**EMERSON.**
Industrial Automation

This Application Note is pertinent to the Unidrive Classic, Unidrive SP, Commander GP20 and Commander SK Families

AC Motor Condensation Elimination
Anti-Windmilling Technique

Background

The AC Induction motor is known for its inherent ruggedness and relative disregard for moisture as compared with DC brush motors. In areas of high humidity, internal condensation can build-up which can result in undesirable internal rusting/corrosion and in some extreme cases where frigid temperatures exist, ice formations could result which could impede operation. However, a more important consideration today with high frequency PWM drive outputs, is the possibility of spurious tripping upon starts after long periods of being off. Internal moisture can settle on critical areas having the effect of lowering the overall dielectric strength of internal insulated areas that can result in overcurrent tripping due to high-voltage breakdown. Unfortunately, this may occur when you need the motor the most, after being off for a period of time.

There are some products on the market that can be applied to keep a nominal amount of current flowing through *one* of the motors stator phases during long idle periods that will heat the internal windings enough to reduce condensation damage. This equipment typically requires a switched isolating contactor such as a motor starter.
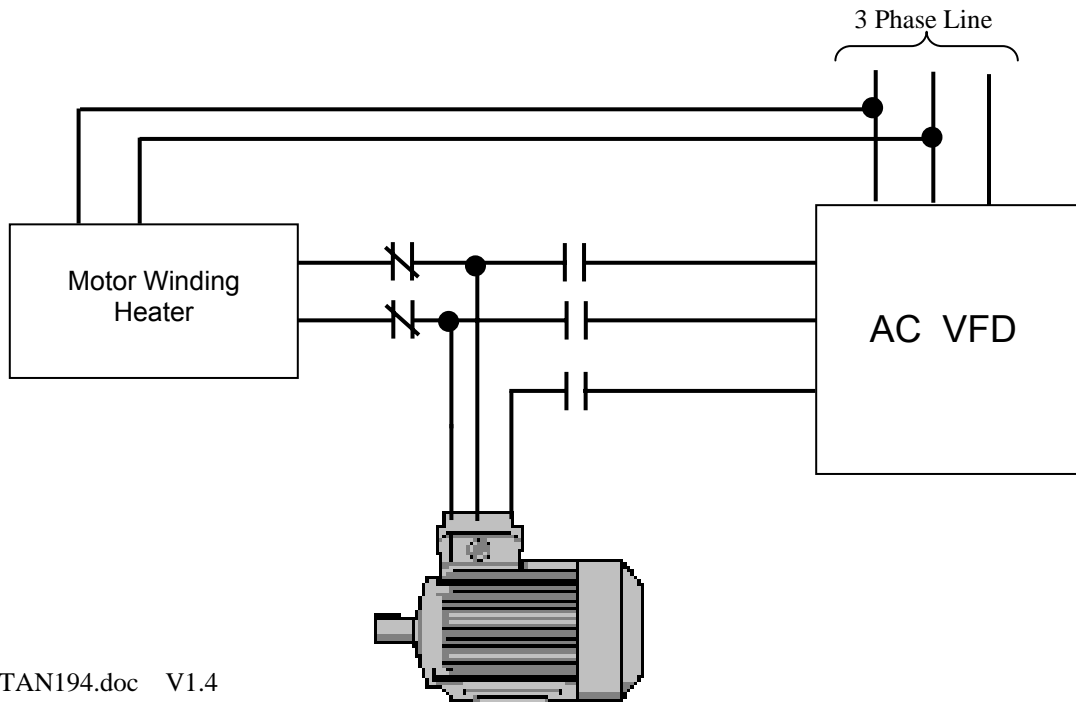
Using such a device, the power system needs to be sequenced such that when the VFD is off, output contactor switches over to excite 1 phase of the motor. Besides needing this external contactor and sequencing logic, mounting/installation costs, the cost of the Motor Winding Heater can be a rather expensive solution.
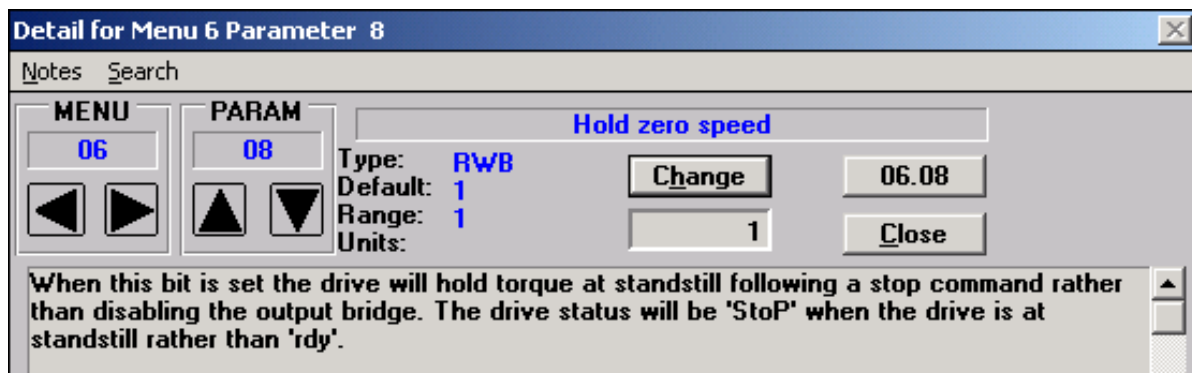
This application note advocates a more elegant solution by accomplishing the same goal but eliminating the need for these costly external power components.

Implementation

Normally when one commands a drive to Stop the drive will decelerate or let the motor coast and then turn off the output transistor stage. Our drives have a built-in feature, namely **Hold Zero Speed**, whereby , after a commanded Stop, the output stage can remain active which typically is used to keep the motor shaft from rotating- the display will indicate **StoP**.

Often in the case of cooling tower blowers or similar applications where there are forces that can cause the motor to rotate when the drive is not actively running a commanded speed, this function is available to keep the motor still-(Anti-Windmilling). However, a side benefit of this feature is that it will keep the motor warm thereby preventing moisture condensation and even ice build up on the motor housing during long quiescent periods. The generated output would be exciting all 3 motor phases with a standby current thereby providing a more symmetrical current flow and evenly distributed heating within the motor stator coil versus the external Motor Heater which only excites 1 phase.

Parameter #6.08, named Hold Zero Speed, is described as follows:

Detail for Menu 6 Parameter 8

Notes Search

MENU: 06 PARAM: 08

Type: RWB
Default: 1
Range: 1
Units:

Hold zero speed

Change   06.08
1   Close

When this bit is set the drive will hold torque at standstill following a stop command rather than disabling the output bridge. The drive status will be 'StoP' when the drive is at standstill rather than 'rdy'.

OPEN LOOP MODE

In the Open Loop- V/Hz (Fd or SrE) Mode of operation (applications without encoder – non-Vector applications), this Holding Torque (and Winding Heating amount) can be adjustable by the Voltage Boost parameter #5.15. This parameter can be adjusted to place up to 25% of the motors rated voltage to create the required holdback standstill torque (and/or Winding Heating amount).

The Voltage Boost is typically adjusted to help provide the necessary motor breakaway torque when starting from zero speed when operating in the common V/Hz Open Loop modes. Typically, this amounts to 1-3%. For sufficient Holdback Standstill torque or for the creation of heat, you may require a little more. This would be too much for normal starting however. So we need a method of switching to a higher Boost amount during the Stop condition but fall back to the normal starting Boost amount when the drive is commanded to run.

Implementation with Commander GP20, Unidrive SP, Commander SK

The following setup will work with Voltage Mode settings of Fd (Fixed Boost-V/Hz) or SrE (Square Law Voltage) selection. The voltage mode is #5.15 in Open Loop drives (parameter 0.07 except in Commander SK where it is 0.41).

This next bit of logic utilizes the built-in AND gate function in Menu 9.   What we want is that when the **Drive IS NOT IN RUN** and **AT ZERO SPEED** we want to select a higher Voltage Boost amount. When we go into RUN we want to revert back to our lower starting boost amount (if any is required).

Logic Function 1
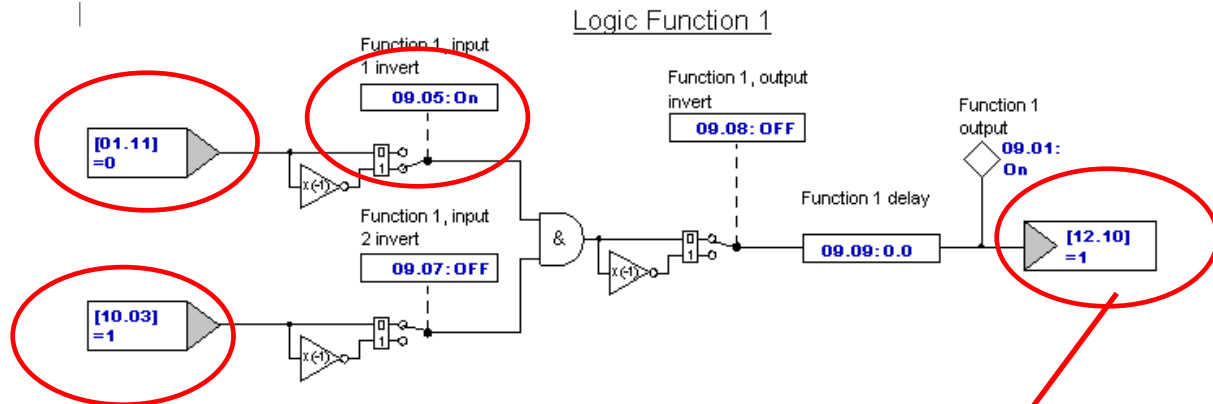
We will use this conditional bit to select between two different values for the Voltage Boost amount.   When #12.10=0 we will be setting the Start Boost amount if required. An when #12.10=1 the heating or hold back torque for "anti-windmilling" will be applied.

Variable selector 1

Being sent to #5.15 Voltage Boost Amount
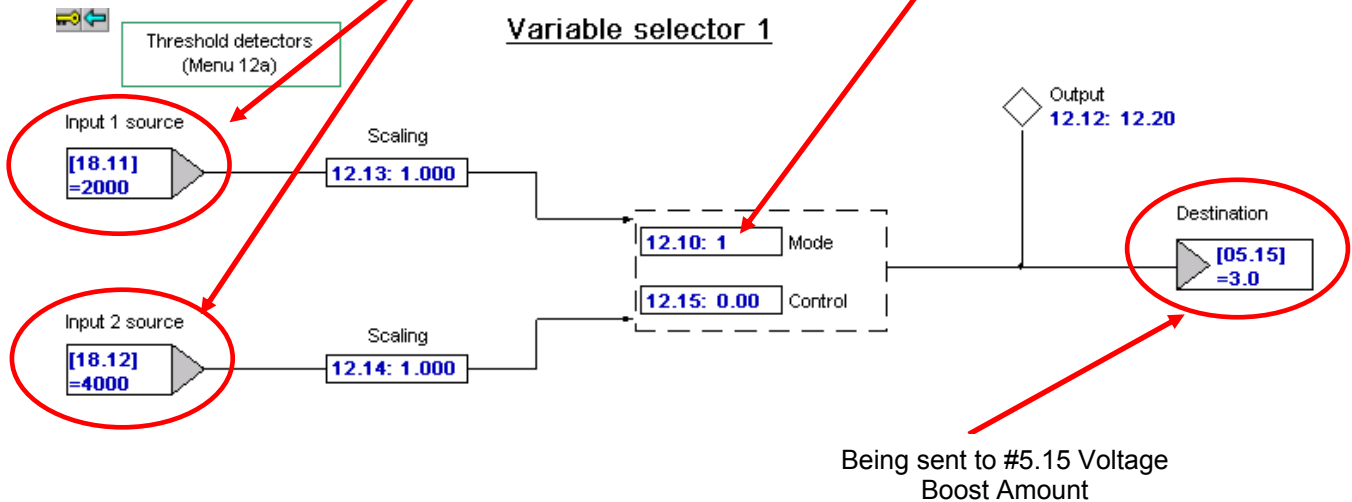
Note: A Drive Reset must be performed for Source & Destination assignments to take effect.

Registers #18.11 and #18.12 are merely holding registers for these two adjustable values. They are scaled as follows:

Boost Settings

Holding Torque/Warming Amount

The Warming/ Holding Torque Amount setting in this example is #18.12. Menu 18 parameters range from 0 to 32767 which represents 100%. After being directed to #5.15 that will be translated to the maximum of that register which will demand 25% boost. This represents 25% motor voltage. So for a boost value of 1.5- 3% (or approximately 7-14v w/460vac motor) , this would be :

$$1.5/25 \approx 0.06 \text{ of the full boost amount } x32000 \approx 2000 \ (1.5\%)$$
$$3/25 \approx 0.12 \text{ of the full boost amount } x32000 \approx 4000 \ (3\%)$$

Keep in mind that on larger motors the stator resistance is quite low.   For example, a 100HP (115FLA) motor may have a stator resistance of about 0.25ohms. With 3% boost or 14v, that would cause about 55A which is 50% of the motor current rating. One should start out with #18.12 low and gradually take it up while monitoring the active current (#4.01) and stay below 25-40% current typically while the Drive is Stopped.

Normal Starting Boost

The normal starting boost amount with this configuration is set by parameter #18.11 which should normally be set around 0.5-1%. This would be calculated as follows:

$$0.5/25 \approx 0.02 \text{ of the full boost amount } x \ 32000 \approx 640 \approx 0.5\%$$
$$1/25 \ \approx 0.04 \text{ of the full boost amount } x \ 32000 \ \approx 1300 \approx 1\%$$

Lower HP motors can tolerate more boost because their stator resistance is higher.

If #18.11 is set too high, it can result in **OI.AC** trips (overcurrent trips) upon start or can cause stator saturation which can also result in the motor not starting.

Setting Boost Too High

If #18.12 is set too high, besides causing the motor to run warmer during the **StoP** condition, it can cause **It.AC** trips (I x t   or Timed Overcurrent trips), which occurs in order to protect the motor from excessive currents. This will be indicated by the display flashing OVLD then eventually the drive will trip indicating **It.AC .**   One could start out with #18.12 low and gradually take it up while monitoring one of the output motor leg currents with an AC clamp-on ammeter and stay below 20-30% current typically.

If #18.11 and 12 is set too high, it can result in **OI.AC** trips (overcurrent trips) upon start or can cause stator saturation which can also result in the motor not starting.

Note:

When this mode is activated, a warning placard may be warranted at the VFD and motor,   that voltage is present when the motor is stopped !

Configuration Setup Summary for
Commander GP20 or Unidrive SP, Commander SK

Open Loop – V/Hz Mode - Voltage Mode= *Fd* or *SrE*

Parameter	Value	Description
#5.14	Fd or SrE	Fixed Boost Mode
#9.04	1.11	Drive Run Command
#9.06	10.03	At Zero Speed/Frequency Reference
#9.05	1	Invert
#9.07	0	Non-Invert
#9.10	12.10	AND Gate result ->Variable Selector #1 Mode
#12.08	18.11	Holding Register for Start Boost Amount
#12.09	18.12	Holding Register for Heating/Hold Torque Boost Amount
#12.11	5.15	Send selected boost amount to #5.15
#18.11	As Req'd *	Starting Torque Boost Full Value= 32000=25% Boost
#18.12	As Req'd *	Heating/Holding Torque Amnt Full Value= 32000=25% Boost
#6.08	1	Activate the Hold Mode (see page 2 description)

*   See Calculations on previous page

After entering parameters perform a Store.

Note: The screen shots on the previous pages were taken directly from CTSoft- the software configuration tool for our drives. This program is free and available from our website to help facilitate set and monitoring of drive activity.

CTSoft   Free

Unidrive Classic Implementation

The following configuration setup takes advantage of several of the standard built-in features within the Unidrive- specifically one of the 2 programmable logic gates is employed and we will use the free PID loop to accomplish switching the Voltage Boost between 2 levels based on whether we are stopped or not.

Configuration Setup Summary

Open Loop – V/Hz Mode

Parameter	Value	Description
#5.14	Fd - 3	Fixed Boost Mode
#9.04	10.03	At Zero Speed/Frequency Reference
#9.06	1.11	Drive Stop Command
#9.07	1	Invert
#9.08	1	Invert
#9.10	14.05	PID Ref Inverter
#14.03	18.11	Dummy excitation for PID
#14.08	1	Enable PID
#14.10	1	Proportional Gain
#14.11	0	Integral Gain
#14.13	6-10	Holding Torque/Warming Amount - 1.5 - 2.5%
#14.14	2-4	Normal Starting Boost Amount - 0.5% - 1%
#14.16	5.15	Destination – Boost Parameter
#18.11	32000	Full Value
#6.08	1	Activate the Hold Mode

After entering parameters perform a Store.

Boost Settings

Holding Torque/Warming Amount

The Holding Torque/Warming Amount setting #14.13, can be 100 which will demand 25% boost at maximum. This represents 25% motor voltage.   So for a boost value of 1.5-2.5% (or approximately 7-12v w/460vac motor) , this would be :

> 1.5/25 = 6% of the full boost amount (1.5%)
> 2.5/25 = 10% of the full boost amount (2.5%)

Keep in mind that on larger motors the stator resistance is quite low.   For example, a 100HP (115FLA) motor may have a stator resistance of about 0.25ohms. With 3% boost or 14v, that would cause about 55A which is 50% of the motor current rating. One should start out with #14.13 low and gradually take it up while monitoring the active current (#4.02) and stay below 25-40% current typically while the Drive is Stopped.

<u>Normal Starting Boost</u>

The normal starting boost amount with this configuration is set by parameter #14.14 which should normally be set around 0.5-1%. This would be calculated as follows:

$$0.5/25 = 2\% \text{ of the full boost amount} = 0.5\%$$
$$1/25 = 4\% \text{ of the full boost amount} = 1\%$$

Lower HP motors can tolerate more boost because their stator resistance is higher.

If #14.14 is set too high, it can result in **OI.AC** trips (overcurrent trips) upon start or can cause stator saturation which can also result in the motor not starting.

Setting Boost Too High

 If #14.13 is set too high, besides causing the motor to run warmer during the StoP condition, it can cause **It.AC** trips (I x t or Timed Overcurrent trips), which occurs in order to protect the motor from excessive currents. This will be indicated by the display flashing OVLD then eventually the drive will trip indicating **It.AC .** One could start out with #14.13 low and gradually take it up while monitoring one of the output motor leg currents with an AC clamp-on ammeter and stay below 20-30% current typically.

If #14.14 is set too high, it can result in **OI.AC** trips (overcurrent trips) upon start or can cause stator saturation which can also result in the motor not starting.

<u>Note</u>:

When this mode is activated, a warning placard may be warranted at the VFD and motor, that voltage is present when the motor is stopped !

Questions ?? Ask the Author:

<u>Author</u>:   **Ray McGranor**   **e-mail :** ray.mcgranor@emerson.com
                  (716)-774-0093