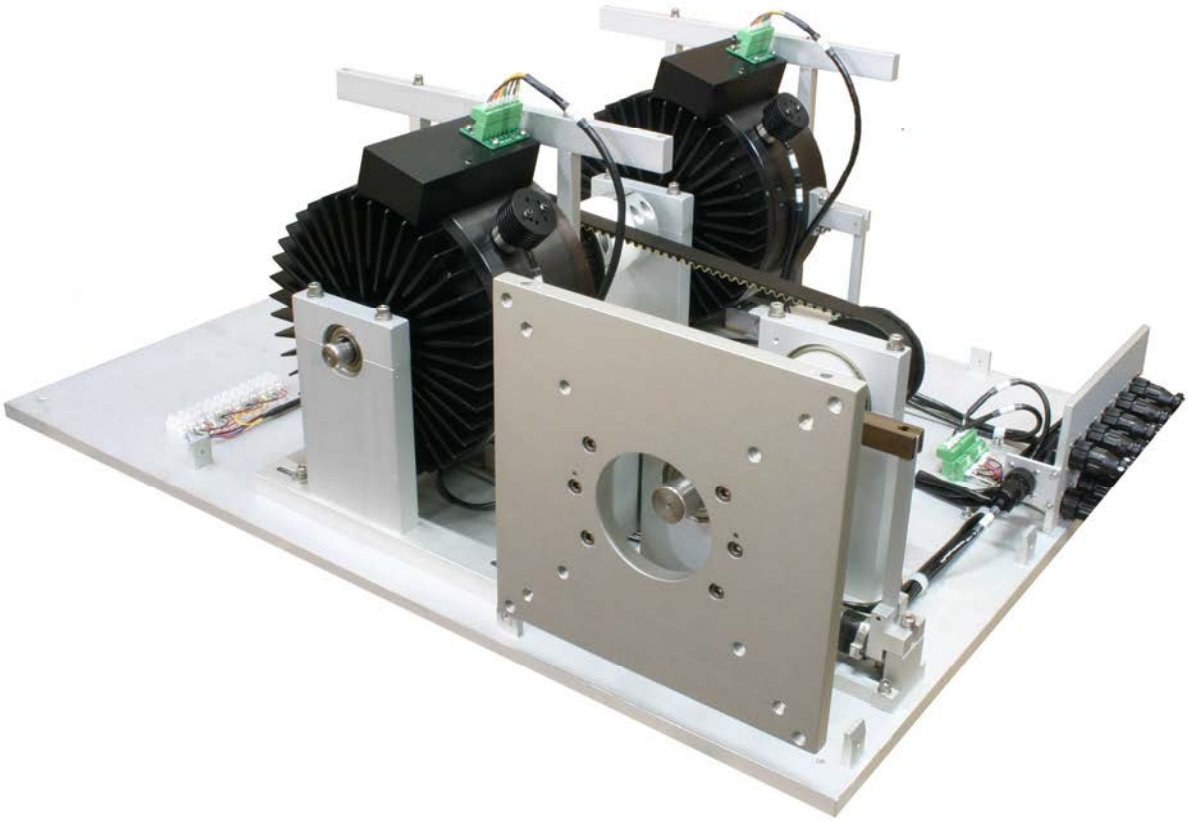
MAGNETIC BRAKE SYSTEMS

A DIVISION OF TECHNICAL FILM SYSTEMS, INC.

DYNAMOMETER DATA SHEET

(Version 1.1)



MODELS:

DB6B-5.7T-FM DB6M-5.7T-FM
DB6B-5.7T-BM DB6M-5.7T-BM

Max. continuous power dissipation:	6.74 HP (5.0 kW)
Max. Power for 30 seconds:	9.42 HP (7.0 kW)
Max. continuous brake torque:	100 in-lbs. (11.3 N-m) @ 2,500 RPM
Max. brake torque:	125 in-lbs. (14.1 N-m)
Max. brake speed:	8,000 RPM

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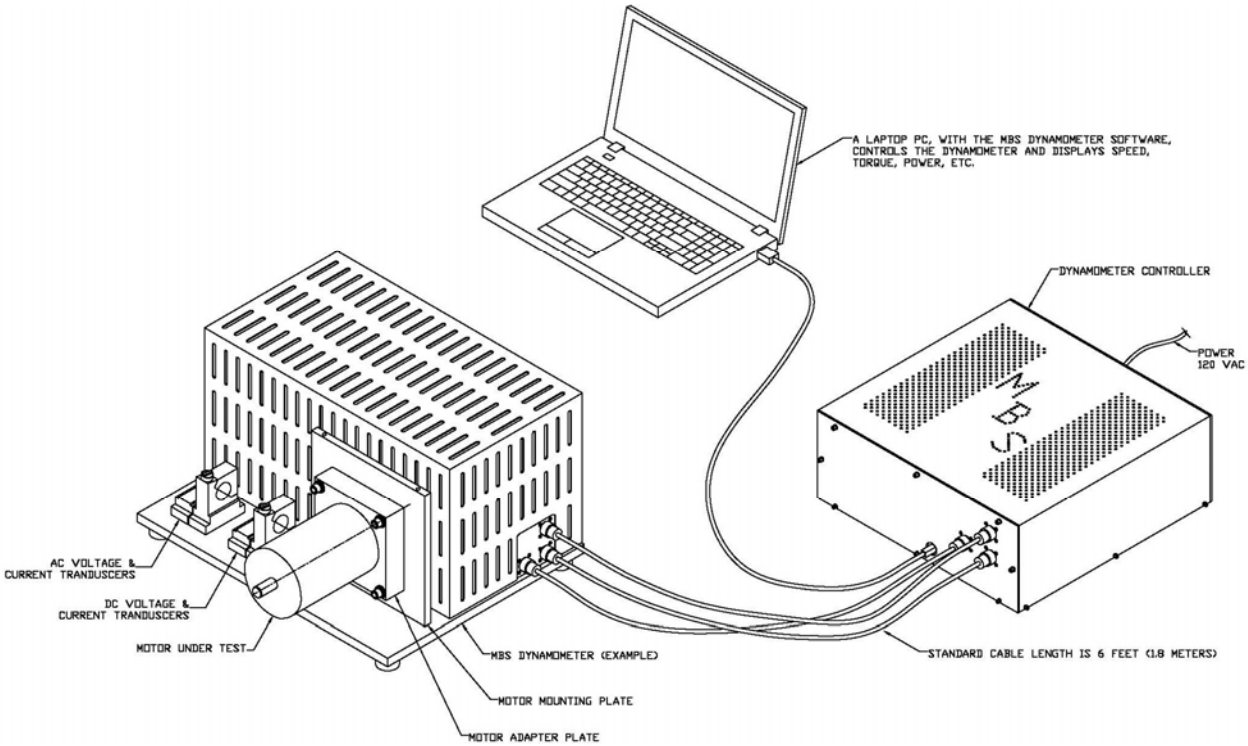
1. OVERVIEW

This data sheet is a reference for the performance specifications of the dynamometer models listed on the cover page.

The MBS dynamometers may be used to test just about any type of motor (i.e. electric, hydraulic, pneumatic, reciprocating). Types of testing include: endurance testing, speed versus torque curves, measure stall torque, efficiency, temperature rise, performance verification, etc. MBS dynamometers are sold as complete systems (shown in image below) that include: the dynamometer, controller, computer with software, calibration weight, manual and all cables. Our systems do not require annual fees, licenses or permits. The software is user friendly, is very configurable (i.e. changing units, display scale limits, data acquisition rate, etc.) and has some safety precautions built in to prevent damage to the motor under test and/or the system (i.e. brake temperature sensor, setting current limit, setting power limit, trigger input signals).



The nomenclature of the dynamometer part number is described at the end of this document. The power dissipation rating for this system is located on the bottom of the cover page. This data sheet may also be used to determine the best configuration for a system.

Dynamometers, or more specifically the size of the brakes for the dynamometers, are selected based on the required power dissipation and required torque.

A belt coupled system will provide a much broader range of torque supplied to the motor under test, which makes a dynamometer more cost effective and diverse than a direct drive system.

This system may be received in one of two ways:

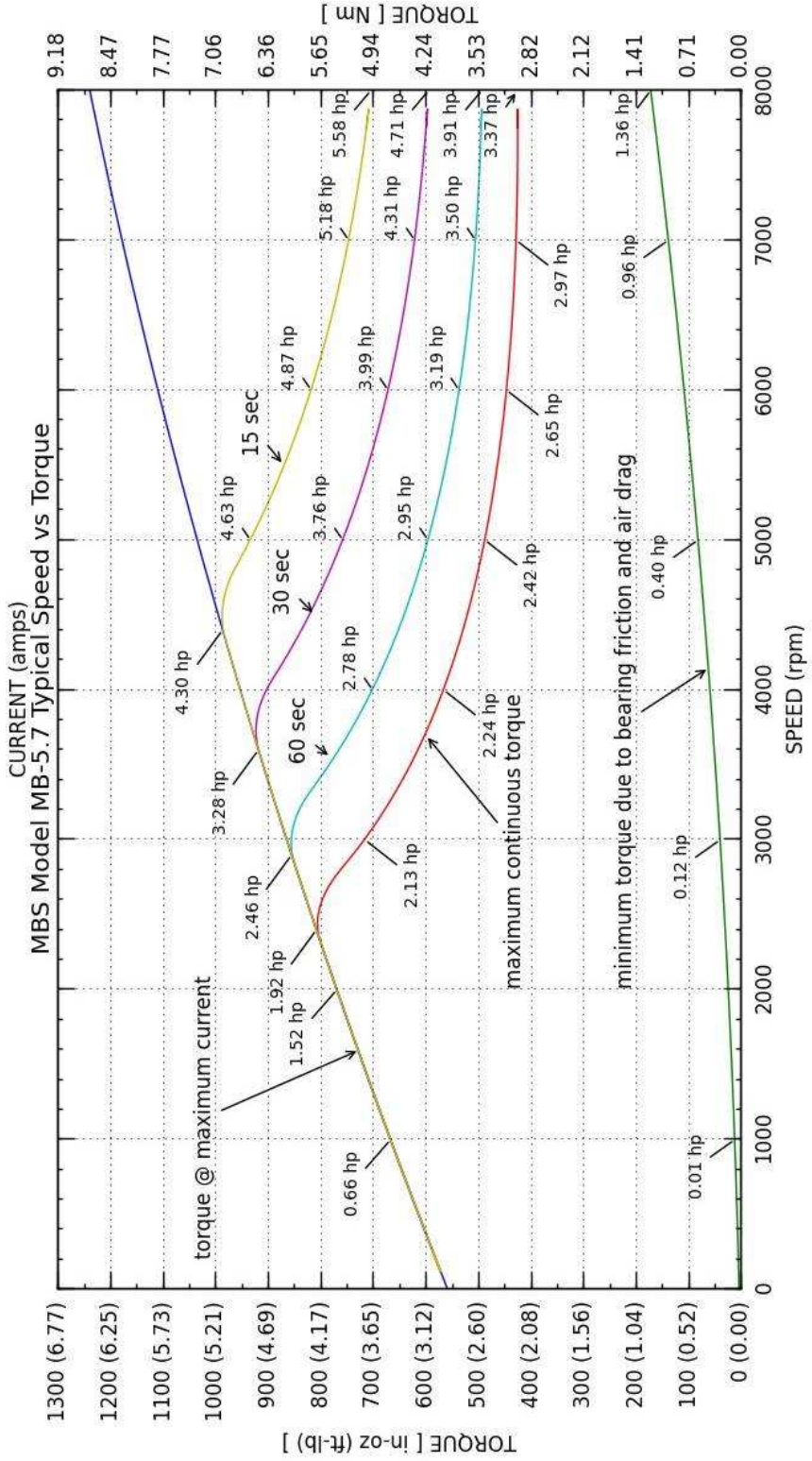
The first option is if the motor load cell is included (i.e. DB6M-5.7T-FM or DB6M-5.7T-BM). In this system, the operator may exchange the motor load cell as required in order to provide the highest accuracy of measurement for a particular motor. General brake performance may be found in Section 2. Transmission tables, showing optional possibilities of torque and speed may be viewed in Section 3: Motor Torque and Speed. Section 5: Load Cell Accuracy Plots is cross-referenced with Table 7, Load Cell Reference.

The second option is if the motor load cell is not included (i.e. Model DB6B-5.7T-FM or DB6B-5.7T-BM). For this system, the motor torque is captured by measuring the brake torque, multiplied by the transmission. Omitting the motor load cell allows the testing of motors that are in an environmental test chamber or where the motor power source may influence the torque measurement. Though belt friction, bearing friction and any other minor losses may not be accounted for in the measurements, the bearing friction is usually negligible and a properly aligned belt may have an efficiency as high as 98%. When measuring the brake torque, the air drag from the brake is not measured; however, the dynamometer software compensates for the air drag.

The motor torque, speed, voltage and current ranges (and types; i.e. DC, AC, AC-3ph) need to be specified when purchasing a dynamometer in order to select the limits for the instrumentation. The following performance specifications for load cells, transducers, etc., are based on vendor specifications.

A calibration weight comes with each system. The zero torque and gain are adjusted by the operator as part of the calibration procedure. Calibration takes a couple of minutes and may be performed as often as desired. To check for accuracy, customers may use their own calibration weight to simulate a specific load, while the system is at rest.

2. SPEED vs. TORQUE CURVE – FOR ONE MB-5.7 BRAKE



3. MOTOR TORQUE & SPEED:

For a system measuring the motor torque, Tables 1 through 6 may be referenced for selecting the pulley ratios based on the required torque to the motor and motor speed. Reference Table 7 for the "L.C. Ref. #," column. These tables show performance examples of the dynamometer; any pulley ratio in between 4:1 and 1:4 is a viable option. Remember to take air drag of the brake(s) into account for the minimum torque required at speed.

3.1 Pulley Ratio's (English Units)

Motor_Spd (RPM)	Motor Torque (in-lbs.)	Power (HP)	Pulley Ratio (mtr/brk)	Qty. Brks	Brake Torque (in-lbs.)	Brake_Spd (RPM)	Time (sec)	L.C. Ref. # **
0	275	0	4:1	2	69	0	cont.	10
450	375	2.7	4:1	2	94	1,800	cont.	12
600	400	3.8	4:1	2	100	2,400	cont.	12
900	300	4.3	4:1	2	75	3,600	cont.	10
900	450	6.4	4:1	2	113	3,600	30.	13
2,000	212	6.7	4:1	2	53	8,000	cont.	8
2,000	297	9.4	4:1	2	74	8,000	30	10

Table 1: Speed, Torque & Power (English Units) 4:1 Pulley Ratio

Motor_Spd (RPM)	Motor Torque (in-lbs.)	Power (HP)	Pulley Ratio (mtr/brk)	Qty. Brks	Brake Torque (in-lbs.)	Brake_Spd (RPM)	Time (sec)	L.C. Ref. # **
0	69	0	1:1	2	69	0	cont.	5
1,000	84	1.3	1:1	2	84	1,000	cont.	5
1,800	94	2.7	1:1	2	94	1,800	cont.	6
2,400	100	3.8	1:1	2	100	2,400	cont.	6
3,600	75	4.3	1:1	2	75	3,600	cont.	5
3,600	113	6.4	1:1	2	113	3,600	30	6
8,000	74	9.4	1:1	2	74	8,000	30	5

Table 2: Speed, Torque & Power (English Units) 1:1 Pulley Ratio

Motor_Spd (RPM)	Motor Torque (in-lbs.)	Power (HP)	Pulley Ratio (mtr/brk)	Qty. Brks	Brake Torque (in-lbs.)	Brake_Spd (RPM)	Time (sec)	L.C. Ref. # **
0	17	0	1:4	2	69	0	cont.	2
1,800	19	0.5	1:4	2	75	450	cont.	3
3,600	21	1.2	1:4	2	84	900	cont.	3
10,000*	25	3.9	1:4	2	100	2,500	cont.	3
15,000*	20	4.8	1:3	2	60	5,000	cont.	3
15,000*	10	2.4	1:3	1	30	5,000	cont.	2
15,000*	1.7	0.4	1:3	1	5 ***	5,000	cont.	1

Table 3: Speed, Torque & Power (English Units) 1:4 Pulley Ratio

* Maximum motor speed is dependent upon limits of pulleys and belt.
** See Table 7 for L.C. (Load Cell) specifications based on the number shown.
*** Minimum torque required due to air drag of brake.

3.2 Pulley Ratio's (SI Units)

Motor_Spd (RPM)	Motor_Tq (Nm)	Power (kW)	Pulley Ratio (mtr/brk)	Qty. Brakes	Brake_Tq (Nm)	Brake_Spd (RPM)	Time (sec)	L.C. Ref. # **
0	31.2	0	4:1	2	7.8	0	cont.	10
450	42.5	2.01	4:1	2	10.6	1,800	cont.	12
600	45.2	2.83	4:1	2	11.3	2,400	cont.	12
900	33.9	3.21	4:1	2	8.5	3,600	cont.	10
900	51.1	4.77	4:1	2	12.8	3,600	30.	13
2,000	24.0	5.00	4:1	2	6.0	8,000	cont.	8
2,000	33.4	7.01	4:1	2	8.4	8,000	30	10

Table 4: Speed, Torque & Power (SI Units) 4:1 Pulley Ratio

Motor_Spd (RPM)	Motor_Tq (Nm)	Power (kW)	Pulley Ratio (mtr/brk)	Qty. Brakes	Brake_Tq (Nm)	Brake_Spd (RPM)	Time (sec)	L.C. Ref. # **
0	7.8	0	1:1	2	7.8	0	cont.	5
1,000	9.5	0.97	1:1	2	9.5	1,000	cont.	5
1,800	10.6	2.01	1:1	2	10.6	1,800	cont.	6
2,400	11.3	2.83	1:1	2	11.3	2,400	cont.	6
3,600	8.5	3.21	1:1	2	8.5	3,600	cont.	5
3,600	12.8	4.77	1:1	2	12.8	3,600	30	6
8,000	8.4	7.01	1:1	2	8.4	8,000	30	5

Table 5: Speed, Torque & Power (SI Units) 1:1 Pulley Ratio

Motor_Spd (RPM)	Motor_Tq (Nm)	Power (kW)	Pulley Ratio (mtr/brk)	Qty. Brakes	Brake_Tq (Nm)	Brake_Spd (RPM)	Time (sec)	L.C. Ref. # **
0	1.9	0	1:4	2	7.8	0	cont.	2
1,800	2.1	0.37	1:4	2	8.5	450	cont.	3
3,600	2.4	0.90	1:4	2	9.5	900	cont.	3
10,000*	2.8	2.91	1:4	2	11.3	2,500	cont.	3
15,000*	2.3	3.58	1:3	2	6.8	5,000	cont.	3
15,000*	1.1	1.79	1:3	1	3.4	5,000	cont.	2
15,000*	0.2	0.30	1:3	1	0.6***	5,000	cont.	1

Table 6: Speed, Torque & Power (SI Units) 1:4 Pulley Ratio

* Maximum motor speed is dependent upon limits of pulley and belt.
** See Table 7 for load cell specifications based on the number shown.
*** Minimum torque required due to air drag of brake.

Tables 1 through 6 are based on the performance graph for the MBZ-8.7 brake, shown in Section 2. Reference the accuracy plots, starting in section 4, for recommended load cells.

3.3 Load Cell Size

The load cell(s) for the system should be specified by their load rating (column 2 or 3).

Load Cell Ref. #	Load Rating (lbs.)	Load Rating (Kg.)	Arm (inches [cm])	Max Torque (in-lbs.)	Max Torque (Nm)
1	2.2	1	4 [10.16]	8.8	1
2	4.4	2	4 [10.16]	17.6	2
3	11	5	4 [10.16]	44	5
4	13	6	4 [10.16]	52.9	6
5	22	10	4 [10.16]	88.5	10
6	33	15	4 [10.16]	132	15
7	44	20	4 [10.16]	176	20
8	55	25	4 [10.16]	220	25
9	66	30	4 [10.16]	264	30
10	77	35	4 [10.16]	308	35
11	50	23	4 [10.16]	200	23
12	100	45	4 [10.16]	400	45
13	150	68	4 [10.16]	600	68
14	250	113	4 [10.16]	1,000	113
15	500	226	4 [10.16]	2,000	226

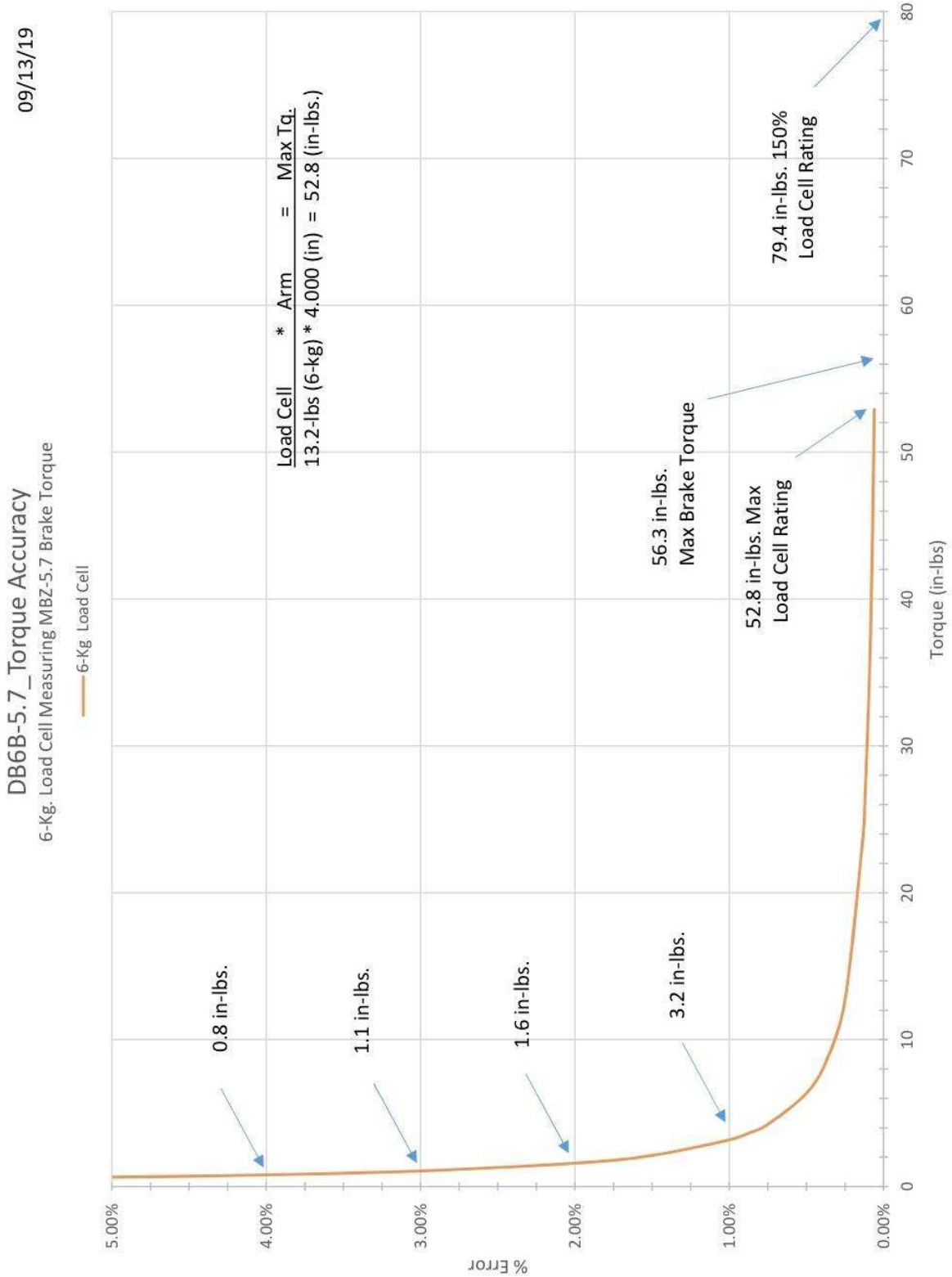
Table 7: Load Cell Reference

The following sections, 4 & 5, are the specifications for the different types of load cells.

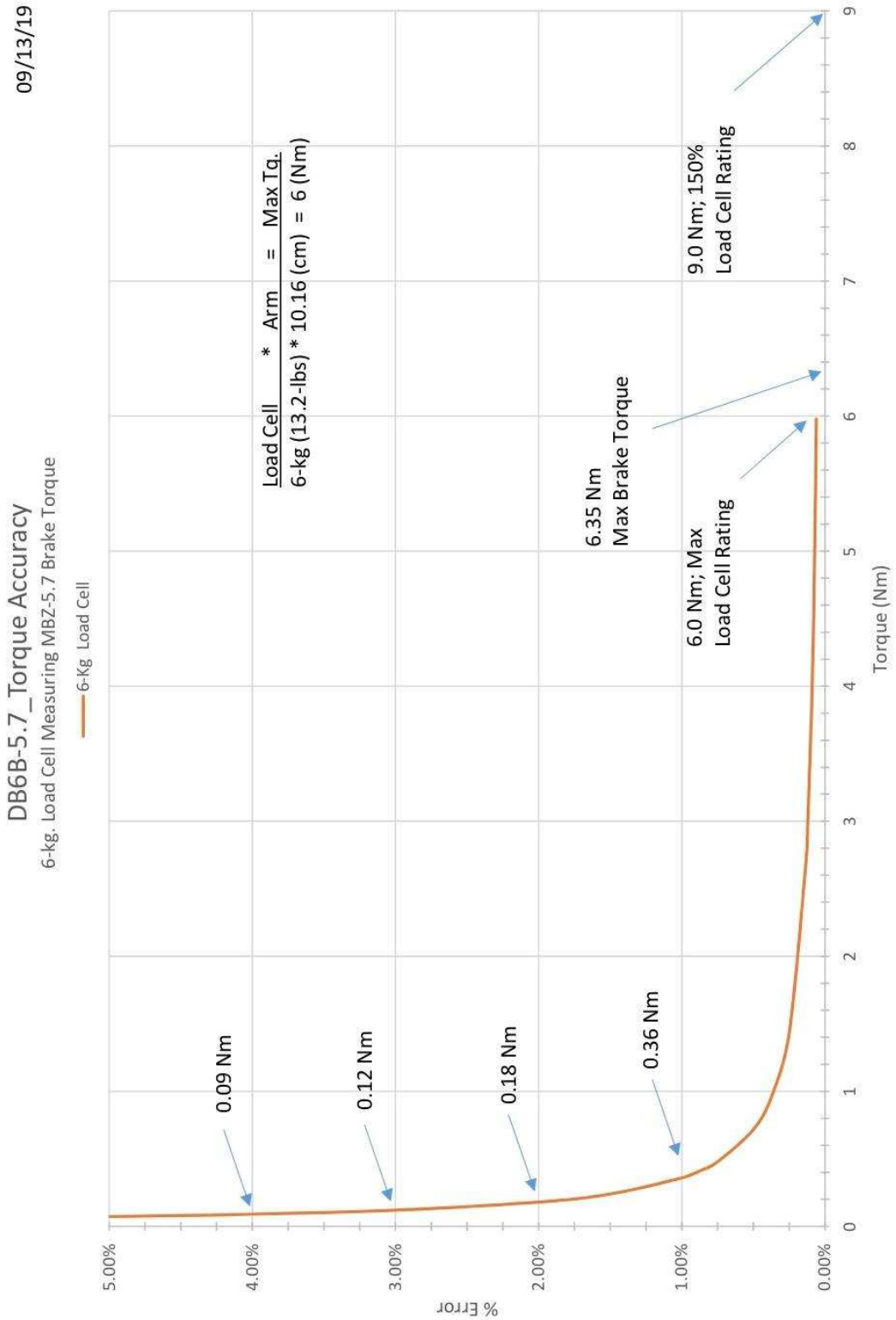
4. LOAD CELLS (DB6B-5.7T-FM, Measure Brake Torque):

Max Brake Torque	56.2 in-lbs. (6.35 Nm)
Recommended L.C	13.2 lbs. (6 kg)
Arm Length	4.0 inches (10.16 cm)
L.C rated torque	52.9 in-lbs. (31 Nm)
Safe Overload	150% of R.L.*
Non-Linearity	0.02% of Rated Load (R.L.)
Hysteresis	0.02% of R.L.
Non-Repeatability	0.02% of R.L.
Zero Balance	±1% of R.L.
Compensated Temperature Range	14℉ to 104℉
Safe Temperature Range	14℉ to 140℉
Temperature Effect on Output	0.002% of Load/℉
Temperature Effect on Zero	0.002% of Load/℉

4.1 Load Cell Accuracy Plot – Brake Torque (in-lbs.) - Linear



4.2 Load Cell Accuracy Plot – Brake Torque (Nm) - Linear



5. LOAD CELLS (DB6M-5.7T-FM, Measure Motor Torque):

5.1 TYPE I (Low Load):

Load Rating (lbs.) 2.2, 4.4, 11, 13, 22, 44, 66, 77
Load Ratings (kg.) 1, 2, 5, 6, 10, 20, 30, 35
Load Cell Arm ..... 4.0 in. (10.16 cm)
Torque Limits (in-lbs.) 8.8,17.6, 44, 53, 88.5, 177, 265, 309
Torque Limits (Nm) 1, 2, 5, 6, 10, 20, 30, 35
Non-Linearity ..... 0.02% of R.L.
Hysteresis ..... 0.02% of R.L.
Non-Repeatability ..... 0.02% of R.L.
Zero Balance ..... ±1% of R.L.
Compensated Temperature Range ..... 14℉ to 104℉
Safe Temp. Range ..... 14℉ to 140℉
Temp. Effect on Output ..... 0.002% of Load/℉
Temp. Effect on Zero ..... 0.002% of Load/℉
Safe Overload ..... 150% of R.L.*

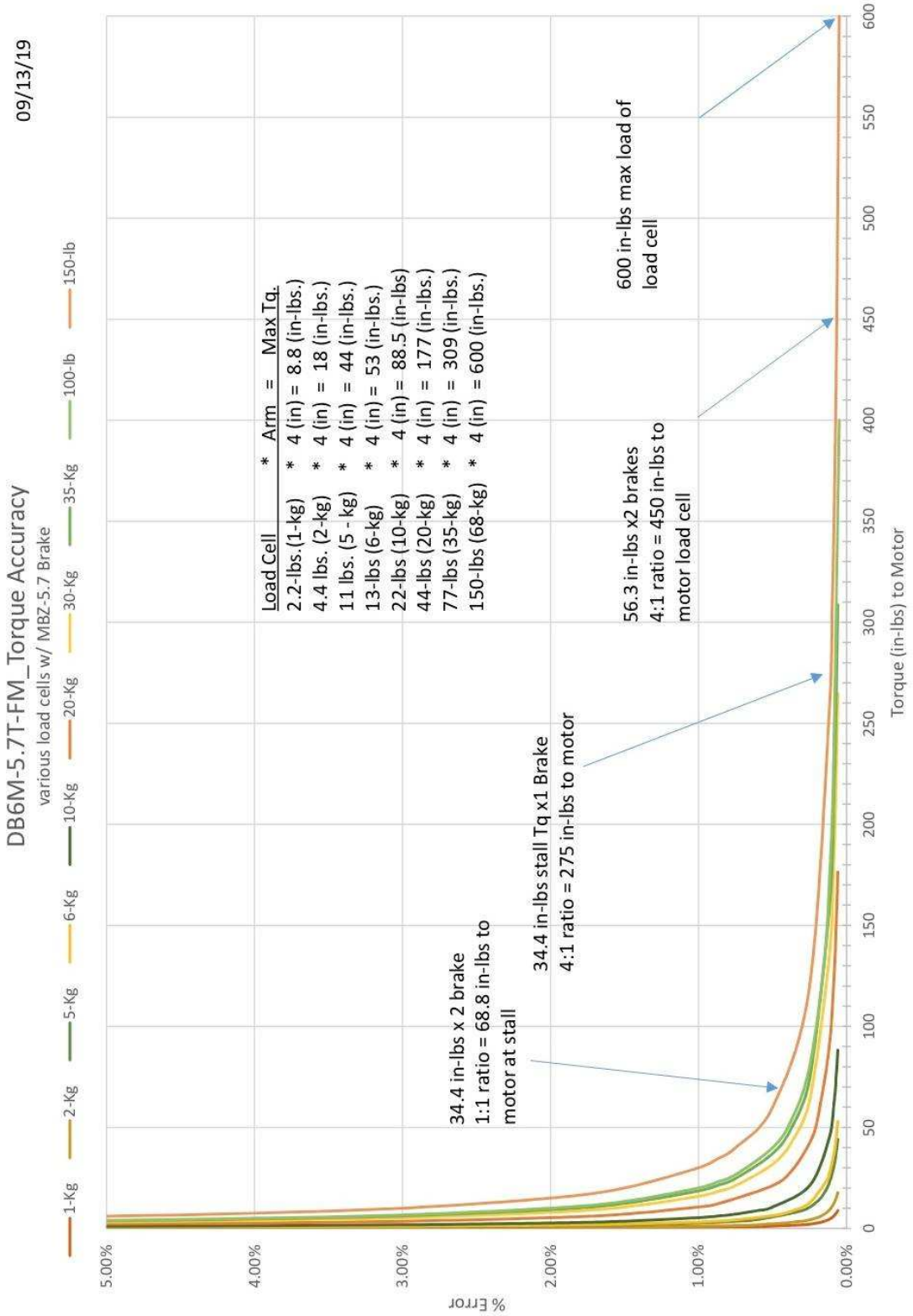
5.2 TYPE II (High Load):

Load Rating (lbs.) 100, 150, 250, 500
Load Ratings (kg.) 45, 68, 113, 227
Load Cell Arm ..... 4 in. (10.16 cm)
Torque Limits (in-lbs.) 400, 600, 1,000, 2,000
Torque Limits (Nm) 45, 68, 113, 226
Non-linearity ..... 0.03% of R.L.
Hysteresis ..... 0.02% of R.L.
Zero Balance ..... ±1% of R.L.
Operating Temperature Range ..... -40℉ to 150℉ / -40℃ to 65℃
Temp. Effect on Output ..... 0.002% of Load/℉
Temp. Effect on Zero ..... 0.002% of Load/℉
Safe Overload ..... 150% of R.L.*

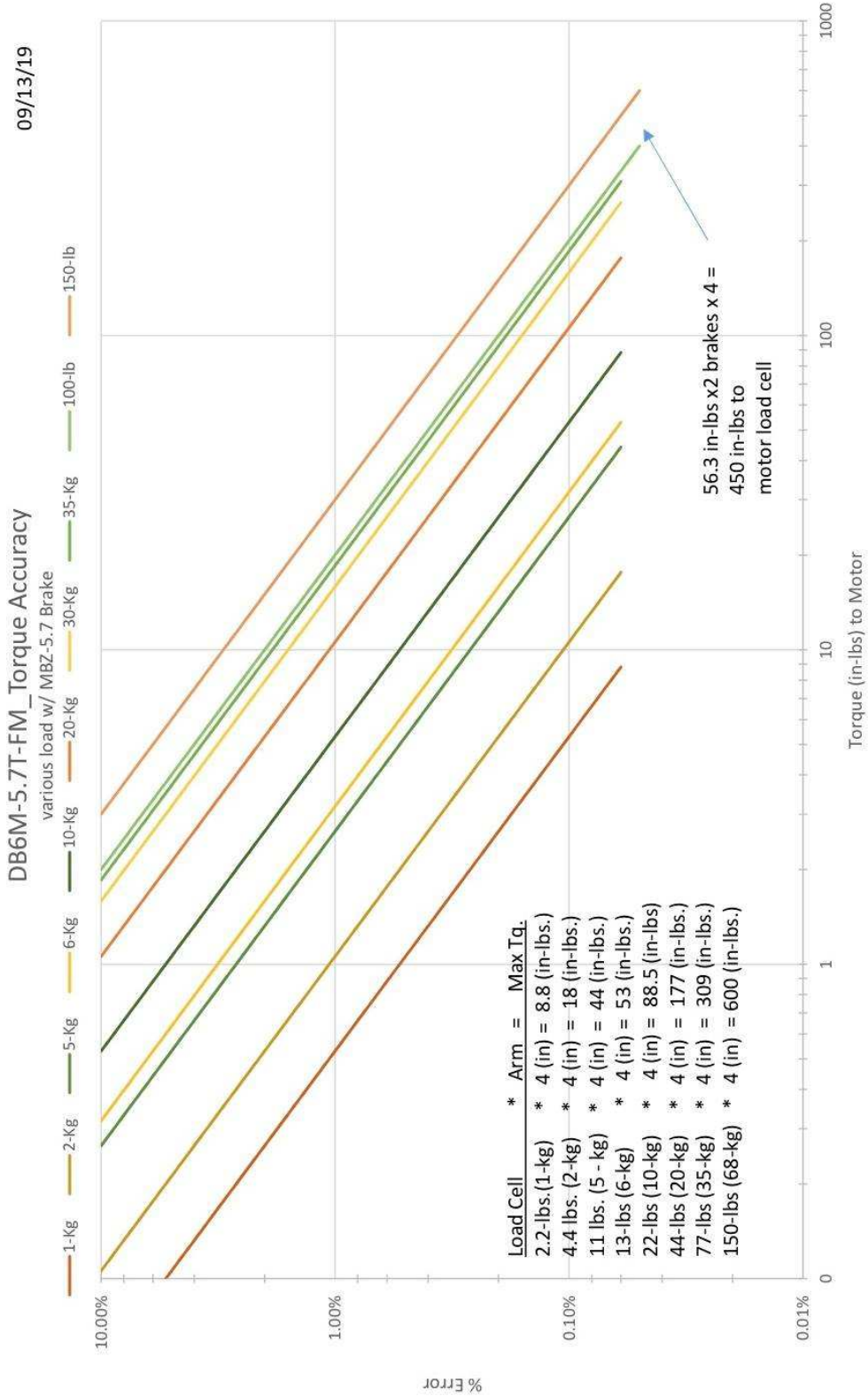
* Hard stops are in place to help prevent damage from over-load.

The Torque Accuracy plots, 5.3 through 5.6, show the percentage error as a function of measured torque. These plots show the range that a load cell will accurately measure. Plots are shown on a linear scale and, for clarity, on a logarithmic scale. The maximum torque to the motor is based on the pulley ratio selected for belt coupled systems. The accuracy plot is based on published data from the vendor for the load cell.

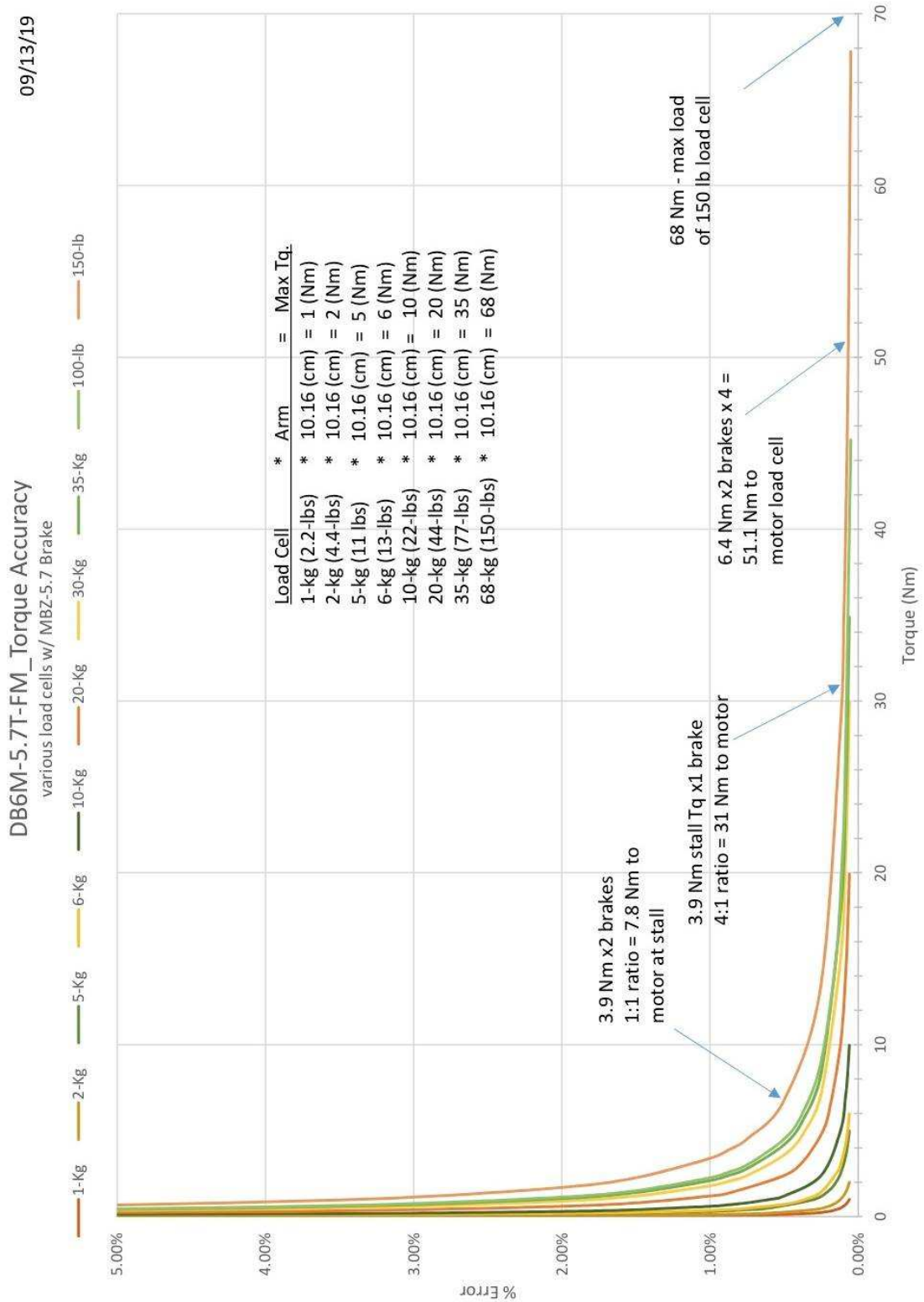
5.3 Torque Accuracy Plot - Motor (in-lbs.) – Linear



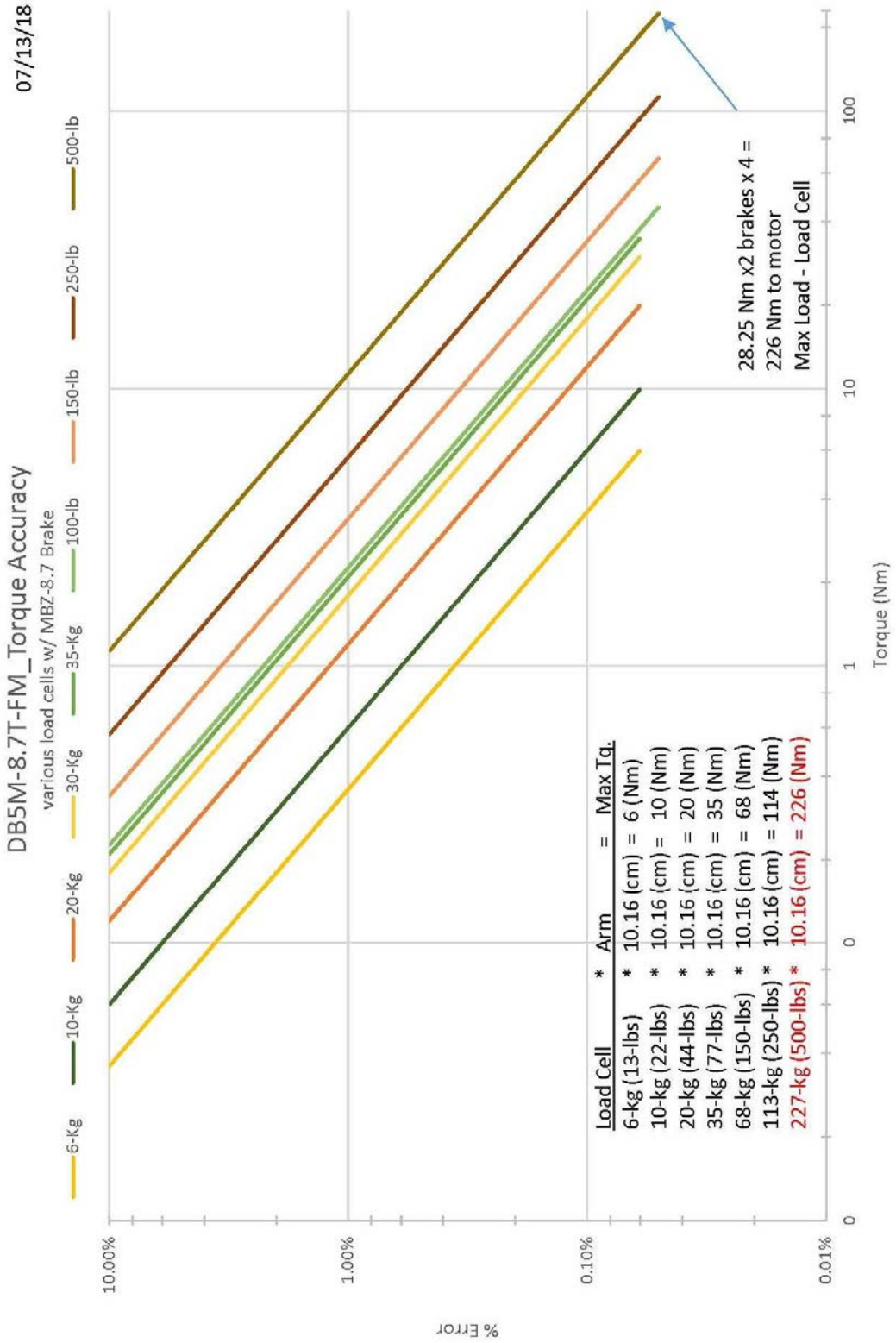
5.4 Torque Accuracy Plot - Motor (in-lbs.) – Logarithmic



5.5 Torque Accuracy Plot - Motor (Nm) – Linear



5.6 Torque Accuracy Plot - Motor (Nm) – Logarithmic



6. SPEED:

A standard brake has five magnets (alternative quantity or an external encoder is optional) which trigger a hall effect sensor. The speed is averaged over one revolution of the brake. A 48-MHZ clock is used to measure the time between magnets (or pulses).

Parameter	Conditions	Min.	Typ.	Max.	Units
Clock Error	~25℃		±30		PPM
	-10℃ to 60℃		±50		PPM
	-40℃ to 85℃		±100		PPM
Brake Speed	5 magnets	12		180,000*	RPM
	30 magnets	2		30,000*	RPM
	1,000 PPR	0.066		5,000	RPM
	2,000 PPR	0.033		2,000	RPM

* Theoretical speed; actual maximum speed is limited to the speed of the brake.

7. SAMPLING:

This is the rate at which data is measured/recorded. This rate is adjustable by the operator.

Parameter	Conditions	Min.	Typ.	Max.	Units
Sampling Rate	2.3 MHz Proc.	20	50	-	ms

8. LAPTOP COMPUTER:

Parameter	Conditions	Min.	Typ.	Max.	Units
Processor		2.3			GHz
Memory		8			GB
Display	LED LCD		15.6		inches

A computer with a more powerful processor may allow a higher sampling frequency.

9. POWER REQUIREMENTS

The MBS Dynamometer requires two 115 or 230 VAC power outlets: one for the laptop computer and one for the controller. The brakes in the dynamometer structure receive power from the controller. The AC power supplies the power supplies and cooling fan in the controller; everything else is 24 VDC (or less) in the system.

Item	Voltage	Type	Current (amps)	Freq. (Hz)	# Plugs
Controller	115/230	VAC	1.1/0.6	50/60	1
Laptop	110-240	VAC	1.2	50/60	1
Dynamometer	24	VDC	6.0	-	none

10. DC VOLTAGE TRANSDUCERS:

10.1 Input:

Range..... 0 VDC to: 1, 5, 10, 50, 150, 200 up to 600
VDC Overload ..... 2x voltage range selected
Frequency Range ..... DC only

The range represents transducers that measure from 0-1 VDC, 0-5 VDC, 0-10 VDC, etc.

10.2 Output:

Basic Accuracy 1.0%
Linearity..... 10% to 100% F.S.
Thermal Drift..... 500 PPM/℃
Response Time ..... 250 ms max.

10.3 Environmental and Physical Characteristics:

Operating Temperature ..... 0℃ to +50℃
Insulation Category..... CAT II
Vibration Tested to ..... IEC 60068-2-6, 1995
Pollution Degree 2
Altitude ..... 2000-meter max.
Insulation Voltage ..... 2500 VDC
MTBF..... Greater than 100K hours
Relative Humidity..... 5% to 95%, non-condensing
Weight ..... 0.5 lbs.

11. AC VOLTAGE TRANSDUCERS – SINGLE PHASE:

11.1 Input:

Range..... 0 VAC to: 50, 150, 250, 500, 600 VAC
Overload..... 2x voltage range selected
Frequency Range ..... 20 Hz to 5 kHz

11.2 Output:

Basic Accuracy…… 0.5%
Linearity..... 10% to 100% F.S.
Calibration ..... True RMS sensing
Thermal Drift..... 500 PPM/℃
Response Time ..... 250 ms

11.3 Environmental and Physical Characteristics:

Operating Temperature ..... 0℃ to +60℃
Insulation Category..... CAT II
Vibration Tested to ..... IEC 60068-2-6, 1995
Pollution Degree 2
Altitude ..... 2000-meter max.
Insulation Voltage ..... 2500 VDC
MTBF..... Greater than 100K hours
Relative Humidity..... 5% to 95%, non-condensing
Weight ..... 0.5 lbs.

12. AC VOLTAGE TRANSDUCERS – THREE PHASE:

12.1 Input:

Range…..……..... 0 VAC to: 50, 150, 250, 500, 600 VAC
Overload……..... ..... 2x voltage range selected
Frequency Range……..... 20 Hz to 5 kHz

12.2 Output:

Basic Accuracy 0.5%
Linearity..... 10% to 100% F.S.
Calibration ..... True RMS sensing
Thermal Drift..... 500 PPM/℃
Response Time ..... 250 ms

12.3 Environmental and Physical Characteristics:

Operating Temperature ..... 0℃ to +60℃
Insulation Category..... CAT II
Vibration Tested to ..... IEC 60068-2-6, 1995
Pollution Degree 2
Altitude ..... 2000-meter max.
Insulation Voltage ..... 2500 VDC
MTBF..... Greater than 100K hours
Relative Humidity..... 5% to 95%, non-condensing
Weight ..... 0.5 lbs.

12.4 Applications:

Harmonic voltages
Chopped waveform drivers
Quickly varying voltage supplies
Phase fired controlled devices

13. DC CURRENT TRANSDUCERS (Split Core):

13.1 Input:

Range (0 ADC up to) ..... 2, 5, 10, 20, 30, 50, 75, 100, 150, 300 ADC
Overload..... 4x current range selected
Frequency Range ..... DC only

13.2 Output:

Basic Accuracy 1.0%
Linearity..... 10% to 100% F.S.
Thermal Drift..... 500 PPM/℃
Response Time ..... 250 ms

13.3 Environmental and Physical Characteristics:

Operating Temperature ..... 0℃ to +50℃
Insulation Category..... CAT II
Vibration Tested to..... IEC 60068-2-6, 1995
Pollution Degree 2
Altitude ..... 2000-meter max.
Insulation Voltage ..... 2500 VDC
MTBF..... Greater than 100K hours
Relative Humidity..... 5% to 95%, non-condensing
Weight ..... 0.5 lbs.

14. AC CURRENT TRANSDUCERS – SINGLE PHASE (Split Core):

14.1 Input:

Range (0 AAC up to) ..... 5,10, 15, 20, 25, 30, 40, 50, 75, 100..600 AAC
Overload..... 4x current range selected
Frequency Range ..... 20 Hz to 5 kHz

14.2 Output:

Basic Accuracy 0.5%
Linearity..... 10% to 100% F.S.
Calibration ..... True RMS sensing
Thermal Drift..... 500 PPM/℃
Response Time ..... 250 ms

14.3 Environmental and Physical Characteristics:

Operating Temperature..... 0℃ to +60℃
Insulation Category..... CAT II
Vibration Tested to ..... IEC 60068-2-6, 1995
Pollution Degree 2
Altitude ..... 2000-meter max.
Insulation Voltage ..... 2500 VDC
MTBF..... Greater than 100K hours
Relative Humidity..... 5% to 95%, non-condensing
Weight ..... 0.5 lbs.

15. AC CURRENT TRANSDUCERS – THREE PHASE (Low Current):

15.1 Input:

Range (0 up to:)..... 0.5, 5, 10, 15, 16, 20, 25 AAC
Overload..... 4x current range selected
Frequency Range ..... 20 Hz to 5 kHz

15.2 Output:

Basic Accuracy 0.5%
Linearity..... 10% to 100% F.S.
Calibration ..... True RMS sensing
Thermal Drift..... 500 PPM/℃
Response Time ..... 250 ms max., 0 - 90%

15.3 Environmental and Physical Characteristics:

Operating Temperature ..... 0℃ to +60℃
Insulation Category..... CAT II
Vibration Tested to ..... IEC 60068-2-6, 1995
Pollution Degree 2
Altitude ..... 2000-meter max.
Insulation Voltage ..... 2500 VDC
MTBF..... Greater than 100K hours
Relative Humidity..... 5% to 95%, non-condensing
Weight ..... 0.5 lbs.

16. AC CURRENT TRANSDUCERS – THREE PHASE (High Current):

16.1 Input:

Range (0 up to)..... 150, 200, 250, 400, 500, 600, 800, 1000 AAC
Overload (per range selected) ..... 600, 750, 800, 1000, 1200, 1200, 1500 AAC
Frequency Range ..... 47 to 63 Hz

16.2 Output:

Current Signal..... 4 to 20 mA-DC (Full Scale)
Accuracy..... (Over the temperature range) ±0.5% F.S. max (±100 mA)

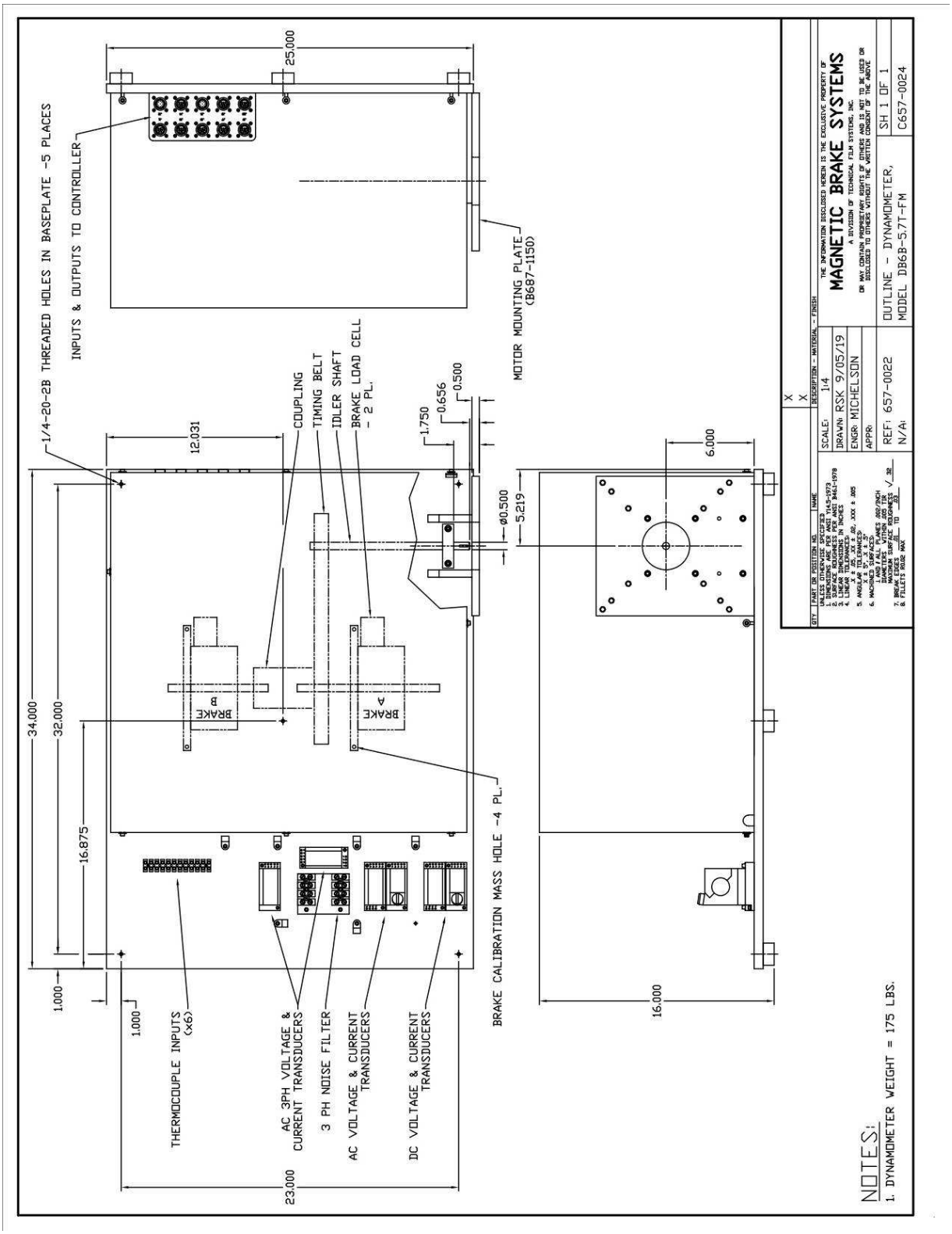
(Specified accuracy includes the combined worst-case effects of 4mA Offset, Temperature, Hysteresis, Supply Swings and Current Cable Positioning.)

Ripple ..... 0.2% max (40 uA-AC)
Response Time (10 to 90%) ..... 300 ms
Load Resistance (RL) ..... 250 Ohms Nominal (0-300 Ohms Range)
Crest Factors ..... 0 to 5
Current Signal @ Overload..... 23 mA-DC typical
Output Protection..... Reverse Polarity Protection

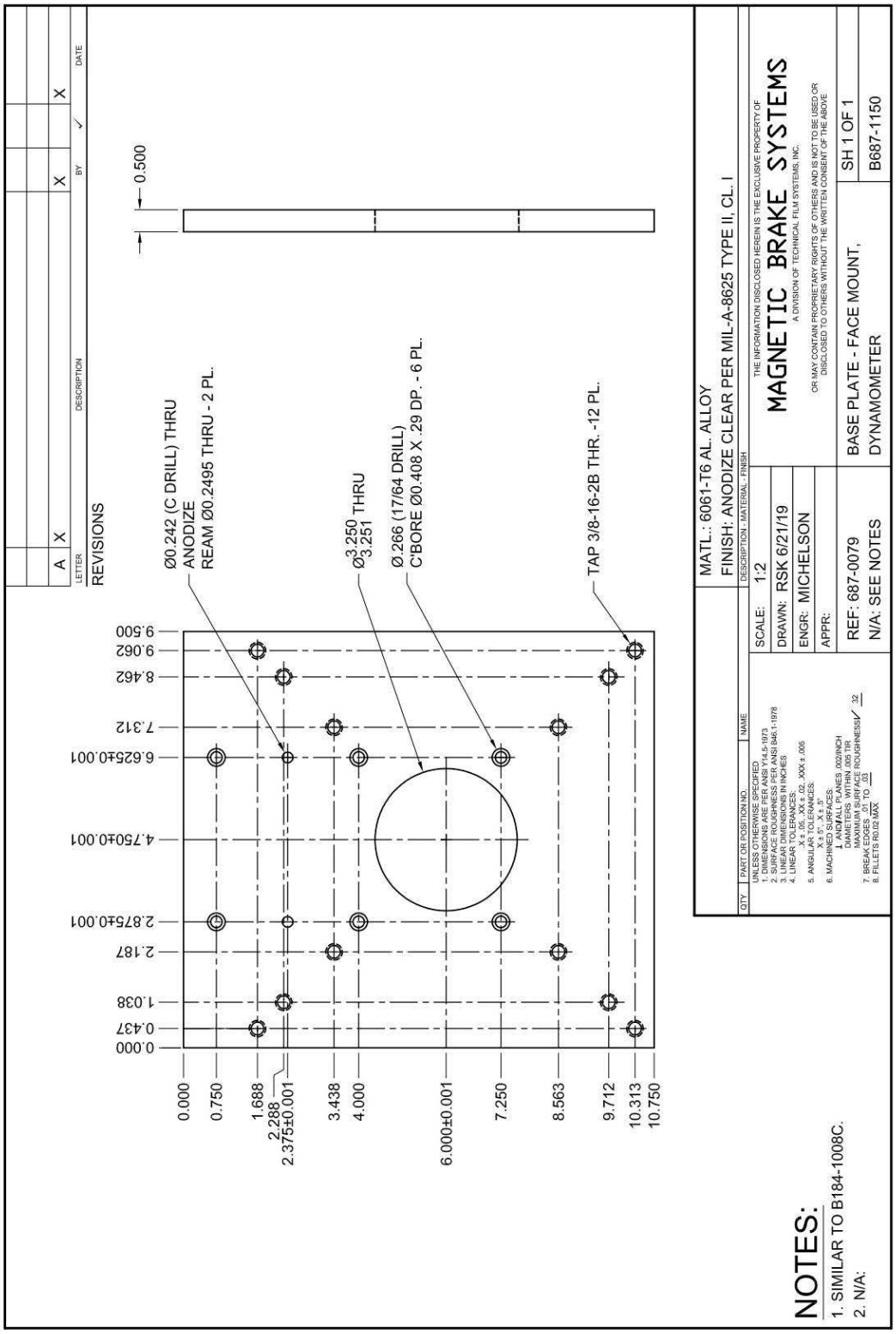
16.3 Environmental and Physical Characteristics:

Operating Temperature Range ..... -40℃ to +85℃
Conducted Susceptibility..... DO-160E Section 20 (1.5 Ma @ 10KHz to 75 Ma @ 500 kHz to 400 MHz
Transient Burst (EN 50155) ..... ±2KV Open CKT test voltage supply leads
Electrostatic Discharge (ESD)..... DO-160E Section 25 Category A
Humidity (Operating)..... 0% to 100% R.H.
Moisture Resistance ..... MIL-STD-202 Method 106
Random Vibration (Operating) MIL-STD-810F, Proc.1, Cat.12,
WO=0.095G2/Hz, ... Time1 hr., Overall Level 12.G-RMS
Shock ..... 50g 11m-sec. half sine pulse
Isolation ..... Input to output 5KV RMS 60 Hz/1min.
Insulation Resistance..... 500 M-Ohms @ 100 VDC
Case Material ..... Brass
Finish..... Fuse tin plate per ASTM-B-545
Weight ..... 4 lbs. Max

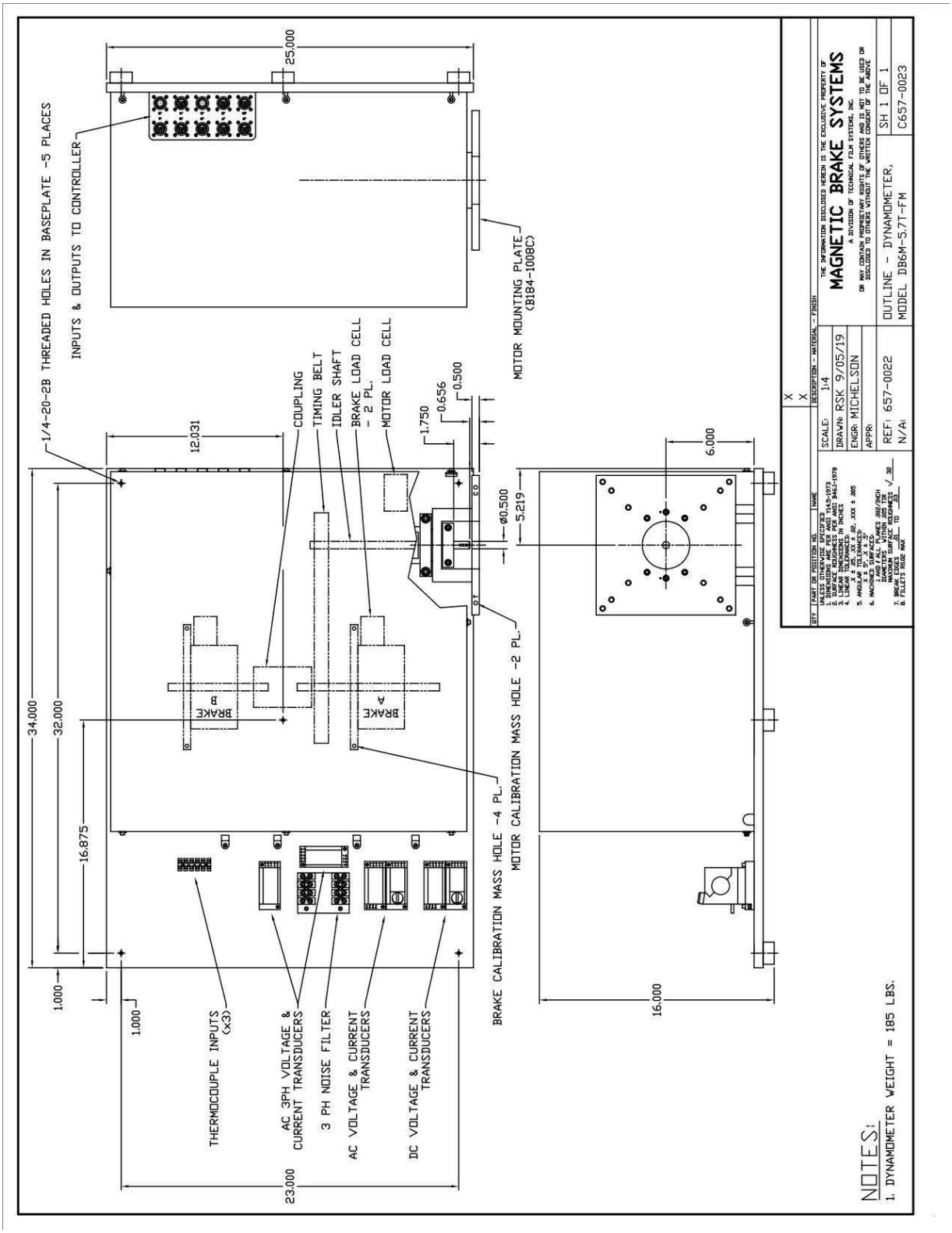
17. DYNAMOMETER LAYOUT – DB6B-5.7T-FM, L.C. ON BRAKES



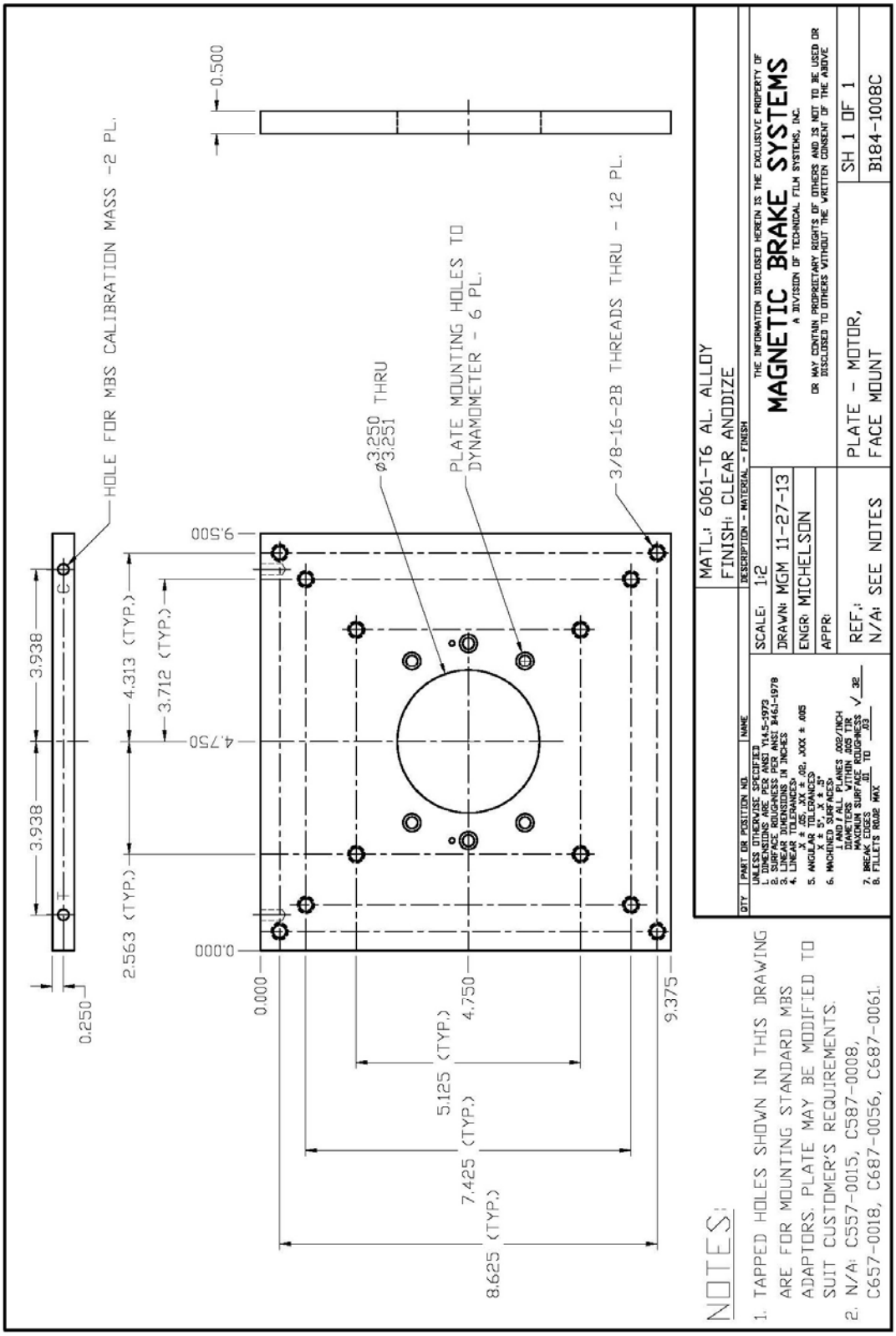
18. MOTOR MOUNTING PLATE – DB6B



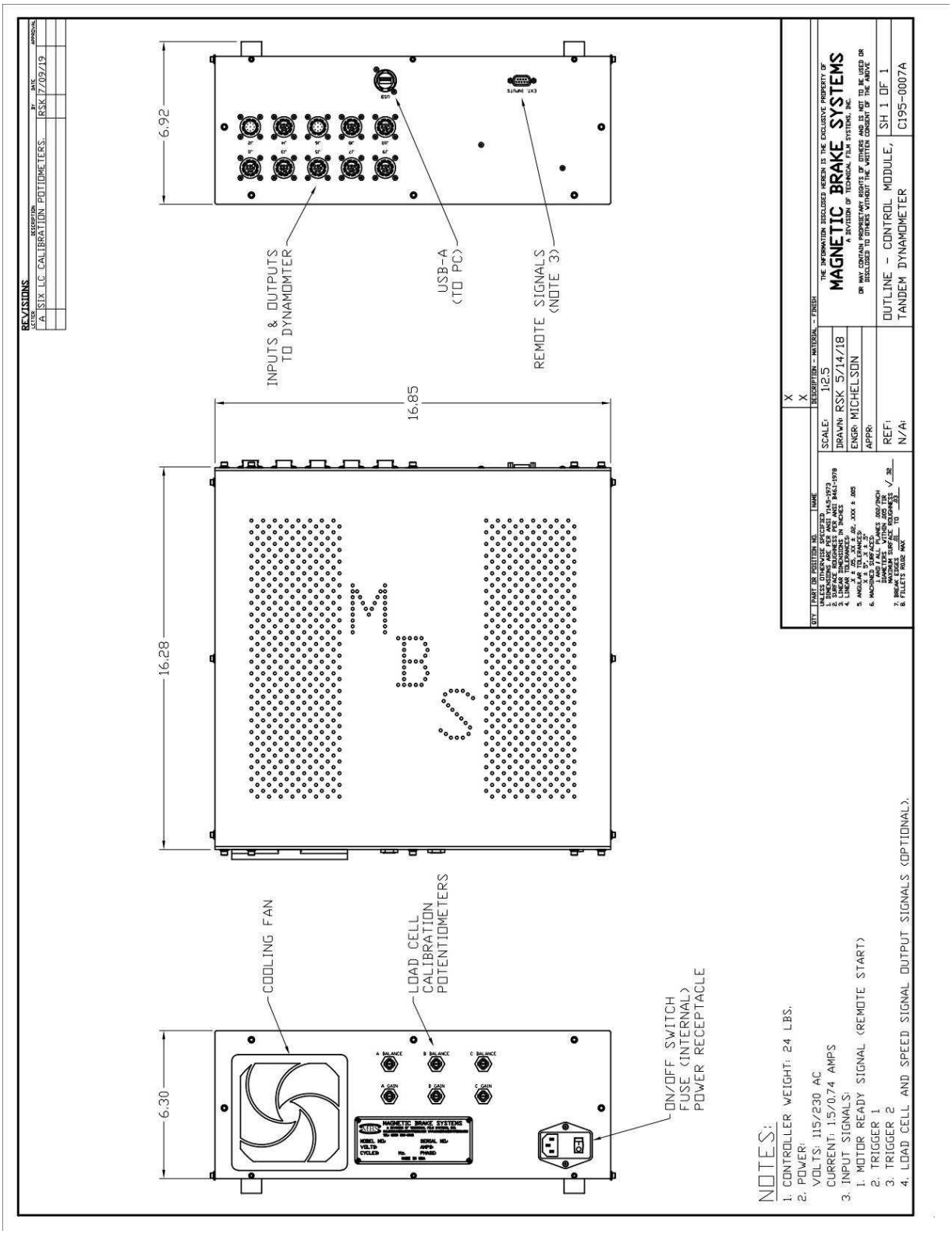
19. DYNAMOMETER LAYOUT – DB6M-5.7T-FM, L.C. ON MOTOR



20. MOTOR MOUNTING PLATE – DB6M



21. CONTROLLER – DYNAMOMETER, TANDEM



20. NOMENCLATURE OF DYNAMOMETER PART NUMBER

DB6M-8.7T-FM

Motor Mounting Style:
- **FM = Face Mount**
- **BM = Base Mount**
- **CB = Carriage Base**

Number of Brakes:
- **T = Tandem System**
- **Omitting T = single brake system**

Brake Size:
- **17.5 = MBZ-17.5 brake**
- **8.7 = MBZ-8.7 brake**
- **5.7 = MBZ-5.7 brake**
- **3.7 = MBZ-3.75 brake**
- **2.4 = MBZ-2.4 brake**

Load Cell Location:
- **M = Measuring Motor Torque**
- **B = Measuring Brake Torque**

Centerline Distance:
- **5 = 5 inches from top of baseplate to centerline of motor shaft.**
- **6 = 6 inches from top of baseplate to centerline of motor shaft**

System Type:
- **B = Belt Coupled system**
- **I = Inline system**

- **D = Dynamometer**

The load cell(s) size(s) and type(s) of voltage & Current transducers are to be specified individually.