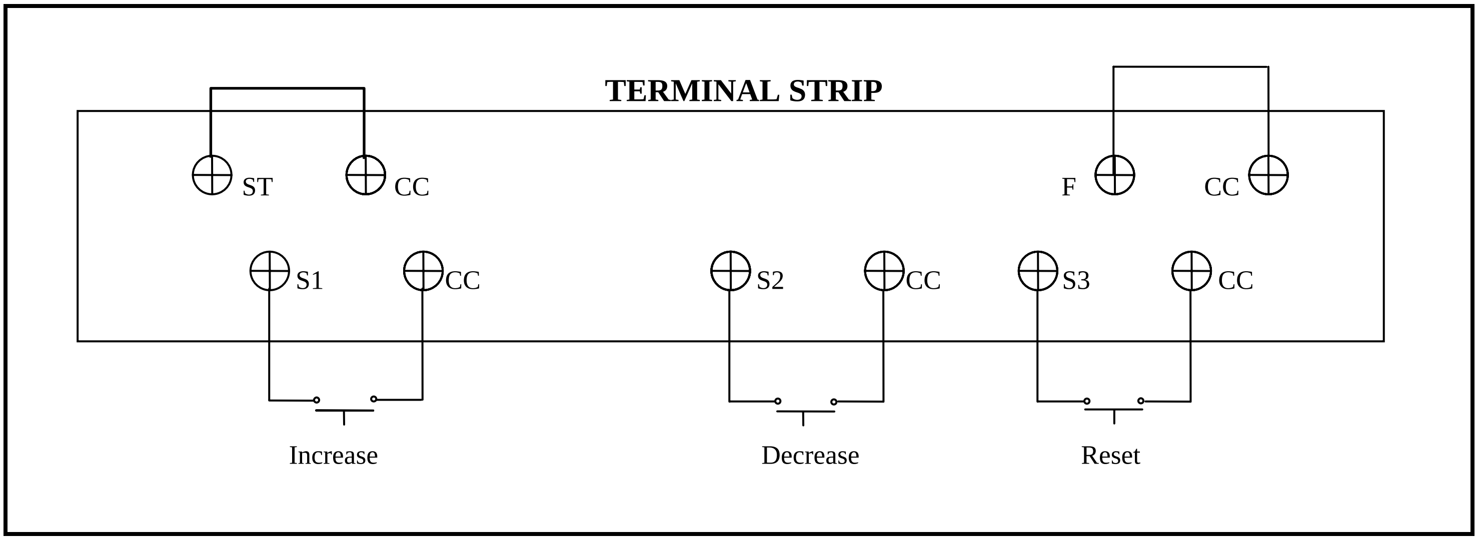
Direct Access	Parameter Path	Parameter Name	Comments
F115	Program→Terminal Selection Parameters→Input Terminal Function	S1	Set S1 function to 47 as when S1 is closed to CC, the drive will start
F116	Program→Terminal Selection Parameters→Input Terminal Function	S2	Set S2 function to 48 as when S2 is closed to CC, the drive will stop
F117	Program→Terminal Selection Parameters→Input Terminal Function	S3	Set S3 function to 49 as when S3 is closed to CC, the drive will be in reverse direction

(1) Place G7 in remote control mode
(2) Push Start button to close S1 to CC terminal momentarily
(3) Use speed pot to adjust frequency
(4) The drive will ramp up to the set speed from the pot in forward direction
(5) Close S3 to CC terminal
(6) The drive will ramp down speed and pass zero hertz and speed up to set speed from the pot in reverse direction
(7) Push Stop button to close S2 to CC terminal momentarily
(8) The drive will ramp down to stop

Motor Operated Pot (MOP)

Introduction

Connections



Frequently used for pendant stations on cranes, MOP control generates a speed reference for the G7 based on how long a momentary contact is made. When the "increase" contact is made, the drive increases its output frequency until the contact is released, at which point it maintains the current frequency. When the "decrease" contact is made, the drive decreases its output frequency until the contact is released, at which point it maintains the current frequency. A closure of the momentary "reset" contact ramps the drive down to zero hertz. Do not use this control scenario with ACCEL and/or DECEL time greater than 10 seconds.

The following programming example will demonstrate how to set up a G7 to function as a MOP operator.

Programming

Direct Access	Parameter Path	Parameter Name	Comments
F115	Program→Terminal Selection Parameters→Input Terminal Function	S1	Set S1 function to 44 as when S1 is closed to CC, the drive will increase the frequency until the contact is opened
F116	Program→Terminal Selection Parameters→Input Terminal Function	S2	Set S2 function to 45 as when S2 is closed to CC, the drive will decrease the frequency until the contact is opened
F117	Program→Terminal Selection Parameters→Input Terminal Function	S3	Set S3 function to 46 as when S3 is closed to CC, the drive will clear the frequency setting and stop
F004	Program→Fundamental Parameters→Standard Mode Selection	Frequency Mode #1	Set to Use Motorized Pot Simulation

(9) Place G7 in remote control mode
(10) Close F to CC terminal
(11) Close S1 to CC terminal
(12) The drive will ramp up speed until either the S1 contact is opened or upper limit is reached
(13) Close S2 to CC terminal
(14) The drive will ramp down speed until either the S2 contact is opened or lower limit is reached
(15) Close S3 to CC terminal
(16) The drive will ramp down to zero and the frequency setting will be zero

Configuring Analog Inputs

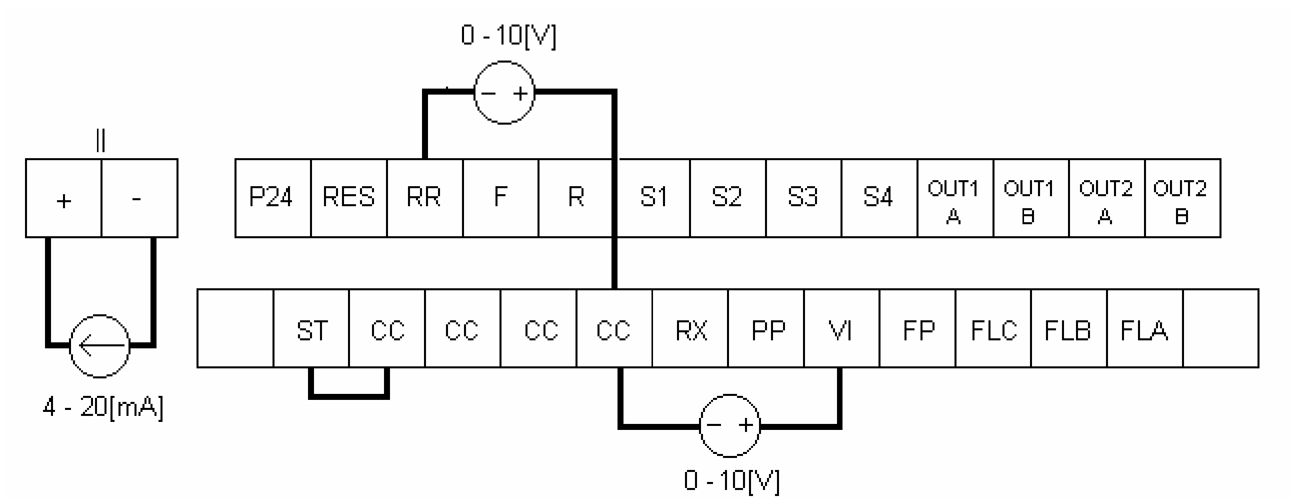
Introduction

The G7 allows several parameters to be controlled by either a 4-20[mA] or 0-10[V] analog input. These parameters include upper limit frequency, acceleration/ deceleration time, and torque boost.

This application note will walk you through all of the steps necessary to configure the G7's analog inputs. The functioning of the controlled parameters will also be discussed.

Before starting, you should consider that several parameters might be controlled by a single input. Care should be taken to ensure that only the desired parameters are being controlled by the analog inputs, and that these parameters are being controlled in the appropriate manner

Connections



Parameter	Location	Default Value	New Value
Upper Limit Frequency Adjustment	Program → Terminal Selection Parameters → Analog Input Functions	Disabled	Use RR*
Acceleration Time Adjustment	Program → Terminal Selection Parameters → Analog Input Functions	Disabled	Use RR*
Deceleration Time Adjustment	Program → Terminal Selection Parameters → Analog Input Functions	Disabled	Use RR*
Torque Boost Adjustment	Program → Terminal Selection Parameters → Analog Input Functions	Disabled	Use RR*

***** The VI/II input terminal can also be used.

Notes

For upper limit frequency the analog input will limit the upper limit frequency in the range 0 - UL[Hz]. If the analog input receives 4[mA] or 0[V], the upper limit frequency will be 0[Hz]. If the analog input receives 20[mA] or 10[V] the upper limit frequency will be set by Upper Limit in Program → Fundamental Parameters →Frequency Settings. Intermediate inputs will result in a linear setting of the upper limit frequency by the formula

$$\text{Upper limit Frequency} = UL * \left(\frac{(X-4)[mA]}{24[mA]} \, Or \, \frac{X[V]}{10[V]} \right)$$

Where X is the input analog input in either mili-Amps or Volts. Note: accel/decel times are still calculated with reference to Maximum Frequency.

Acceleration/Deceleration Time Adjustment - The analog input will determine a multiplier to the Accel/Decel #1 parameters set in Program → Fundamental Parameters →Accel/Decel #1 Settings. With a minimum input resulting in a multiplier of 1 and a maximum input resulting in a multiplier of 10 with intermediate inputs giving a linear multiplier between 1 and 10.

Torque Boost Adjustment – The analog input will determine the percentage of Torque Boost that the drive will output at low speeds in a manner similar to that mentioned in the description of upper limit frequency discussed above.

Configuring Analog Outputs

Introduction

The G7 will output a variety of information, for either monitoring or feedback purposes, through either the AM or FM terminal or through one of two analog outputs available on an option card. The table below shows the drive parameters that can be monitored through the analog output terminals.

Output	Measured in
Output Frequency	Hz
Frequency Reference	Hz
Output Current	% of maximum Amps
DC Bus Voltage	% of maximum Volts
Output Voltage	% of maximum Volts
Post Compensation Frequency	Hz
Speed Feedback (real time)	-
Speed Feedback (1 sec filter)	-
Torque	% Torque
Torque Command	% Torque
Internal Torque Base	-
Torque Current	% of maximum Amps
Excitation Current	% of maximum Amps
PID Feedback Value	-
Motor Overload Ratio	%
ASD Overload Ratio	%
PBR Overload Value	%
PBR Load Ratio	%
Input Power	kW
Output Power	kW
Peak Output Current	% of maximum Amps
Peak DC Bus Voltage	% of maximum Volts
PG Counter	-
Position Pulse	-
RR Input	% of maximum input
VI/II Input	% of maximum input
RX2 Input	% of maximum input
FM Output	% of maximum output
AM Output	% of maximum output
Meter Adjust Value	-

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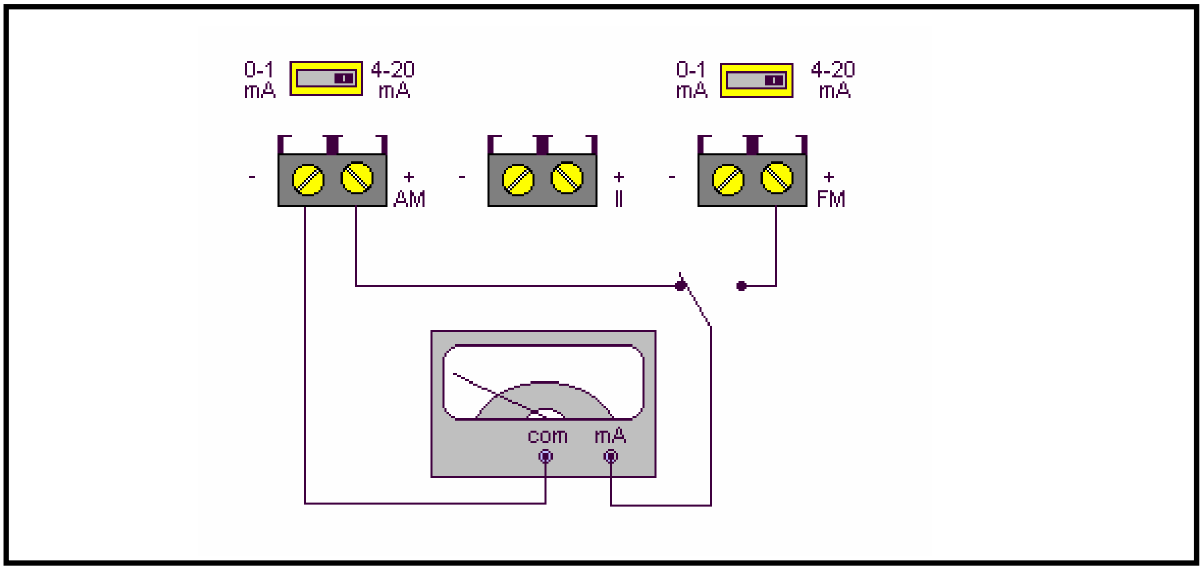
Connection



Note: The above diagram shows connections to use a single meter for either the FM or AM outputs with a selector switch determining which output the meter will display. This is not a required setup and two separate meters may be used to read the two separate outputs.

Programming

Before programming,

1.) Refer to the table above and select the desired drive attribute to output. If more than two outputs are needed, and extender board must be installed. This board will provide two extra outputs Analog1 and Analog2.
2.) Determine which output terminals will output which drive attribute and connect meters appropriately.
3.) Determine whether the output is to be 0-1[mA] or 4-20[mA] and set the switches above each terminal appropriately.

Parameter	Location	New Value
FM Terminal	Program → Meter Terminal Adjustment Parameters →FM	Desired output for FM Terminal
AM Terminal	Program → Meter Terminal Adjustment Parameters →FM	Desired output for FM Terminal
ANALOG1	Program → Meter Terminal Adjustment Parameters →FM	Desired output for Analog1 Terminal
ANALOG2	Program → Meter Terminal Adjustment Parameters →FM	Desired output for Analog2 Terminal

Calibrating output

1.) Now with your meter connected, set the drive in a state that will output the maximum of the output range.
2.) Scroll the adjustment up or down(Program → Meter Terminal Adjustment Parameters → FM → Adjustment) depending on whether the meter is high or low.

NOTE: The output of the terminal will not change until the dial is clicked or the enter key is pressed.

3.) Repeat step 3 until the meter reads its minimum.
4.) Now, with your meter connected, set the drive in a state that will output the minimum of the output range. Check to see that the meter is at its maximum range.

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Acc/Dec Time Switching Frequency

Introduction

In some applications where the acceleration and deceleration time need to be changed at a certain frequency, the G7 drive can be programmed to perform that. G7 drive is capable of 4 acc/dec profiles with 3 switching frequencies. This programming example sets 3 acc/dec profiles and 2 switching frequencies to interchange the 3 different profiles at the 2 preset frequencies. Note that the acc/dec time set is according to the maximum frequency. So if the acc/dec time is set at 10 seconds, max frequency is 80 hz, and upper frequency is at 60 hz, then it will take 7.5 seconds to reach from 0 to 60 hz.

The example sets Accel/Decel #1 Time to 6 seconds, Accel/Decel #2 Time to 12 seconds, Accel/Decel #3 Time to 18 seconds, Accel/Decel Switching Frequency #1 at 20 hertz, and Accel/Decel Switching Frequency #2 at 40 hertz. The max and upper frequencies are both set at 60 hertz. When the drive runs from 0 to 20 hertz, it will take 2 seconds. Between 20 and 40 hertz, the drive will take 4 seconds. Between 40 and 60 hertz, the drive will take 6 seconds.

Programming

Direct Access	Parameter Path	Parameter Name	Comments
F011	Program➔Fundamental Parameters➔Frequency Setting	Maximum Frequency	Set to 60 hertz
F012	Program➔Fundamental Parameters➔Frequency Setting	Upper Limit	Set to 60 hertz
F009	Program➔Special Control Parameters➔Accel/Decel #1 - #4 Settings	Accel #1 Time	Set to 6 seconds
F010	Program➔Special Control Parameters➔Accel/Decel #1 - #4 Settings	Decel #1 Time	Set to 6 seconds
F500	Program➔Special Control Parameters➔Accel/Decel #1 - #4 Settings	Accel #2 Time	Set to 12 seconds
F501	Program➔Special Control Parameters➔Accel/Decel #1 - #4 Settings	Decel #2 Time	Set to 12 seconds
F510	Program➔Special Control Parameters➔Accel/Decel #1 - #4 Settings	Accel #3 Time	Set to 18 seconds
F511	Program➔Special Control Parameters➔Accel/Decel #1 - #4 Settings	Decel #3 Time	Set to 18 seconds
F505	Program➔Special Control Parameters➔Accel/Decel Special	Accel/Decel Switching Frequency #1	Set to 20 hertz
F513	Program➔Special Control Parameters➔Accel/Decel Special	Accel/Decel Switching Frequency #2	Set to 40 hertz

(17) Place G7 in local control mode
(18) Set the frequency command to 60 hertz and enter
(19) Press the Run button to start the drive
(20) The drive should accelerate to 20 hertz in 2 seconds
(21) From 20 to 40 hertz in 4 seconds
(22) From 40 to 60 hertz in 6 seconds
(23) Press the Stop button to stop the drive
(24) The drive should decelerate from 60 to 40 hertz in 6 seconds
(25) From 40 to 20 hertz in 4 seconds
(26) From 20 to stop in 2 seconds

Frequency Priority Switching

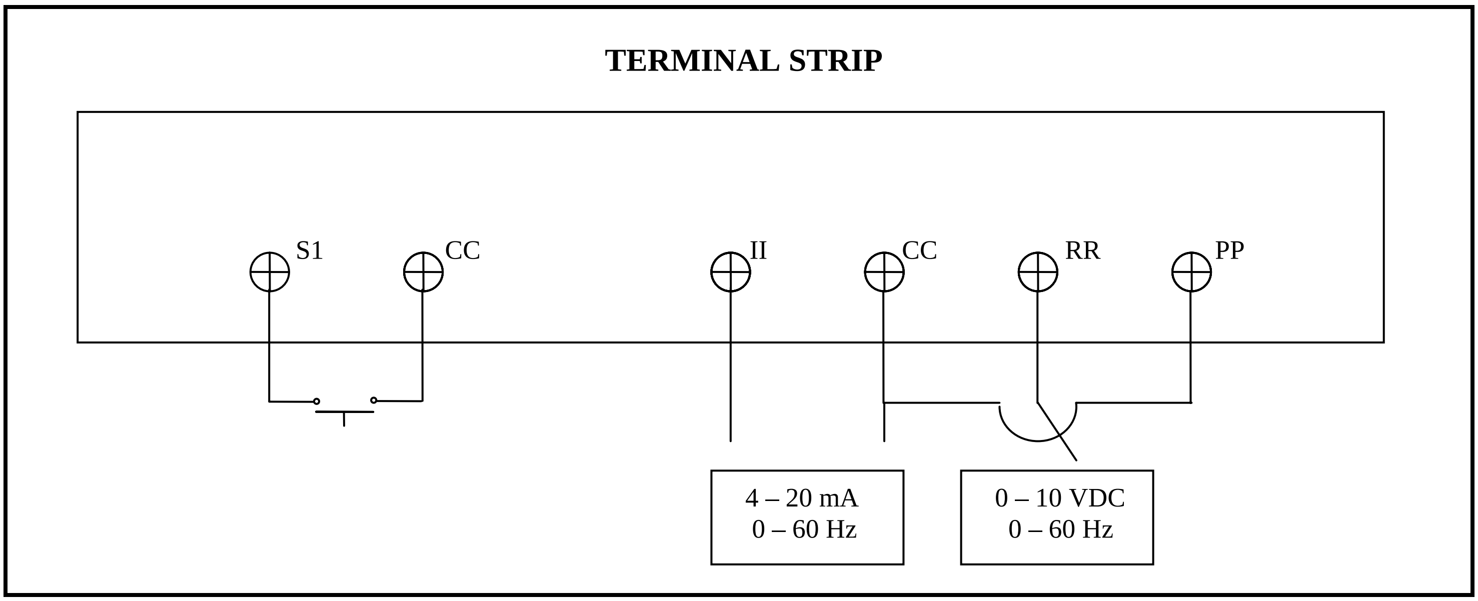
Introduction

In some applications where the analog speed reference input needs to be switched during operation, the drive can be programmed to accommodate that. In this application note, two methods are described to switch the frequency input. The first method uses a discrete input to switch between two analog inputs for speed reference. The second method uses a programmed parameter value for switching reference, but it is different from the first one in terms of when the switching back to the other is taking place.

In both examples, Maximum Frequency and Upper Limit are set to 60 hz for ease of explanation. II and RR inputs are both scaled as 0 – 60 hz span. Please see application note on configuring the analog input if required.

Method 1 -

Connections



In this example, RR input is programmed as Frequency mode #1 and II as the #2.

When S1 is left open, the drive takes the input from RR as its speed reference. When S1 is closed, the drive takes the II as its speed reference. The S1 can be opened and closed while the drive is running.

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Programming

Direct Access	Parameter Path	Parameter Name	Comments
F004	Program➔Fundamental Parameters➔Standard Mode Selection	Frequency Mode #1	Use RR
F207	Program➔Fundamental Parameters➔Standard Mode Selection	Frequency Mode #2	Use VI/II
F115	Program➔Terminal Selection Parameters➔Input Terminal Function	S1	Set to 52 as Frequency Priority
F200	Program➔Fundamental Parameters➔Standard Mode Selection	Reference Priority Selection	Set to Frequency Source Priority Switching

(27) Place G7 in remote control mode
(28) Close F to CC terminal
(29) With the S1 to CC open, the drive will follow the frequency input from RR input
(30) Close S1 to CC terminal
(31) The drive will now follow the II input for its speed reference

Method 2 -

In this example, RR input is programmed as Frequency mode #1 and II as the #2. Connection will be the same as the example above but without the use of S1 input.

Programming

Direct Access	Parameter Path	Parameter Name	Comments
F004	Program➔Fundamental Parameters➔Standard Mode Selection	Frequency Mode #1	Use RR
F207	Program➔Fundamental Parameters➔Standard Mode Selection	Frequency Mode #2	Use VI/II
F208	Program➔Fundamental Parameters➔Standard Mode Selection	Mode #1/#2 Switching Frequency	Set to 30 hz
F200	Program➔Fundamental Parameters➔Standard Mode Selection	Reference Priority Selection	Set to Frequency Source #1 Priority

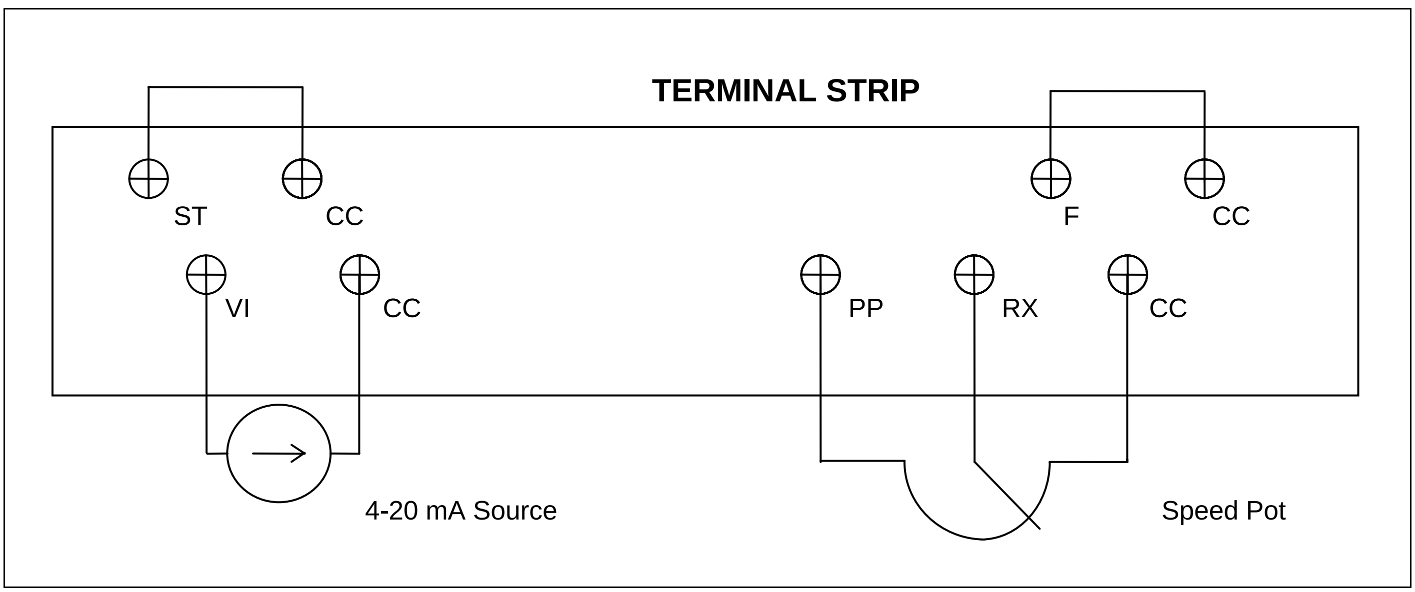
(1) Place G7 in remote control mode
(2) Close F to CC terminal
(3) With the RR input down below 5 VDC (30 hz), the drive follows the II input anywhere in the frequency span
(4) When the RR input is above 5 VDC (30 hz), the drive now follows the RR in the range of 30 – 60 hz regardless of the II input
(5) When the RR input is below 5 VDC (30 hz) again, the drive follows the II input
(6) If the F200 parameter is set to Frequency Source #2 Priority, the reverse will be true for the above example

Trim Pot

Introduction

This guideline will outline a G7 feature that allows a speed reference to be “fine tuned” on the fly via another reference, called the “trim”. All trim sources mentioned below allow addition to the regular reference; (+/-) trim is available only when using the RX terminal and its associated bias and gain have been appropriately programmed. Speed References Allowed: Panel input, 4-20mA, speed pot or voltage source, preset speed, or communication board. Trim Sources Allowed: Speed pot (RX terminal, +/- trim possible, RR terminal, + trim only), 4-20mA (VI/II, + trim only), or panel (+ trim only). Other trim sources can be found in Frequency Override Additive Input (F660). This example will illustrate the connections and programming necessary to follow a 4-20mA speed reference while trimming the reference with a (+/-) trim from a pot connected to the RX terminal.

Connections



Programming

Direct Access	Parameter Path	Parameter Name	Comments
F004	Program➔Fundamental Parameters➔Standard Mode Set	Frequency Mode #1	Set to use VI/II
F660	Program➔Feedback Parameters➔Override Control	Frequency Override Additive Input	Set to use RX
F216	Program➔Frequency Setting Parameters➔Speed Reference Setpoints➔RX	RX Speed Reference Setpoint #1 (%)	Set to value 0
F217	Program➔Frequency Setting Parameters➔Speed Reference Setpoints➔RX	RX Speed Reference Setpoint #1 (frequency)	Set to value 15
F218	Program➔Frequency Setting Parameters➔Speed Reference Setpoints➔RX	RX Speed Reference Setpoint #2 (%)	Set to value 100
F219	Program➔Frequency Setting Parameters➔Speed Reference Setpoints➔RX	RX Speed Reference Setpoint #2 (frequency)	Set to value -22

⇒ In this example, 15 Hz will be added to the frequency commanded by the VI/II input when the pot is at minimum resistance (0 volts on RX terminal); 22 Hz will be subtracted from the frequency commanded by the VI/II input when the pot is at maximum resistance (10 volts on RX terminal).

⇒ When the drive is programmed as above, a zero voltage input to the RX terminal affects the drive output frequency.

⇒ RX can serve as a speed reference if the VI/II reference is zero or not connected.

⇒ Instead of connecting a speed pot to the RX input for continuous speed trim, a user could connect a switch with fixed resistances to give discrete levels of trim.

⇒ To verify correct operation, input the 4-20mA signal to give 60 Hz prior to setting "RX Reference Point #1 Frequency". As soon as this parameter is set to a non-zero value, its reference value is added to the 4-20mA reference value.

⇒ No combination of reference and trim will cause a change in rotation direction.

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Customizing Display Units

Introduction

The G7 allows the user to customize the main display of the drive to show the drives output in a variety of user defined units. This procedure will outline the procedure for changing the units displayed.

Programming

Parameter	Location	New Value
Enable User Defined Unit	Utility Parameters → Display Units → Enable User Defined Unit	Checked
User Defined Units	Utility Parameters→Display Units→User Defined Unit	See Note 1 below
Hz Per User Defined Unit	Utility Parameters→Display Units→Hz Per User Defined Unit	See Note 2 Below
Frequency Display Resolution	Utility Parameters→Display Units→Frequency Display Resolution	See Note 3 Below

Note 1: The user may select up to eight characters to represent their units. Characters may be any upper or lower case letter, 0-9 or any of the following special characters.

SPACE	!	“	#	$	%	&
‘	(	)	*	+	,	-
.	/	:	;	<	=	>
?	@	[	+/-	]	^	_
`						

To change units, move the selection box to the first position under user defined units and press the dial or hit enter. Now rotate the dial until the desired character is displayed and press the dial or hit enter again. Continue until all characters for the desired unit are displayed.

You do not need to change the characters in any particular order, and any character may be edited at any time.

Note 2: Hz per user defined units is the conversion factor between Hz and the user defined units. In most cases, this will have to be determined depending on the unit, the application, etc.

E.G.: The user wants to run a 4 pole motor using the drive and display the output in RPM. Using the formula

$$Rpm = Hz * \frac{120}{\# poles} = 1 * \frac{120}{4} = 30$$

So the Hz per user defined unit should be set to 30.

For a user defined unit that is less than 1 Hz, set the user defined units to fractions of a Hz. This setting might be affected by the display resolution as explained in note 3.

E.G.: A user wants to read Chickens Per Minute(CPM) in his poultry plant. The Drive is running a motor on a machine that processes 6 CPM. So the user defined unit would be 6/60 or 0.1 CPM.

Note 3: Frequency display resolution sets the precision of the user-defined unit. In most cases the factory default of tenths (0.1) is adequate. The number only needs to be changed if the user-defined unit is less than 1/10th of a Hz

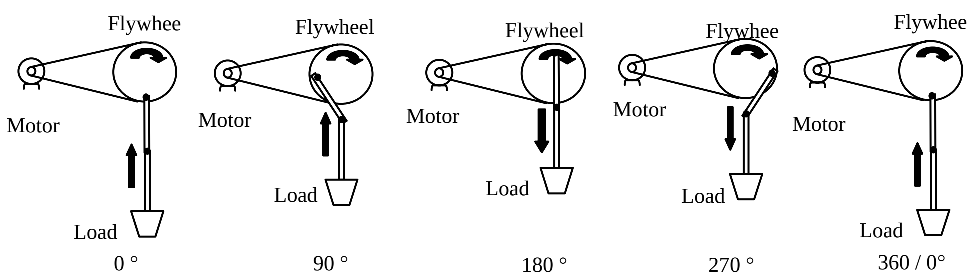
TOSHIBA

Cyclic Overhauling Loads

Introduction:

Many types of loads are a challenge to control with variable frequency drives. One of the more difficult loads is the cyclic overhauling load encountered on vibratory feeders, punch presses, and pump jacks. To properly apply variable frequency drives to loads of this nature requires a thorough understanding of the load requirements, motor characteristics and drive capabilities.

On Cyclic Overhauling Loads, motor torque is a sinusoidal waveform which swings between positive torque (motoring) and negative torque (regeneration). As shown in the drawings below, each cycle consists of load and unload portion. The illustration demonstrates a cyclic overhauling cycle where the load portion causes a load to be lifted and unloading occurs when the load is lowered. When the motor is lifting the load, the motor is providing power. On the downstroke, the load will cause the flywheel to speed slightly faster (due to the weight of the load) causing regeneration. When the motor is providing power to the load, torque is positive. When the load is providing power to the motor, torque is negative.



During the regeneration (unload) portion of the cycle, the motor is turning faster than the speed that the drive is commanding it to run. This causes power to flow in the negative direction from the motor to the drive. This causes the DC bus capacitors to charge and reach a high voltage that will trip the drive on overvoltage. Typically, dynamic braking resistors are employed to take the regenerative energy and dissipate it as heat. With the G7 inverter, these resistors may no longer be necessary because the drive can limit negative torque to a safe level while maintaining flux (excitation) current at the required levels. This configuration must not be used on non-cyclic overhauling loads.

Programming

Parameter	How to get there	New Value
Regeneration Torque Limit #1 (F442)	Program→ Torque Setting Parameters→ Torque Limit Settings	'SETTING'
Regeneration Torque Limit #1 Setting (F443)	Program→ Torque Setting Parameters→ Torque Limit Settings→ Manual Settings	5%
Torque Limit Mode (F450)	Program→ Torque Setting Parameters→ Torque Limit Settings→ Torque Limit Mode	'Positive/Negative'

To complete tuning, run the cyclic overhauling load while monitoring DC bus percent. A good target value is 110%. If the DC bus value is less than 110% during regeneration, increase F443. If the DC bus value is greater than 110% during regeneration, decrease F443.

Sensorless Vector Control (Speed)

Introduction

Toshiba's G7 can, when properly configured, provides speed regulation as great as 0.1% from 0.6Hz to 60.0Hz with no external feedback. This control method is referred to as Sensorless Vector Speed Control.

To maximize the performance of the motor/drive combination, the G7 must be tuned to the motor. G7s have mathematical models of all standard efficient and premium efficient Houston-made Toshiba motors stored in a matrix memory. These motor mathematical models are used by the drive to increase the motor's low speed torque and to reduce the load's affect on RPM (when compared to its performance on a V/Hz drive). If a non-Toshiba motor is being used, the G7 can model the motor by performing an 'auto-tune' or by manual setting of the motor data.

Sensorless Vector Control should not be used on:

Multiple Motor Applications (applications where more than one motor is connected to the G7)
Applications where load end inductors, long lead filters, or output transformers are used
High-speed spindle motors
Motors designed for high slip (NEMA design D)
Motors larger than or more than 2 sizes smaller than the G7's nominal Horse Power rating

It is necessary to define the type and size of the motor to the G7 prior to using either the G7's internal tables or auto-tuning. The G7 requires the following information:

Number of motor poles
Capacity (size) of motor in kW
Motor Type

The number of motor poles may be determined by the motors' base frequency and it's nominal rated RPM.

The chart below may be used to determine the setting for motor poles

Base Frequency	*Nominal RPM*	*Motor Poles*
60	3600	2
60	1800	4
60	1200	6
50	3000	2
50	1500	4
50	1000	6

If the motor nameplate does not list kW, the motor's horsepower may be converted to kW by multiplying Hp by 0.745.

The motor type must be selected as one of the following types:

Toshiba EQPIII TEFC
Toshiba EQPIII ODP
Toshiba EPAC TEFC
Toshiba EPAC ODP
Other

If one of the above types of Toshiba motors is used, no other tuning should be required. If the motor is not a Toshiba motor, or has been rewound by other than a factory authorized service center, the motor type should be set to 'Other'. Also, call your motor manufacturer to ask them for the motor constants; many manufacturers have the motor specs on their websites. If you do not know how to read the motor constants, you can send us an email with the motor specs and we can help you with it if you give us enough time.

Sensorless Vector control with a Toshiba Motor

TOSHIBA

HIGH EFFICIENCY
TEFC
3 PHASE INDUCTION MOTOR

MODEL NUMBER:	4F2001L10C					FRAME	**143T**
HP/kW	**1**			INS. CLASS	**F**	DUTY	**CONT**
VOLTS	**230**			NEMA CODE	**B**	ENCL.	**TEFC**
AMPS	**2.8**			NEMA DESIGN	**B**	TYPE	**IKK**
RPM	**1750**	Hz	**60**	MEETS IP	**54**	FORM	**FBK1**
P.F.	**79**	S.F.	**1.15**	OPP. END BRG.	**6308ZZ**		
NOM. F.L. EFF.		**85.5**		DRIVE END BRG.	**6208ZZ**		
MOTOR WT.		180LBS. Kg.		SERIAL NO.			
MAX. AMB.		**40 DEG C**		USABLE@208V HP AMPS, 1.0S.F.			

OPERATING RANGE FOR VPWM INVERTER APPLICATIONS: V/T = 1000:1 C/T = 4:1

TOSHIBA INTERNATIONAL CORPORATION
HOUSTON, TEXAS - USA

Programming

STEP 1
Reset the G7 to factory defaults
When prompted, run the start-up wizard using the following selections:
Motor Type: 230V 60Hz
Upper Limit: 60Hz
Lower Limit: O.OHz
Automatic Accelldecel: NO
Accel Time: lOsec
Decel Time: lOsec
Voltslhertz pattern: Sensorless Vector Control (speed)
Rated Motor Current: 2.8amps

STEP 2
➢ Configure the G7 for the proper motor rating
Set the number of poles to match your motor
Convert the motor HP to kW and enter the kW rating
Select the proper motor type and enter

Direct Access	Parameter Path	Parameter Name	Comments
F411	Program➔Motor Parameters➔Motor Settings	Number of Motor Poles	Configure the number of motor poles from the chart above
F412	Program➔Motor Parameters➔Motor Settings	Rated Capacity of Motor	Rated capacity of the motor is kW. To determine kW if Hp is known, multiply Hp by 0.745
F413	Program➔Motor Parameters➔Motor Settings	Motor Type	If motor used is not listed as a possible selection, use 'Other'. and perform autotune as last step.

➢ Set the G7 to use the internal motor data based for this motor.

F400	Program➔Motor Parameters➔Vector Motor Model	Autotune	Select 'Reset Motor Defaults'. The G7 will then apply the correct motor model.

Enable tuning of motor constant *#3*

STEP 3
Place the G7 in local mode. Close S4 (E-Stop) and ST (Standby).
Run the motor at 1.0 Hz
Go to monitor and observe excitation current and torque current.
Go to the 'Vector Motor Model' Parameter screen and record the values for
PRIMARY RESISTANCE__________ SECONDARY RESISTANCE___________EXCITATION INDUCTANCE___________

STEP 4

- With the G7 stopped, turn on auto tuning.

F400	Program➔Motor Parameters➔Vector Motor Model	Autotune	Select 'Enable Autotune on Run Command'. The G7 will use the algorithm saved in memory for this motor model.

STEP 5

Place the G7 in local mode. Close S4 (E-Stop) and ST (Standby).
Give the G7 a frequency command of 1 .OHz.
Press the Start Button
Observe the display while the drive autotunes.
CAUTION: AFTER TUNING, THE G7 WILL ACCELERATE THE MOTOR TO THE FREQUENCY SETPOINT
Go to monitor and observe excitation current and torque current.
Go to the 'Vector Motor Model' Parameter screen and record the values for
PRIMARY__________ RESISTANCE SECONDARY_______________ RESISTANCE EXCITATION INDUCTANCE____________
Are these values different from those previously recorded?

Sensorless Vector Control (Torque)

Introduction

Many applications may benefit from controlling torque rather than speed. Applications such as blenders, winders, and web-tensioning are some of the types of equipment where torque is the controlling factor.

One example of this type of application is an ice cream mixer. To maintain the same amount of force on the mix by the paddle blades, the speed will decrease as the mix thickens. When the mix is thin, it may be impossible to obtain the torque setpoint, and the speed will go to some maximum level.

Toshiba's G7, when properly configured, provides torque regulation as great as 10% (with less than 3% ripple) from 50 to 100% the motors torque rating with no external feedback. This control method is referred to as Sensorless Vector Torque Control.

Torque control requires a torque command rather than a speed or frequency command. The torque command may come from any of the G7's analog inputs, the electronic operator interface (EOI), or one of the communication ports. In addition, torque speed limits may be configured for both forward and reverse.

Because the G7 is primarily a speed control device, an input must be configured to switch the drive from speed control to torque control. If the G7 will only operate in torque control mode, this control switch may be assigned to the virtual input terminal (ON).

To maximize the performance of the motor/drive combination, the G7 must be tuned to the motor. G7s have mathematical models of all standard efficient and premium efficient Houston-made Toshiba motors stored in a matrix memory. These motor mathematical models are used by the drive to increase the motor's low speed torque and to reduce the load's affect on RPM (when compared to its performance on a V/Hz drive). If a non-Toshiba motor is being used, the G3 can model the motor by performing an 'auto-tune' or by manual setting of the motor data.

Sensorless Vector Torque Control should not be used on:

Multiple Motor Applications (applications where more than one motor is connected to the G7)
Applications where load end inductors, long lead filters, or output transformers are used
High-speed spindle motors
Motors designed for high slip (NEMA design D)
Motors larger than or more than 2 sizes smaller than the G7's nominal Horse Power rating

Programming

Direct Access	Parameter Path	Parameter Name	Comments
F411	Program➔Motor Parameters➔Motor Settings	Number of Motor Poles	Configure the number of motor poles to match that of the motor used
F412	Program➔Motor Parameters➔Motor Settings	Rated Capacity of Motor	Rated capacity of the motor is kW. To determine kW if Hp is known, multiply Hp by 0.745
F413	Program➔Motor Parameters➔Motor Settings	Motor Type	If motor used is not listed as a possible selection, use 'Other'. and perform autotune as last step.
F014	Program➔Fundamental Parameters➔Frequency Setting	V/f Pattern	Select either 'Sensorless Vector Control (speed)' or 'Sensorless Vector Control (speed/torque switching)'
F400	Program➔Motor Parameters➔Vector Motor Model	Autotune	Select 'Reset Motor Defaults'. The G7 will then apply the correct motor model.
F115	Program➔Terminal Selection➔Input Terminals	S1 (or other discrete input terminal)	Select #56: Control Switch (torque,postion)
F420	Program➔Torque Setting Parameters➔Torque Control	Torque Command Selection	Set to source of torque command. RR used is this example
F214	Program➔Torque Setting Parameters➔Setpoints	RR	Scale RR input as required.
F425	Program➔Torque Setting➔Torque Speed Limiting	Forward Speed Limit Selection	Select 'SETTING'
F426	Program➔Torque Setting➔Torque Speed Limiting	Forward Speed Limit Level	Set to desired maximum output frequency in forward direction while in torque control mode
F427	Program➔Torque Setting➔Torque Speed Limiting	Reverse Speed Limit Selection	Select 'SETTING'
F428	Program➔Torque Setting➔Torque Speed Limiting	Forward Speed Limit Level	Set to desired maximum output frequency in reverse direction while in torque control mode

Start and run the motor in speed control mode to verify operation. Reduce speed to zero Hertz. If you are using the demo terminals strip, close switch S1. Otherwise, you will need to make a dry contact between S1 and CC. This will put the drive into torque control mode.

Feedback Vector Control (Speed)

Introduction

Many applications require precise speed control regardless of changes in the load conditions. Toshiba's G7, when properly configured, provides speed regulation as great as 0.01% over a 1000:1 speed range.

Feedback vector control requires feedback from a rotary encoder mounted on the motor. Toshiba recommends a bi-directional encoder with differential line driver outputs providing 1024 pulses per revolution.

Refer to the manual provided with the vector feedback option board for instruction on mounting and wiring the encoder.

To maximize the performance of the motor/drive combination, the G7 must be tuned to the motor. G7s have mathematical models of all standard efficient and premium efficient Houston-made Toshiba motors stored in a matrix memory. These motor mathematical models are used by the drive to increase the motor's low speed torque and to reduce the load's affect on RPM (when compared to its performance on a V/Hz drive). If a non-Toshiba motor is being used, the G3 can model the motor by performing an 'auto-tune' or by manual setting of the motor data.

Feedback Vector Control should not be used on:

- Multiple Motor Applications (applications where more than one motor is connected to the G7)
- Applications where load end inductors, long lead filters, or output transformers are used
- High-speed spindle motors
- Motors designed for high slip (NEMA design D)
- Motors larger than or more than 2 sizes smaller than the G7's nominal Horse Power rating

Before programming the G7 for feedback vector control, connect the motor to the drive and check the motor's direction of rotation with a forward run command while using a constant volts per hertz relationship. The motor must rotate CCW (counter clockwise) when viewed from the opposite drive end when rotating in the forward direction. If the motor's direction of rotation is incorrect, this must be corrected by reversing any two motor leads either at the G7 or the motor.

The programming example demonstrates the programming required when using a bi-directional, differential line driver encoder providing 1024 pulses per revolution.

Programming

Direct Access	Parameter Path	Parameter Name	Comments
F015	Program→Fundamental Parameters→Frequency Setting	V/f Pattern	Select either PGFeedback Vector Control (speed/torque) or PGFeedback Vector Control (speed/position)
F411	Program→Motor Parameters→Motor Settings	Number of Motor Poles	Configure the number of motor poles to match that of the motor used
F412	Program→Motor Parameters→Motor Settings	Rated Capacity of Motor	Rated capacity of the motor is kW. To determine kW if Hp is known, multiply Hp by 0.745
F413	Program→Motor Parameters→Motor Settings	Motor Type	If motor used is not listed as a possible selection, use Other and perform autotune as last step
F400	Program→Motor Parameters→Vector Motor Model	Autotune	Select Reset Motor Defaults. The G7 will then apply the correct motor model
F367	Program→Feedback Parameters→PG Settings	Number of PG Input Pulses	1024 (set to match PPR of encoder)
F368	Program→Feedback Parameters→PG Settings	PG Input Phases	2 (use 1 if using non directional encoder)
F702	Program →Utility Parameters→ Display Units	Frequency Display Resolution	Change to 0.01
FXXX	Program→Special Control Parameters→ Frequency Control	Start-up frequency	Set to 0.00 to allow the G7 and motor to produce holding torque at zero speed

(32) Place G7 in local control mode.
(33) Using the EOI, give the G7 a 1Hz frequency set point.
(34) Press Run.
(35) If output frequency does not reach 1.0Hz, or the display indicates OT or OC, press stop. Possible problems are, direction of rotation, encoder parameters, motor parameters, and encoder wiring. Please verify motor direction of rotation and the parameters configured in the programming section.
(36) Increase the frequency setpoint to 60.0 Hz.
(37) Test system under varying load conditions.
(38) If response is slow, or appears to be unstable, contact Toshiba for assistance.

Feedback Vector Control (Torque)

Introduction

Many applications may benefit from controlling torque rather than speed. Applications such as blenders, winders, and web-tensioning devices are some of the types of equipment where torque is the controlling factor.

One example of this type of application is an ice cream mixer. To maintain the same amount of force on the mix by the paddle blades, the speed will decrease as the mix thickens. When the mix is thin, it may be impossible to obtain the torque setpoint, and the speed will go to some maximum level.

Toshiba's G7, when properly configured, provides torque regulation as great as 5% (with less than 2% ripple) from 50 to 100% the motors full load torque rating.

Feedback vector torque control requires feedback from a rotary encoder mounted on the motor. Toshiba recommends a bi-directional encoder with differential line driver outputs providing 1024 pulses per revolution.

Refer to the manual provided with the vector feedback option board for instruction on mounting and wiring the encoder.

Torque control requires a torque command rather than a speed or frequency command. The torque command may come from any of the G7's analog inputs, the electronic operator interface (EOI), or one of the communication ports. In addition, torque speed limits may be configured for both forward and reverse.

Because the G7 is primarily a speed control device, an input must be configured to switch the drive from speed control to torque control. If the G7 will only operate in torque control mode, this control switch may be assigned to the virtual input terminal (ON).

To maximize the performance of the motor/drive combination, the G7 must be tuned to the motor. G7s have mathematical models of all standard efficient and premium efficient Houston-made Toshiba motors stored in a matrix memory. These motor mathematical models are used by the drive to increase the motor's low speed torque and to reduce the load's affect on RPM (when compared to its performance on a V/Hz drive). If a non-Toshiba motor is being used, the G3 can model the motor by performing an 'auto-tune' or by manual setting of the motor data.

Feedback Vector Torque Control should not be used on:

- Multiple Motor Applications (applications where more than one motor is connected to the G7)
- Applications where load end inductors, long lead filters, or output transformers are used
- High-speed spindle motors
- Motors designed for high slip (NEMA design D)
- Motors larger than or more than 2 sizes smaller than the G7's nominal Horse Power rating

Before programming the G7 for feedback vector torque control, connect the motor to the drive and check the motor's direction of rotation with a forward run command while using a constant volts per hertz relationship. The motor must rotate CCW (counter clockwise) when viewed from the opposite drive end when rotating in the forward direction. If the motor's direction of rotation is incorrect, this must be corrected by reversing any two motor leads either at the G7 or the motor.

The programming example demonstrates the programming required when using a bi-directional, differential line driver encoder providing 1024 pulses per revolution.

Programming

Direct Access	Parameter Path	Parameter Name	Comments
F014	Program→Fundamental Parameters→Frequency Setting	V/f Pattern	Select either 'PG Vector Control (speed/torque switching)'
F411	Program→Motor Parameters→Motor Settings	Number of Motor Poles	Configure the number of motor poles to match that of the motor used
F412	Program→Motor Parameters→Motor Settings	Rated Capacity of Motor	Rated capacity of the motor is kW. To determine kW if Hp is known, multiply Hp by 0.745
F413	Program→Motor Parameters→Motor Settings	Motor Type	If motor used is not listed as a possible selection, use 'Other'. and perform autotune as last step.
F400	Program→Motor Parameters→Vector Motor Model	Autotune	Select 'Reset Motor Defaults'. The G7 will then apply the correct motor model.
F367	Program→Feedback Parameters→PG Settings	Number of PG Input Pulses	1024 (set to match PPR of encoder)
F368	Program→Feedback Parameters→PG Settings	PG Input Phases	2 (use 1 if using non directional encoder)
F702	Program →Utility Parameters→ Display Units	Frequency Display Resolution	Change to 0.01
FXXX	Program→Special Control Parameters→ Frequency Control	Start-up frequency	Set to 0.00 to allow the G7 and motor to produce holding torque at zero speed
F115	Program→Terminal Selection→Input Terminals	S1 (or other discrete input terminal)	Select #56: Control Switch (torque,postion)
F420	Program→Torque Setting Parameters→Torque Control	Torque Command Selection	Set to source of torque command. RR used is this example
F214	Program→Torque Setting Parameters→Setpoints	RR	Scale RR input as required.
F425	Program→Torque Setting→Torque Speed Limiting	Forward Speed Limit Selection	Select 'SETTING'
F426	Program→Torque Setting→Torque Speed Limiting	Forward Speed Limit Level	Set to desired maximum output frequency in forward direction while in torque control mode
F427	Program→Torque Setting→Torque Speed Limiting	Reverse Speed Limit Selection	Select 'SETTING'
F428	Program→Torque Setting→Torque Speed Limiting	Forward Speed Limit Level	Set to desired maximum output frequency in reverse direction while in torque control mode

(39) Place G7 in local control mode
(40) Using the EOI, give the G7 a 1Hz frequency setpoint
(41) Press Run

(42) If output frequency does not reach 1.0Hz, or the display indicates OT or OC, press stop. Possible problems are, direction of rotation, encoder parameters, motor parameters, and encoder wiring. Please verify motor direction of rotation and the parameters configured in the programming section.
(43) Increase the frequency setpoint to 60.0 Hz.
(44) Test system under varying load conditions.
(45) If response is slow, or appears to be unstable, contact Toshiba for assistance.
(8) Close S1 to place the G7 in torque control mode

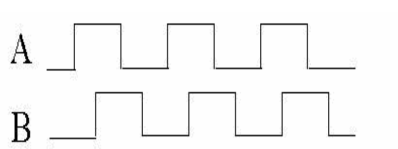
Encoder Recommendations

Introduction

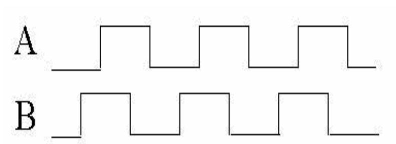
This guideline is to simplify the selection of encoders that will work with the most common G7 applications while avoiding typical pitfalls.

Shaft encoders for motors may be flange, face or foot mounted. Shaft encoders have no flexture therefore coupling one to a motor requires a flexible coupling. Direct mount encoders have no shafts & are mounted directly onto motor shafts. Since coupling between encoder and motor shafts does not occur, flexible shaft couplings are not required. A hub shaft or hollowshaft encoder should be mounted so that its shaft receptacle is in as close as possible alignment with the motor shaft. Clamp or set screws should then be tightened to secure the encoder. Do not defeat or restrict the flexure. This causes failure of the encoder or driving shaft bearings. A ring kit encoder should be mounted with its mounting holes in exact alignment with holes or studs on the motor frame. All fasteners should be equally torqued so as to not distort the ring shape. A gearbox is then positioned on the motor centered relative to the sensor. The rotation of the motor shaft & gear must be checked to determine that the specified gap between the gear teeth & sensor is maintained.

All encoders have a power input (+DC), a common & output signal(s). The power input is always +DC for encoders with a range of 5 to 26 volts & should be regulated to +/-5% at the encoder. Common should always be connected to the negative (-) side of DC power but not grounded. All unidirectional encoders will have at least one output signal (A). A bi-directional encoder will have at least two output signals (A & B). When using bi-directional encoders, the direction of feedback must match the direction of rotation. Forward rotation is counter clockwise shaft rotation when viewed from the opposite drive end of the motor (fan end). Reverse rotation is clockwise shaft rotation when viewed from the opposite drive end of the motor (fan end). An encoder may also include an index pulse which gives one pulse per revolution. (Z, C, X or index). Do not connect A, B or Z to the + or – side of DC power.



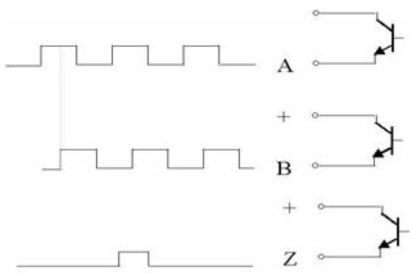
Forward Rotation



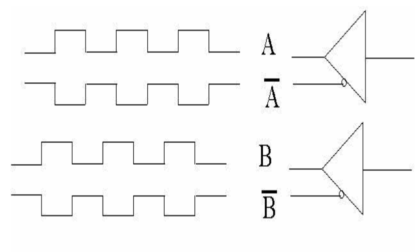
Reverse Rotation

The number of pulses per revolution (PPR) affects the resolution of feedback & thus the accuracy of the speed regulation. PPR's range from 100 to 2048.

Output types include open collector, open collector with pull-ups & line driver. Open collector types are low cost, have poor noise immunity & can have a maximum wire length of 10 meters. Line driver outputs have a high speed response, high noise immunity & can be transmitted over a length of 30 meters. A differential line driver has two signals for each of the outputs. Each signal has a compliment or inverse (mirror image) referred to as A not, B not & Z not. These can be transmitted 100 meters. Do not connect A not, B not or Z not together or to the + or- side of DC power.



Open Collector Output



Line Driver

Wiring should be shielded cable & should be run through dedicated harnesses or conduits (not shared with any other wiring) spaced 12 inches apart. Cable assemblies can be ordered from the encoder manufacturer. Never connect or disconnect the encoder connector or wiring while the power is on. Doing so may damage the encoder. Do not ground the encoder through both the machine & the cable wiring. Connect the shield at the input device only. If the shield is connected at both ends, grounding problems that degrade system performance will result.

Detailed information can be obtained through encoder manufacturers which include BEI, Dynapar & Lakeshore among others.

Encoders should be selected for specific applications. However, a general recommendation would be a 1024 PPR, bi-directional, differential line driver output with an index pulse. Power should be 12 or 15 VDC.

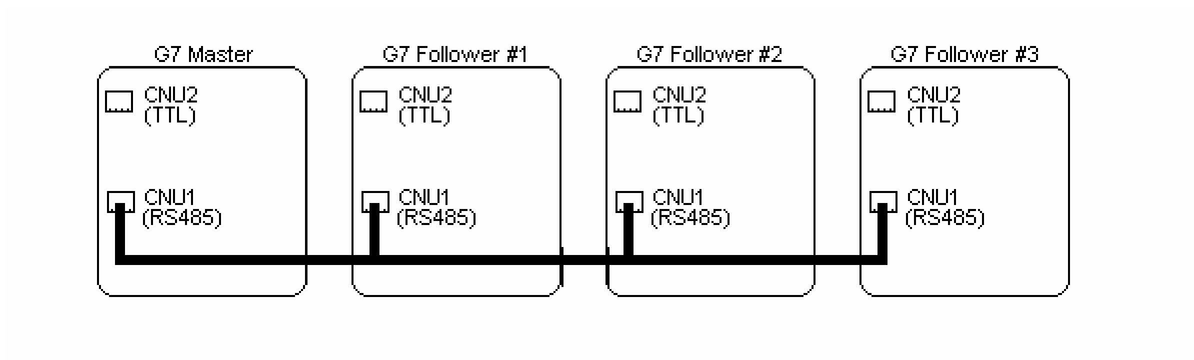
G7 Master/Follower Via Communications

Introduction

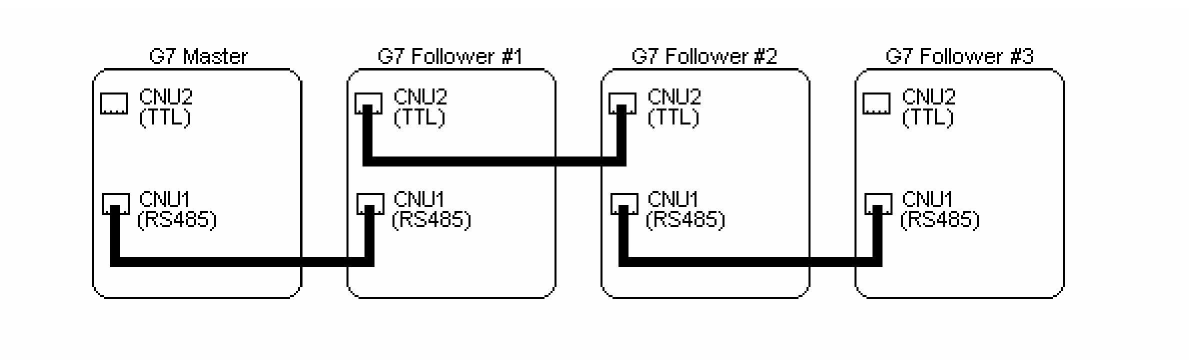
Master/follower setup on the Toshiba G7 can be accomplished using the on board communications ports. There are a number of arrangements that can be used to set up the drive. All make use of the RS232/485 communications port on the drive

There are two basic arrangements that allow the communications ports on the G7 to be used to provide a frequency or torque signal to subsequent follower drives.

1.) Multi-Drop: In this configuration, the same RS485 or TTL signal from the master drive is fed to



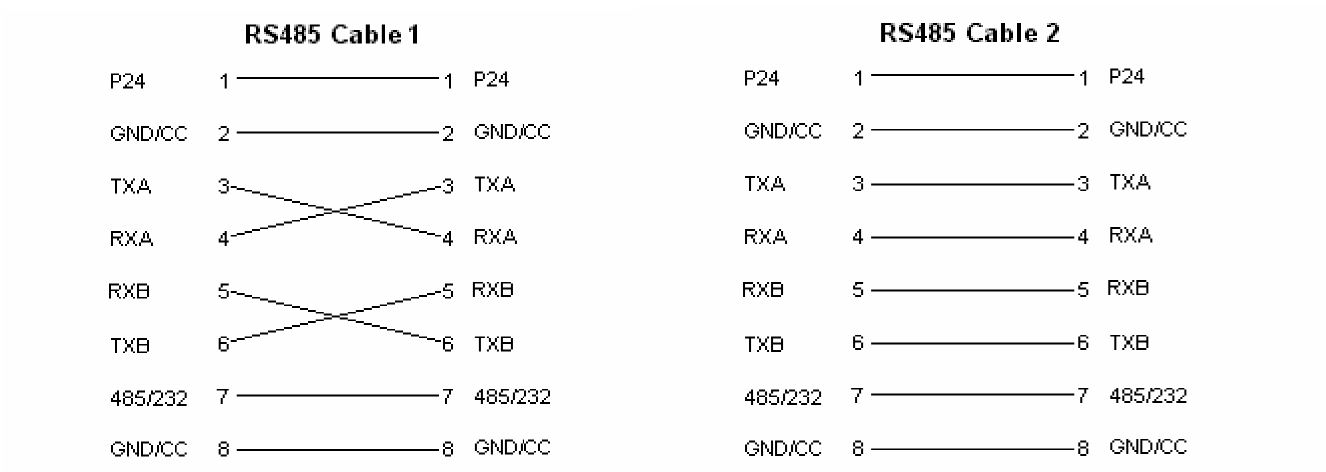
several follower drives. The signal is fed into the same port on each drive, which will need to be fed into a 1(M) to 2(F) RJ45 splitter to feed the signal further down the line. This arrangement allows the user to maintain a keypad on each drive in the series. However, signal loss is possible in drives further down the line and a definite maximum number of drives will eventually be reached.

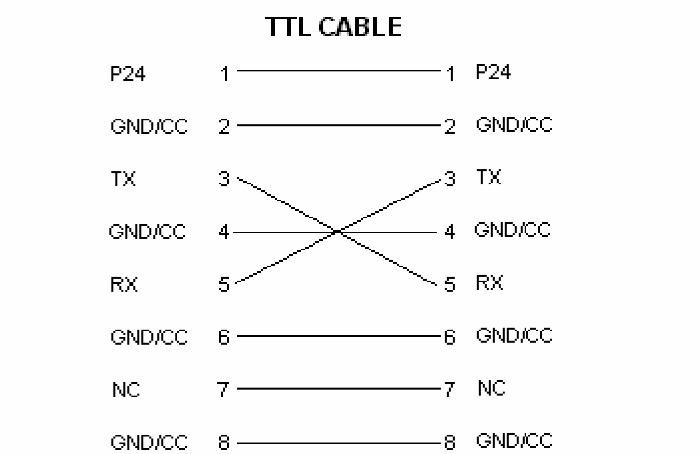


2.) Daisy chain: In this configuration, communications is passed down the line alternating through the RS485 and TTL ports. In effect, each follower drive will then become a master for each subsequent drive This arrangement requires more setup and programming than the multi-drop option and all drives in between the first and the last would be unable to support a keypad. However, this option provides a very reliable signal transfer and an almost unlimited number of drives that could be added to the chain. This option also allows for more precise control of individual followers.

In this application note we will see how to set up either of these arrangements. The following Cabling will be referenced in both setups.

Connections (cabling)

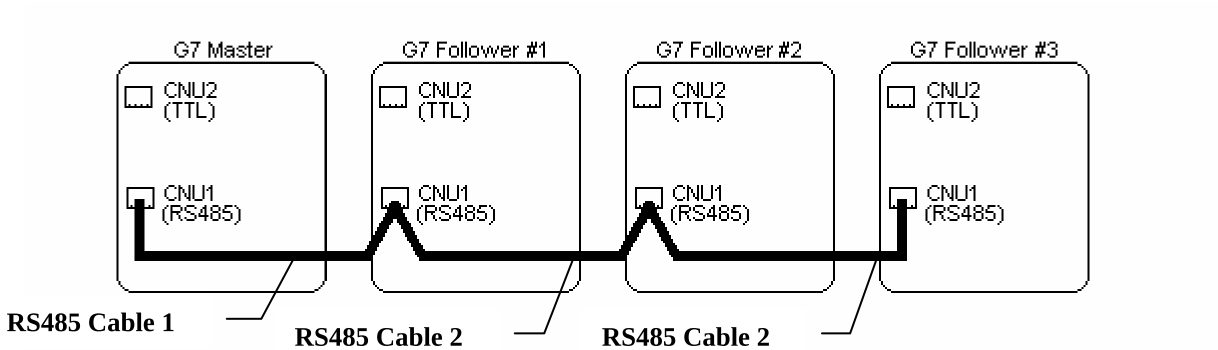




1.) Multi Drop Option

In Multi Drop, one master drive feeds a signal out to X number of follower drives. This arrangement requires either a multi-drop cable or an RS485 1(male) to 2 (female) splitter in conjunction with some category 5 cable. This setup will make use of the latter arrangement. The splitter mentioned is readily available and a web search for "RJ45 splitter" should produce several vendors.

Cabling



The Multi Drop option uses a single RS485 (RS485 Cable 1) Cross-over cable between the master drive and the first follower and then a straight through cable (RS485 Cable 2) to each subsequent follower. Please note: do not make these connections while either the master or follower drive is powered.

Programming

Parameter		Location/Direct Access	New Value
Master	RS485/232 Master Output Selection*	F826	**
Follower	Frequency Mode #1	F004	Use RS485/232
	Frequency Point Selection	F810	Use RS232/485

*Caution: Both the RS485 port (CNU1) and the TTL port (CNU2) on the G7 control board may be programmed to output. Programming both ports to output at the same time will effectively lock out keypad control and programming.

****No Slave** - Port remains an input port

Frequency Reference - Port outputs the master's present frequency reference, regardless of whether the master is running or not.

Output Command Frequency - Port outputs the master's present operating frequency. If the master is not running all followers will be stopped

Torque Command - Port outputs the master's present torque reference, regardless of whether the master is running or not.

Output Torque Command - Port outputs the master's present operating frequency. If the master is not running all followers will be stopped

Note: Power must be cycled on the drive for any change in F825 or F826 to take effect

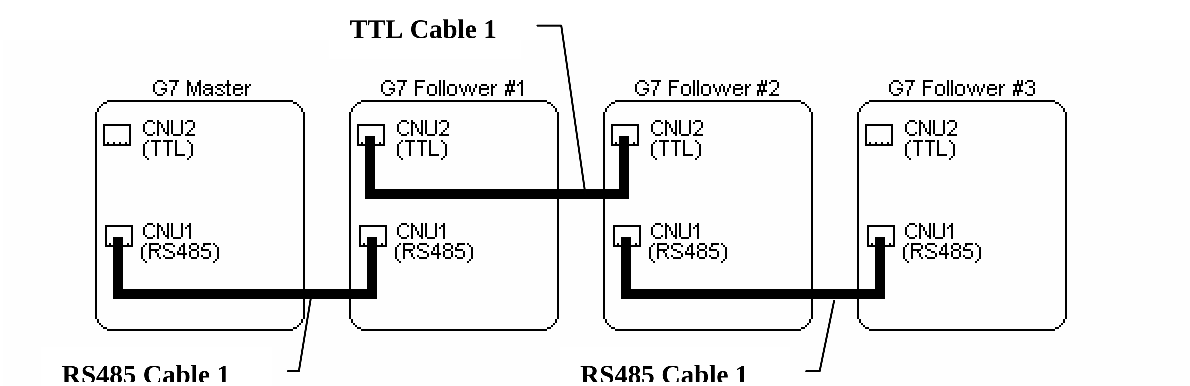
Note: faulting the master drive will prevent the port from outputting a signal

A note on Command Mode Selection: Both the master and follower drive may make use of any Command Mode Selection except "Use RS485/232".

2.) Daisy Chain Option

In daisy chaining, each drive receives an input into either its TTL or RS232/485 port and then outputs a command from the opposite port. This requirement means that drives other than the primary master and the last follower in the series will be unable to utilize their keypads.

Cabling



This arrangement makes use of an RS485 crossover cable (RS48 Cable 1) between the master/even numbered followers and subsequent odd numbered followers; and a TTL crossover cable (TTL Cable 1) between odd numbered followers and subsequent even numbered followers.

Programming

Parameter		Direct Access	New Value
Primary Master	RS485/232 Master Output Selection*	F826	**
RS485 Follower	Frequency Mode #1	F004	Use RS485/232
	TTL Master Output*	F806	**
TTL Follower	Frequency Mode #1	F004	Use Common (TTL)
	RS485/232 Master Output Selection*	F826	**

*Caution: Both the RS485 port (CNU1) and the TTL port (CNU2) on the G7 control board may be programmed to output. Programming both ports to output at the same time will effectively lock out keypad control and programming.
No Slave - Port remains an input port
Frequency Reference - Port outputs the master's present frequency reference, regardless of whether the master is running or not.
Output Command Frequency - Port outputs the master's present operating frequency. If the master is not running all followers will be stopped
Torque Command - Port outputs the master's present torque reference, regardless of whether the master is running or not.
Output Torque Command - Port outputs the master's present operating frequency. If the master is not running all followers will be stopped
Note: Power must be cycled on the drive for any change in F825 or F826 to take effect
Note: faulting the master drive will prevent the port from outputting a signal

A note on Command Mode Selection: Both the master and follower drive may make use of any Command Mode Selection except "Use RS485/232".

One thing to keep in mind with this arrangement is that each follower drive is then a master drive for the next follower down the line. The follower drive will receive it's frequency command either through the TTL port or the RS485 port on the control board. The same follower drive will then output a frequency command on the port that is not being used for input frequency.

Since both ports are being used either for Input or output, the keypad on the in cannot be used on the drives between the primary master and the last follower. This means that proper setup is important for successful operation of the followers.

Start with the last follower in the series and work back towards the primary master using the steps below and referencing the programming table above.

a.) Count the total number of drives (Master and Followers) in the series. If the total is even, go to step b if the total is odd, go to step c
b.) Program the drive as an RS485 Follower. If the next drive in the series is the Primary Master go to step f, otherwise go to step d.
c.) Program the drive as a TTL Follower, go to step e.
d.) Working backwards, connect the present drive to the next drive in the series using a RS485 cross-over cable (RS485 cable 1) plugged into port CNU1 on both drives. Program the drive as a TTL Follower. Give both drives a run command and check that the RS485 Follower follows the signal from the TTL Follower drive. Go to step E.
e.) Working backwards, connect the present drive to the next drive in the series using a TTL cross-over cable (TTL cable) plugged into port CNU2 on both drives. Program the drive as an RS485 Follower. Give both drives a run command and check that the TTL Follower follows the signal from the RS485 Follower drive. If the next drive in the series is the Primary Master go to step f, otherwise go to step d.
f.) Working backwards, connect the current drive to the Primary Master using an RS485 cross-over cable (RS485 Cable 1) plugged into port CNU2 on both drives. Program the drive as a Primary Master. Give all drives in the series a run command and adjust the frequency command of the Primary Master. Check the Keyboard on the last follower to verify that the frequency reference is being transmitted appropriately. Verify that all intermediate followers are running.

.If one of the drives in the series is not running:

Verify that the drive is receiving a run command either from the keypad, the terminal strip or via a communications card.

Check that the Drive is connected to the previous drive in the series.

Check the programming for the drive.

If all drives in the series after a particular drive are not running.

Verify that the first non-operational drive is receiving a run command either from the keypad, the terminal strip or via a communications card. Check all other drives in the series to verify that all drives in the series are receiving a run command.

Check that the Drive is connected to the previous drive in the series. Make sure that the proper ports are being used.

Check the programming for the drive. Note: If item F806 or F826 are programmed to Output Command Frequency and the drive is stopped, the frequency command will not be passed to other drives in the series.

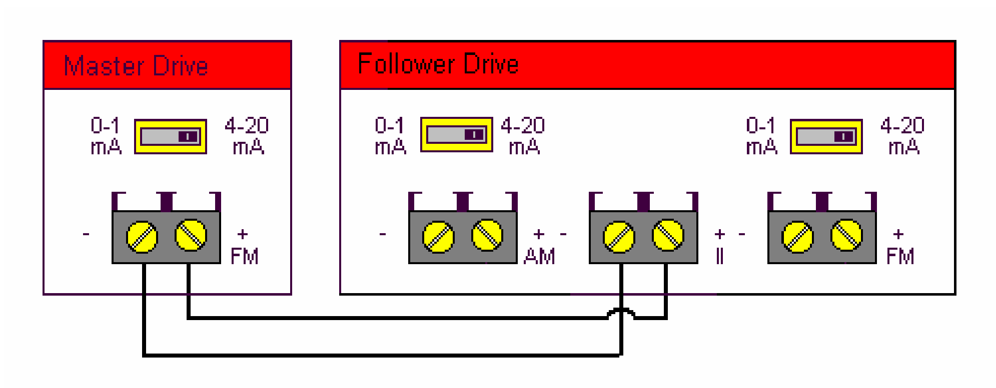
TOSHIBA

Master/Follower Using Analog Terminals

Introduction

There are several ways to configure two(or more) G7 drives to operate in master/follower mode. This application note will walk you through the steps necessary to configure a G7 drive for master/Follower follower operation using the FM analog output terminal on the master drive and the II analog input terminal on the follower.

Connections



Programming (Master Unit)

Direct Access	Parameter Path	Parameter Name	Comments
F005	Program→Meter Terminal Adjustment Parameters→FM	FM Terminal Assignment	Set to Output Frequency

Programming (Follower Unit)

Direct Access	Parameter Path	Parameter Name	Comments
F004	Program→Fundamental Parameters→ Standard Mode Selection	Frequency Mode #1	Set to Use VI/II

(46) Place the Master G7 in Local control mode
(47) Place the Follower G7 in Remote control mode
(48) Push Run button to start the Master drive
(49) Close F-CC to start the Follower drive
(50) Use the encoder dial to adjust frequency on Master drive
(51) The Mastger drive will ramp up to the set speed entered from the encoder dial
(52) The Follower drive will follow the Master drive speed

Basic Drooping

Introduction

Drooping is a torque based change in output frequency often used on applications where multiple motors are driving a common load to ensure all motors provide torque proportional to their abilities.

On Impact loads, drooping may be used to prevent overcurrent during impact by allowing the motor to ‘slip’ on a mechanically bound system.

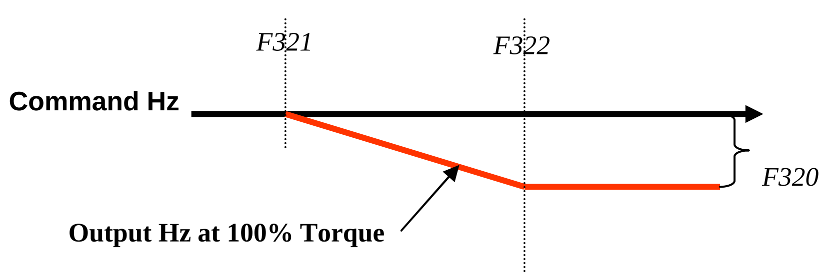
The G7 has eight parameters used to configure drooping. Four of the parameters interact to define and configure drooping while four parameters are used primarily for tuning and stability. The basic parameters used to configure drooping are:

F320 – Drooping Gain 100%
F321 – Speed at Drooping Gain 0%
F322 – Speed at Drooping Gain 100%
F323 – Drooping Insensitive Torque Band

F320 – Drooping Gain 100% -- configures the amount of droop (slip) at full motor torque based on the scaling provided by parameters F321 and F323. Droop is applied as a linear reduction of output frequency based on load. Ie – at 25% motor torque, the amount of frequency reduction will be 25% of the maximum droop available at a given frequency reference based on the settings of parameters F321 and F322.

F321-- Speed at Drooping Gain 0% -- F321 sets the frequency where the maximum amount of droop at full load (100% motor torque) is 0%. Droop becomes ineffective at and below the frequency specified in the parameter. Parameter F321 and F322 set the span and taper for drooping at 100% motor torque.

F322 -- Speed at Drooping Gain 100% -- sets the frequency where the maximum amount of droop at full load is 100% of the value specified in parameter F320. Droop above the frequency specified by parameter F322 is based on the value programmed in parameter F320. For example, if F320 is programmed for 10% and parameter F322 is set to 60Hz, from 60Hz and up, 100% droop is 6Hz.



As shown to the left, F320 sets the amount of droop at 100% motor torque at the frequency specified by parameter F322. F321 and F322 define a linear taper for drooping at 100% motor torque. If parameter F320 is 10%, Parameter F321 is 30Hz, and Parameter F322 is 60Hz, with a 60Hz command frequency droop at 100% motor torque is 6 Hz (10% of 60). With the same configuration and a command frequency of 45Hz, droop at 100% motor torque is 3Hz.

The droop at 100% motor torque when operating at and above the frequency programmed in F322 is calculated using the formula:

*100%Droop @ F322 = F320 * (F322 * 0.01)*

Example: F322 = 60 Hz
F320 = 5

100% Droop @ F322 = F320 * (F322 * 0.01)
= 5 * (60 * 0.01)
= 5 * 0.6
= 3 Hz

When operating between the frequencies programmed in F321 and F322, the droop at 100% motor torque tapers from a max value at F322 to 0% at the frequency of F321. The actual value may be calculated using the formula:

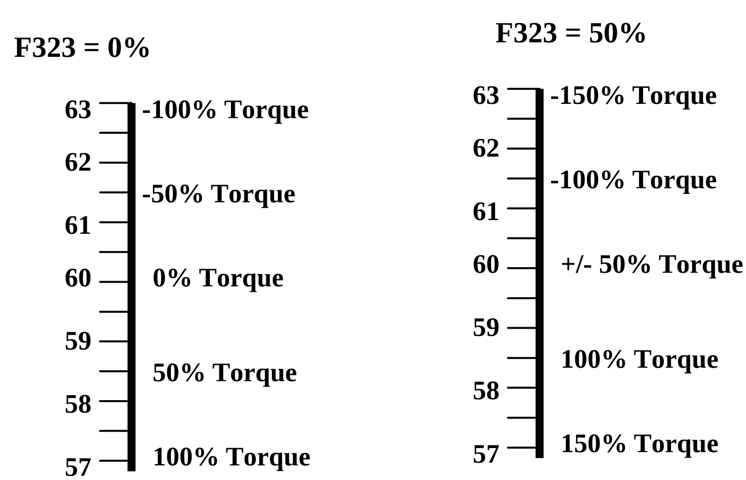
*100% Droop (between F321 and F322) = (F322 * (F320 * 0.01)) * (CmdHz – F321/(F322 – F321))*

Example: F322 = 60
F320 = 5
F321 = 30
CmdHz = 45

100% Droop (between F321 and F322) = (60 * (5 * 0.01)) * (45 – 30/(60 – 30))
= (3) * (15/30)
= 1.5Hz

F323 -- Drooping Insensitive Torque Range -- configures the lowest amount of motor torque on which to apply droop by the application of an offset in the amount of F323. With F323 programmed for 0.0, the percent droop matches the percent torque based on the configuration of parameters F230, 231, and 232. With F323 programmed for 50%, droop is not calculated until the motor output torque reaches 50% motor torque and is offset by this amount throughout the range.

As shown in the chart to the right, the drooping insensitive band is in effect for both positive torque and negative torque.



The programming in the following table sets up 3% slip from 10 to 60 Hz with a 25% deadband.

Programming

Parameter	How to get there	New Value
F320 Drooping Gain 100%	Program→Feedback Parameter→ Drooping Control	3%
F321 Speed at Drooping Gain 0%	Program→Feedback Parameter→ Drooping Control	10.0 Hz
F322 Speed at Drooping Gain 100%	Program→Feedback Parameter→ Drooping Control	60.0 Hz
F323 Drooping Insensitive Torque Band	Program→Feedback Parameter→ Drooping Control	25.0%

If instabilities occur as a result of drooping, refer to the document/application note titled 'Drooping (advanced)' which covers items such as droop filtering, load inertia, and drooping references.

Remote Mount EOI

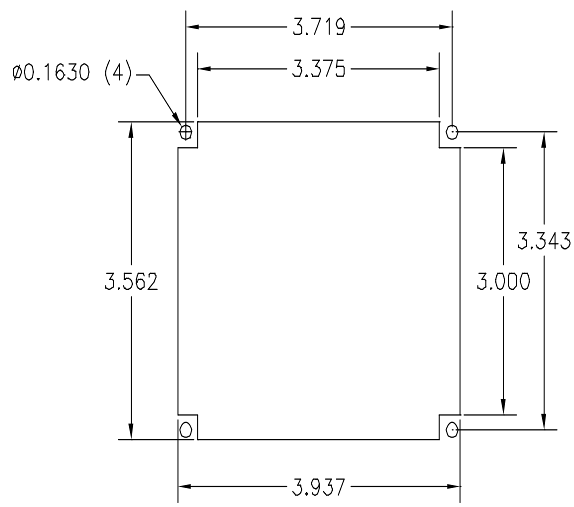
Electronic Operator Interface

Introduction

This G7 Electronic Operator Interface (EOI) can be mounted remotely from the unit. This guideline provides the information for mounting the EOI properly to avoid damage to your interface. The mounting screw length is most critical in remote mounting the EOI. You may cause deformation of the outer surface of the bezel if the screws used are too long. The interface can operate safely up to distances of 15 feet via the TTL Port. For distances beyond 15 feet, it is recommended to use the RS-485 Port.

EOI

Mounting dimensions (in.)



Mounting Instructions

<u>Parts Required</u>

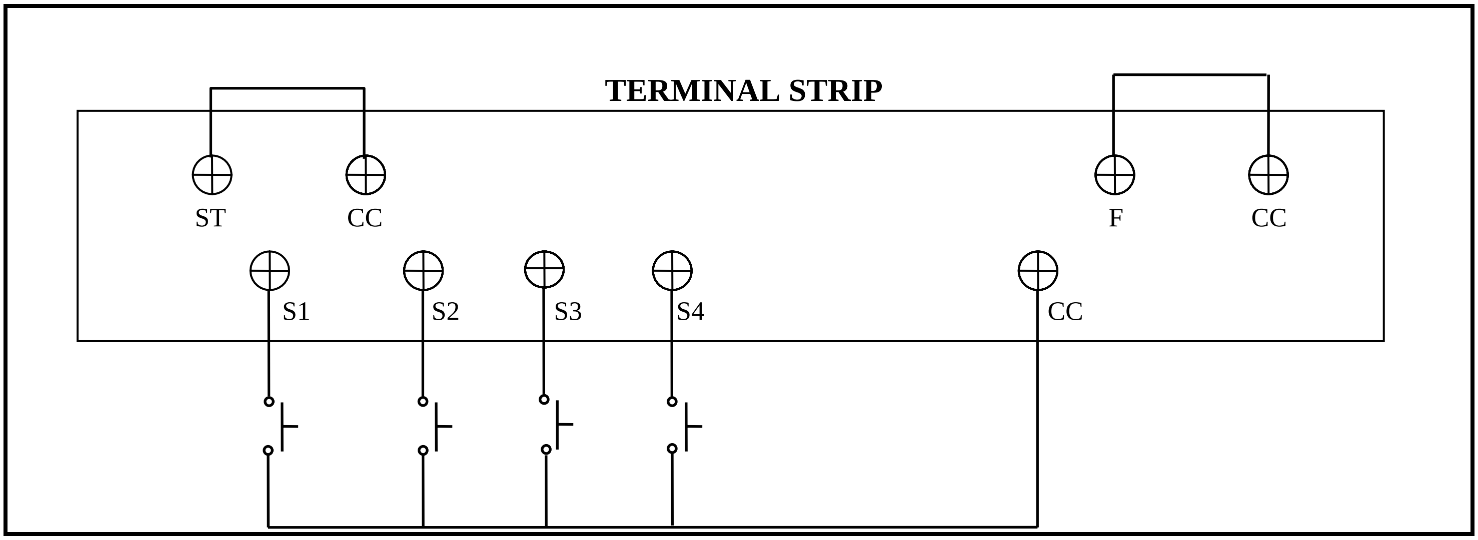
- 6-32 x 5/16 Long Pan Screw (Qty. 4 each)
- #6 Split Lock Washer (Qty. 4 each)
- #6 Flat Washer (Qty. 4 each)
- 1 of the following cables
  CAB0011-0 (1 meter option connection cable)
  CAB0013-0 (3 meter option connection cable)
  CAB0015-0 (5 meter option connection cable)

Preset Speeds

Introduction

Among the many speed references the G7 can accept are dry contact closures which it can be programmed to interpret as preset speeds. A maximum of fifteen preset speeds can be accessed via four terminals and a binary implementation. The following example will program all 3 preset speeds from 5 Hz for Preset Speed 1, 25Hz (Reverse) for Preset Speed 2, and to 45 Hz for Preset Speed 3.

Connections



Preset	S4 MSB	S3	S2	S1 LSB	Output
1	0	0	0	1	F018
2	0	0	1	0	F019
3	0	0	1	1	F020
4	0	1	0	0	F021
5	0	1	0	1	F022
6	0	1	1	0	F023
7	0	1	1	1	F024
8	1	0	0	0	F287
9	1	0	0	1	F288
10	1	0	1	0	F289
11	1	0	1	1	F290
12	1	1	0	0	F291
13	1	1	0	1	F292
14	1	1	1	0	F293
15	1	1	1	1	F294
Note: 1 = Terminal connected to CC.					

Preset speed selected as function of input contact condition

S4-CC (8)	S3-CC (4)	S2-CC (2)	S1-CC (1)	Preset Speed
closed	open	open	closed	5Hz (Forward)
closed	open	open	closed	25Hz (Reverse)
closed	open	closed	closed	45 (Forward)
				N/A

Direct Access	Parameter Path	Parameter Name	Comments
F018	Program➔Pattern Run Controls➔Preset Speeds➔1	#1 Frequency & Characteristics	Set to 5Hz, Forward, ACC/DEC: 1
F500	Program➔Fundamental Parameters➔Accel/Decel #1 Settings	Accel /Decel #1	Set to 45 secs each
F115	Program➔Terminal Selection Parameters➔Input Terminals➔S1	Terminal S1	Set to 5:Preset Speed Command 1
F019	Program➔Pattern Run Controls➔Preset Speeds➔2	#2 Frequency & Characteristics	Set to 25Hz, Reverse, ACC/DEC: 2
F500	Program➔Fundamental Parameters➔Accel/Decel #2 Settings	Accel /Decel #2	Set to 10 secs each
F116	Program➔Terminal Selection Parameters➔Input Terminals➔S2	Terminal S2	Set to 6:Preset Speed Command 2
F020	Program➔Pattern Run Controls➔Preset Speeds➔3	#3 Frequency & Characteristics	Set to 45Hz, Forward, ACC/DEC: 1
F500	Program➔Fundamental Parameters➔Accel/Decel #1 Settings	Accel /Decel #1	Set to 45 secs each
F117	Program➔Terminal Selection Parameters➔Input Terminals➔S3	Terminal S3	Set to 7:Preset Speed Command 3
F380	Program➔Frequency Setting Parameters➔Preset Speed Mode➔Use Speed Modes	Use Speed Mode	Set to Use speed modes by putting a mark in the box