Unitronics Motion

Braking Resistor Calculation

1. Braking Resistor

User have to choose different resistance and power ratings based on the real application needs, the brake resistance cannot be less than the minimum brake resistance defined by the manufacturer.

The braking resistor should be selected based on motor power ratings, and will vary according to the system inertia, deceleration time and load potential energy. The greater inertia is, the shorter deceleration time is, the bigger brake duty ratio is, the bigger power rating and smaller resistance should be.

In cases of *"Peak Braking Power"* (P_b) is higher than the VFD rated power or the braking duty ratio is higher than 10%, external braking resistor is required.

The resistor *ohmic* value must be above the VFD *"min braking resistor ohmic value"* as shown in the **Model Brake Data** table.

2. Calculation Required Information

- Power rating of the motor (watts)
- Motor speed rating (rpm)
- Deceleration time required by the application
- Motor and load inertia ($kg \times m^2$)
- Gear Ratio

3. Definitions

- $\omega_{b-Rated\ angular\ rotation\ speed\ (^{rad}/_{sec})}$
- $\omega_{o-Final\ angular\ rotation\ speed\ (^{rad}/_{sec})\ after\ deceleartion,\ \ can\ be\ zero}$
- $\omega = \frac{2\pi N}{60}\left(^{rad}/_{sec}\right)$
- $N_{-\ Motor\ shaft\ speed\ (rpm)}$
- $GM_{-\ Gear\ Ratio,dimention\ less\ (1:2\ is\ 0.5)}$
- $J_{-\ inertia\ (kg \times m^2)}$
- $t_{-\ deceleration\ time\ from\ \omega_t\ to\ \omega_o\ (sec)}$
- $D_{-\ brake\ duty\ ratio,\ \ the\ brake\ time\ out\ of\ the\ total\ cycle\ time\ (\%)}$

4. Unit conversions

- $1\ (lb \times ft) = 1.355818\ (N \times m)$
- $1\ (HP) = 746\ (watts)$

5. VFD DC Bus Voltage

Input Voltage (V)	DC Bus Voltage (V)
220	310
400	560
480	670

6. Typical applications brake duty ratio

Application	Percentage
Elevator	15%
Oil Pump	15%
Winding	55%
Centrifuge	15%
Tower Crane	30%
Others	10%

7. Calculations Formulas

1. Total Inertia: $J_T = J_{motor} + (GM^2 \times J_{load})$
2. Peak Braking Power: $P_b = \frac{J_T[\omega_b(\omega_b - \omega_o)]}{t}$
3. Braking Resistor Resistance: $R = \frac{{V_{DC}}^2}{P_b}$
4. Recommended Braking Resistor Power: $P_R = \frac{P_b \times D}{0.7}$

8. Model Brake Data

Model	Braking resistor at 100% of braking torque (Ω)	Consumed power of the braking resistor (kW)			Min. braking resistor (Ω)
		10% braking	50% braking	80% braking	
UMI-0004BE-B1	361	0.06	0.30	0.48	42
UMI-0007BE-B1	192	0.11	0.56	0.90	42
UMI-0015BE-B1	96	0.23	1.10	1.80	30
UMI-0022BE-B1	65	0.33	1.70	2.64	21
UMI-0007EE-B1	653	0.11	0.56	0.90	240
UMI-0015EE-B1	326	0.23	1.13	1.80	170
UMI-0022EE-B1	222	0.33	1.65	2.64	130
UMI-0040EE-B1	122	0.6	3	4.8	80
UMI-0055EE-B1	89.1	0.75	4.13	6.6	60
UMI-0075EE-B1	65.3	1.13	5.63	9	47
UMI-0110EE-B1	44.5	1.65	8.25	13.2	31
UMI-0150EE-B1	32.0	2.25	11.3	18	23
UMI-0185EE-B1	27	3	14	22	19
UMI-0220EE-B1	22	3	17	26	17
UMI-0300EE-B1	17	5	23	36	17
UMI-0370EE-B1	13	6	28	44	11.7
UMI-0450EE-B1	10	7	34	54	8
UMI-0550EE-B1	8	8	41	66	8
UMI-0750EE-B1	6.5	11	56	90	6.4
UMI-0900EE-B1	5.4	14	68	108	4.4
UMI-1100EE-B1	4.5	17	83	132	4.4
UMI-0004BU-B1	361	0.06	0.30	0.48	42
UMI-0007BU-B1	192	0.11	0.56	0.90	42
UMI-0015BU-B1	96	0.23	1.10	1.80	30
UMI-0022BU-B1	65	0.33	1.70	2.64	21
UMI-0004CU-B1	361	0.06	0.3	0.48	131
UMI-0007CU-B1	192	0.11	0.56	0.90	93
UMI-0007EU-B1	653	0.11	0.56	0.90	240
UMI-0015EU-B1	326	0.23	1.13	1.80	170
UMI-0022EU-B1	222	0.33	1.65	2.64	130
UMI-0007CU-B5	192	0.11	0.56	0.9	93

Model	Braking resistor at 100% of braking torque (Ω)	Consumed power of the braking resistor (kW)			Min. braking resistor (Ω)
		10% braking	50% braking	80% braking	
UMI-0015CU-B5	96	0.23	1.1	1.8	44
UMI-0022CU-B5	65	0.33	1.7	2.64	44
UMI-0040CU-B5	36	0.6	3	4.8	33
UMI-0055CU-B5	26	0.75	4.13	6.6	25
UMI-0075CU-B5	19	1.13	5.63	9	13
UMI-0110CU-B5	13	1.6	8	12.8	8.8
UMI-0150CU-B5	9.6	2	11	18	6.4
UMI-0185CU-B5	8	3	14	22	6.4
UMI-0220CU-B5	6.5	3	17	26	6.4
UMI-0300CU-B5	4.8	2	23	36	4.4
UMI-0370CU-B5	3.9	6	28	44	4.4
UMI-0450CU-B5	3.2	7	34	54	2.4
UMI-0550CU-B5	2.6	8	41	66	2.4
UMI-0015EU-B5	326	0.23	1.1	1.8	170
UMI-0022EU-B5	222	0.33	1.7	2.6	130
UMI-0040EU-B5	122	0.6	3	4.8	80
UMI-0055EU-B5	89	0.75	4.1	6.6	60
UMI-0075EU-B5	65	1.1	5.6	9	47
UMI-0110EU-B5	44	1.7	8.3	13.2	31
UMI-0150EU-B5	32	2	11	18	23
UMI-0185EU-B5	27	3	14	22	19
UMI-0220EU-B5	22	3	17	26	17
UMI-0300EU-B5	16	5	23	36	17
UMI-0370EU-B5	13	6	28	44	11.7
UMI-0450EU-B5	10	7	34	54	6.4
UMI-0550EU-B5	8	8	41	66	6.4
UMI-0750EU-B5	6.5	11	56	90	6.4
UMI-0900EU-B5	5.4	14	68	108	4.4
UMI-1100EU-B5	4.5	14	83	132	4.4

9. Unitronics Breaking Properties

Unitronics part number	Rated Power and Voltage	Resistor Properties
UMI-S0050	0.4KW/220V	360Ω/600W
UMI-S0051	0.75KW/220V	150Ω/390W
UMI-S0052	1.5KW/220V	85Ω/260W
UMI-S0053	2.2KW/220V	100Ω/600W
UMI-S0054	0.75KW/400V	600Ω/100W
UMI-S0055	1.5KW/400V	250Ω/260W
UMI-S0056	2.2KW/400V	150Ω/390W
UMI-S0053	4KW/400V	100Ω/600W
UMI-S0058	5.5KW/400V	85Ω/1000W
UMI-S0059	7.5KW/400V	65Ω/1500W
UMI-S0060	11KW/400V	40Ω/1560W
UMI-S0061	15KW/400V	27Ω/3000W
UMI-S0061	18.5KW/400V	27Ω/3000W
UMI-S0062	22KW/400V	20Ω/4500W
UMI-S0062	30KW/400V	20Ω/4500W
UMI-S0063	37KW/400V	13.6Ω/6000W
UMI-S0064	45KW/400V	6.8Ω/12000W
UMI-S0064	55KW/400V	6.8Ω/12000W
UMI-S0064	75KW/400V	6.8Ω/12000W
UMI-S0065	90KW/400V	4.5Ω/17kW
UMI-S0065	110KW/400V	4.5Ω/17kW

10. Example

Application Data

a. Centrifuge system, $D = 15\%$
b. Motor rated speed 1400rpm decelerated to 0.
c. Required deceleration time 10 seconds.
d. Cycle period of 60 seconds.
e. Load inertia of 0.3$(kg \times m^2)$.
f. Motor inertia of 0.1$(kg \times m^2)$.
g. Selected VDF: 0.75kW VFD, 480VAC input voltage, part number UMI-0007EU-B1.
h. No gear installed

Calculations

a. Rated angular rotation speed: $\omega_b = 2\pi\frac{1400}{60} = 146.6\,{}^{rad}/_{sec}$

b. Final angular rotation speed: $\omega_o = 2\pi\frac{0}{60} = 0$

c. System total inertia: $J_T = 0.3 + 0.1 = 0.4(kg \times m^2)$

d. Peak Braking Power: $P_b = \frac{J_T[{\omega_b}^2]}{t} = \frac{0.4\times146.6^2}{10} \cong 860\ watts$

Because the **Peak Braking Power** > **Rated VFD Power** an external braking resistor is **required**.

e. External resistor calculations:

   a. Required Braking Resistor Resistance: $R = \frac{670^2}{860} \cong 522\ ohm$

   b. Recommended Braking Resistor Power: $P_R = \frac{860\times0.15}{0.7} \cong 184\ watts$

See below the highlighted row from the **Model Brake Data** table showing UMI-0007EU-B1 VFD showing:

1. Min. braking resistor (Ω) value is 240Ω.
2. Calculated Required Braking Resistor Resistance value is 522Ω.
3. Check if **Required Braking Resistor Resistance** ≥ **Min. braking resistor**:
   a. If yes, use the calculated resistor values
   b. If no, use at least the **Min. braking resistor** recommended value, otherwise damage can be caused to the VFD.

Model	Braking resistor at 100% of braking torque (Ω)	Consumed power of the braking resistor			Min. braking resistor (Ω)
UMI-0007BU-B1	192	0.11	0.56	0.90	42
UMI-0015BU-B1	96	0.23	1.10	1.80	30
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UMI-0007CU-B5	192	0.11	0.56	0.9	93