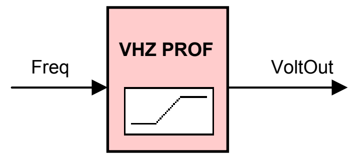
V_Hz_PROFILE	***Volt/Hertz Profile for AC Induction Motor***

Description

This module generates an output command voltage for a specific input command frequency according to the specified volts/hertz profile. This is used for variable speed implementation of AC induction motor drives.



Availability

This IQ module is available in one interface format:

1) The C interface version

Module Properties

Type: Target Independent, Application Dependent

Target Devices: 28x Fixed Point or Piccolo

C Version File Names: vhzprof.h

IQmath library files for C: IQmathLib.h, IQmath.lib

C Interface

Object Definition

The structure of VHZPROF object is defined by following structure definition

```
typedef struct   { _iq  Freq;          // Input: Input Frequency
                   _iq  VoltOut;       // Output: Output voltage
                   _iq  LowFreq;       // Parameter: Low Frequency
                   _iq  HighFreq;      // Parameter: High Frequency at rated voltage
                   _iq  FreqMax;       // Parameter: Maximum Frequency
                   _iq  VoltMax;       // Parameter: Rated voltage
                   _iq  VoltMin;       // Parameter: Voltage at low Frequency range
                 } VHZPROF;

typedef VHZPROF *VHZPROF_handle;
```

Item	Name	Description	Format*	Range(Hex)
Inputs	Freq	Input Frequency	GLOBAL_Q	80000000-7FFFFFFF
Outputs	VoltOut	Output voltage	GLOBAL_Q	80000000-7FFFFFFF
VHZPROF parameter	LowFreq	Low Frequency	GLOBAL_Q	80000000-7FFFFFFF
	HighFreq	High Frequency at rated voltage	GLOBAL_Q	80000000-7FFFFFFF
	FreqMax	Maximum Frequency	GLOBAL_Q	80000000-7FFFFFFF
	VoltMax	Rated voltage	GLOBAL_Q	80000000-7FFFFFFF
	VoltMin	Voltage at low Frequency range	GLOBAL_Q	80000000-7FFFFFFF

*GLOBAL_Q valued between 1 and 30 is defined in the IQmathLib.h header file.

Special Constants and Data types

VHZPROF
The module definition is created as a data type. This makes it convenient to instance an interface to volt/hertz profile. To create multiple instances of the module simply declare variables of type VHZPROF.

VHZPROF_handle
User defined Data type of pointer to VHZPROF module.

VHZPROF_DEFAULTS
Structure symbolic constant to initialize VHZPROF module. This provides the initial values to the terminal variables as well as method pointers.

Methods

VHZ_PROF_MACRO(VHZPROF_handle);

This definition implements one method viz., the volt/hertz profile computation macro. The input argument to this macro is the module handle.

Module Usage

Instantiation
The following example instances two VHZPROF objects
VHZPROF vhz1, vhz2;

Initialization
To Instance pre-initialized objects
VHZPROF vhz1 = VHZPROF_DEFAULTS;
VHZPROF vhz2 = VHZPROF_DEFAULTS;

Invoking the computation macro
VHZ_PROF_MACRO(vhz1);
VHZ_PROF_MACRO(vhz2);

Example
The following pseudo code provides the information about the module usage.

```
main()
{

}

void interrupt periodic_interrupt_isr()
{
        vhz1.Freq = Freq1;                   // Pass inputs to vhz1
        vhz2.Freq = Freq2;                   // Pass inputs to vhz2

        VHZ_PROF_MACRO(vhz1);                        // Call compute macro for vhz1
        VHZ_PROF_MACRO(vhz2);                        // Call compute macro for vhz2

        VoltOut1 = vhz1.VoltOut;             // Access the outputs of vhz1
        VoltOut2 = vhz2.VoltOut;             // Access the outputs of vhz2
}
```

Technical Background

If the voltage applied to a three phase AC Induction motor is sinusoidal, then by neglecting the small voltage drop across the stator resistor, we have, at steady state,

$$\hat{V} \approx j\omega \, \hat{\Lambda}$$

i.e.

$$V \approx \omega \, \Lambda$$

where $\hat{V}$ and $\hat{\Lambda}$ are the phasor representations of stator voltage and stator flux, and V and Λ are their magnitude, respectively. Thus, we get

$$\Lambda \approx \frac{V}{\omega} = \frac{1}{2\pi} \frac{V}{f}$$

From the last equation, it follows that if the ratio V/f remains constant for any change in f, then flux remains constant and the torque becomes independent of the supply frequency. In actual implementation, the ratio of the magnitude to frequency is usually based on the rated values of these parameters, i.e., the motor rated parameters. However, when the frequency, and hence the voltage, is low, the voltage drop across the stator resistor cannot be neglected and must be compensated for. At frequencies higher than the rated value, maintaining constant V/Hz means exceeding rated stator voltage and thereby causing the possibility of insulation break down. To avoid this, constant V/Hz principle is also violated at such frequencies. This principle is illustrated in Figure 1.

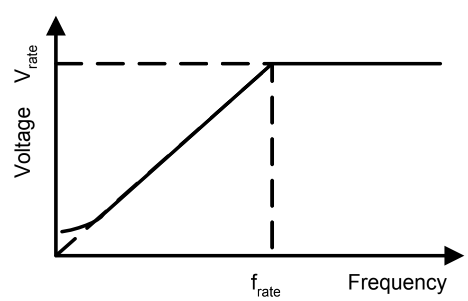


Figure 1: Voltage versus frequency under the constant V/Hz principle

Since the stator flux is maintained constant (independent of the change in supply frequency), the torque developed depends only on the slip speed. This is shown in Figure 2. So by regulating the slip speed, the torque and speed of an AC Induction motor can be controlled with the constant V/Hz principle.

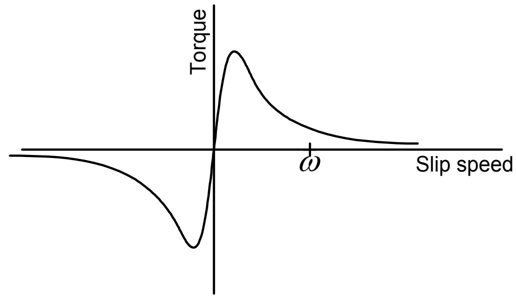


Figure 2: Torque versus slip speed of an induction motor with constant stator flux

Both open and closed-loop control of the speed of an AC induction motor can be implemented based on the constant V/Hz principle. Open-loop speed control is used when accuracy in speed response is not a concern such as in HVAC (heating, ventilation and air conditioning), fan or blower applications. In this case, the supply frequency is determined based on the desired speed and the assumption that the motor will roughly follow its synchronous speed. The error in speed resulted from slip of the motor is considered acceptable.

In this implementation, the profile in Figure 1 is modified by imposing a lower limit on frequency. This is shown in Figure 3. This approach is acceptable to applications such as fan and blower drives where the speed response at low end is not critical. Since the rated voltage, which is also the maximum voltage, is applied to the motor at rated frequency, only the rated minimum and maximum frequency information is needed to implement the profile.

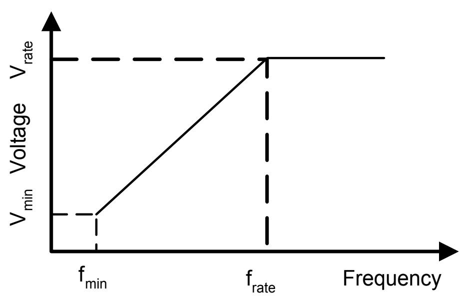


Figure 3: Modified V/Hz profile

The command frequency is allowed to go below the minimum frequency, $f_{min,}$ with the output voltage saturating at a minimum value, $V_{\min}$. Also, when the command frequency is higher than the maximum frequency, f_{max}, the output voltage is saturated at a maximum value, V_{max}.