In this study, a state-space representation of a motor drive inverter is obtained. the circuit diagram is as follows:



The model has a three-phase RL load, an inverter with a single DC bus capacitor and without parasitics, and a simple DC bus input model with a controllable DC supply. the parameter classification is as follows:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Type** | **Description** |
| Vin | Input | It is a controlled variable. Harmonics (such as 300 Hz may be injected). |
| Iin | State | This parameter is treated as a state since the harmonic content to the input side is unknown at this point. |
| Rin, Lin | Constant | These are modeling the parasitics between the source and inverter. Values of these parameters are unknown. |
| Vdc | State | This is obviously a state parameter, ripple content of which is to be kept at acceptable levels. |
| Idc | Mid-state | This parameter can be represented in terms of phase currents (which are states). Therefore, it is treated as a mid-state variable. |
| Cdc | Constant | Parameter is known. |
| Ic | Mid-state | This parameter can be represented in terms of DC bus voltage (which is state). Therefore, it is treated as a mid-state variable. |
| SA, SB, SC | Constant | These are the switching states. They are controlled by the user, and can be treated as constants. n’s are inverter switching states. |
| Vca, Vcb, Vcc | Mid-state | These parameters can be represented in terms of DC bus voltage (which is state). Therefore, they are treated as a mid-state variable. They represent the voltage between each phase and neutral. |
| Isa, Isb, Isc | State | Phase currents are state parameters. |
| RA, RB, RC, LA, LB, LC | Constant | Parameters are known. They can be used for unbalanced cases. |

SA, SB and SC depend on the switching method. A model without switching harmonics shown in (1) - (3), for Sinusoidal PWM, where *ma* is the modulation index, *ω0* is the fundamental frequency and *δ* is the load angle.

|  |  |
| --- | --- |
|  | (1) |
|  | (2) |
|  | (3) |

Since this model does not include switching harmonics, and it is time consuming to obtain such a model, switching states will be obtained using a carrier signal for the time being.

Vin has the characteristics shown in (4) to represent a constant DC voltage source (*Vdcin*) with a rectifier, where *V6th* is the peak voltage of sixth harmonic, *ωr0* is the fundamental frequency and *φr0* is the fundamental phase of rectifier.

|  |  |
| --- | --- |
|  | (4) |

We have the inverter output voltages in terms of DC bus voltage and phase currents as in (5) - (7).

|  |  |
| --- | --- |
|  | (5) |
|  | (6) |
|  | (7) |

The DC bus current can also be represented by phase currents as in (8). On the DC bus, the input current flows through capacitor and inverter as shown in (9). Finally, the DC bus voltage can be related to capacitor current as in (10).

|  |  |
| --- | --- |
|  | (8) |
|  | (9) |
|  | (10) |

On the input side, the voltage drop equation is shown in (11) to relate the input current and voltage.

|  |  |
| --- | --- |
|  | (11) |

Now, from (5) – (7), we have the state equations of phase currents, by eliminating *Vca, Vcb and Vcc*, as in (12) – (14).

|  |  |
| --- | --- |
|  | (12) |
|  | (13) |
|  | (14) |

From (8) – (10), we have the state equation of DC bus voltage, by eliminating *Idc and Ic*, as in (15).

|  |  |
| --- | --- |
|  | (15) |

And from (11), the input current state equation can be rearranged as in (16).

|  |  |
| --- | --- |
|  | (16) |

The state space representation of this model in the form of is shown in (17).

|  |  |
| --- | --- |
|  | (17) |