Westec Instrumentation

M   i l lM   in d er

AUDIO SIGNAL CONVERTER

IM-1

September 2003

USA: 10537 Bradshaw Dr. Fort Worth, TX 76108
Tel/682-336-1259
E-mail: westecinstrumentation@gmail.com

CATALOG NUMBERING SYSTEM

MILLMINDER 9 0 2 0 _ _ _ 2

First blank (enclosure):

- 0 OPEN STYLE
- 1 NEMA 4 STEEL
- 2 NEMA 4X SS

Second blank (power):

- 1 115V 50/60 HZ
- 2 230V 50/60 HZ

Third blank:

- 1-5 NUMBER OF CHANNELS

MILLPHONE 6 1 0 0 1 0 1 1

SPECIFICATIONS

POWER SUPPLY	- 115 VAC, 50 / 60 HZ, 20 VA – STANDARD - 230 VAC, 50 / 60 HZ, 20 VA – OPTIONAL
ENCLOSURE	- NEMA 4 MILD STEEL - NEMA 4X 304 STAINLESS STEEL - 20”H X 16”W X 7.5”D
INPUT	- MILLPHONE
OUTPUT	- ONE PER CHANNEL, EACH WITH AN INDIVIDUAL ZERO AND SPAN TO ALIGN RECORDER TRACE OR TO SUIT SPECIAL CALIBRATION - 4-20 MA INTO 750 OHMS MAX. - ALL NEGATIVE TERMINALS ARE ON A COMMON BUS

INSTALLATION

MODULE RACK

The Module Rack should be mounted in an area that is clean, dry, vibration free, within the equipment's ambient temperature range and non-corrosive to the electronics or the enclosure if supplied. The enclosure door should swing fully, allowing access for wiring and calibration.

DO NOT MOUNT THE MODULE RACK IN DIRECT SUNLIGHT

Refer to figure 1 for mounting dimensions and remove the Module Rack from the enclosure when drilling for conduit or cable entrance.

MILLPHONE

The millphone location on the mill shell is extremely critical as there may be only a small specific area where the sound signal is actually inversely proportional to the mill load. Some locations will have sound signal reversals, that is, for a further decrease in actual load the mill will start to become quieter.

Therefore, the mounting brackets must allow for a large variation in microphone location so that the final location can be determined during start-up of the control system. Refer to figure 2 for mechanical dimensions and figure 3 for the area of the mill shell that must fall within the adjustment range of the microphone.

INTERCONNECTION and CABLING

ALL WIRING MUST BE DONE IN CONJUNCTION WITH APPROVED CONDUIT, BOXES AND FITTINGS AND TO PROCEDURES IN ACCORDANCE WITH ALL GOVERNING REGULATIONS.

The Module Rack and millphone (s) should be interconnected per figure 4. The cabling should be a two wire twisted shielded pair from the microphone to the Module Rack. Use Belden 8760 or equivalent to a maximum run of 1,000 feet.

The mA output signal cabling can also be Belden 8760, to a maximum run of 2000 feet.

Cabling should be run in separate conduits or in instrument cable trays per standard instrumentation practices. The microphone signals are low-level millivolt A.C. and deserve the consideration these types of signal levels require.

Millphone locations are identified in the application bulletins in the back of this manual.

OPERATION

APPLICATIONS

The MillMinder is a mill load level sensing system used to monitor the sound (noise) emanating from a grinding mill. The millphone assembly placed below the point of impact between the mill charge and the mill shell detects the predominantly audible frequencies. The millphone / sound sensor transmits its signal to an amplifier / converter where the signal at a selected frequency is amplified and converted to an analog mA output signal.

CIRCUIT DESCRIPTION

The MillMinder contains the following cards

1. Module Rack … … … ……MR-50
2. Voltage Regulator Card VR-50
3. Meter Card … … … … …MC-50
4. Sonic Sensor Card… … …SS-50

MODULE RACK, MR-50

The MR-50 is supplied with 115 VAC (or optional 230 VAC) power supply. The supply line is wired into terminal block 6TB. There is a set of fused (5A Slo-Blo) auxiliary supply terminals provided. An On / Off power switch is supplied for the MR-50 but the auxiliary supply is not switched. A ¼ AMP Slo-Blo (1/8 Amp for 230 VAC units) fuse protects the supply line and a surge suppressor is used to protect the circuitry from high surges in the supply. The transformers and large filter capacitors for the power supply are mounted on the MR-50 Module Rack.

VOLTAGE REGULATOR, VR-50

The VR-50 consists of three power supplies for the system. The card is plugged into 7ECN on the MR-50 Module Rack.

There is a +5V bus, with D COMMON, for the digital circuitry, a +24V bus, with P COMMON, for the relay driver circuits, and a +15V and –15V bus, with A COMMON for the analog circuitry. The three commons are connected together on the VR-50 card, but are to be wired as separate COMMON busses at the terminal block 7TB on the MR-50.

The four LED's indicate when the power supply is ON. If the supply is less than rated, the LED will be dimmer than normal.

METER CARD, MC-50

The MC-50 is a 0 to +10 VDC meter which is used during set-up and calibration.

The MC-50 consists of a full wave precision rectifier to assure that there will be a positive voltage to the meter regardless of the polarity of the input signal.

The input signal connected at test point TP2 (Red) is fed through a buffer, IC1-c. The signal is applied directly to an inverting amplifier, IC1 -a, and through a half wave rectifier, IC1-b.

If the input is a negative voltage the voltage at the anode of D1 will be zero. Therefore, the output of IC1-a is the inverted signal.

If the input is positive voltage the output of IC1-b will be the inverted input signal. This is summed with the input signal. The output of IC1.a is the input signal plus twice the inverted input signal.

The signal is available at the test point TP1 (Yellow) for connection to an auxiliary meter.

The COMMON test point TP3 (Green), is used when measuring a signal from equipment other than the MR-50 and for use with an auxiliary meter.

The LED signifies a negative voltage input.

SONIC SENSOR CARD, SS-50

The SS-50 is an input card for the millphone signal. The cards are plugged into edge connectors 1ECN to 5ECN on the MR -50 Module Rack, one per channel (millphone). The SS -50 consists of a signal conditioner, limit circuitry and a voltage to current converter.

The signal conditioner consists of a two-stage amplifier with fine and coarse gain control, an active filter with adjustable center frequency dependent upon the type of mill being controlled (refer to Page 8 for R_A and R_B values for a specific frequency), and a full wave precision rectifier with an offset and gain control.

The two stage amplifier consists of IC1 and IC2 with coarse gain control SW1, and fine gain control (P1) GAIN A. R24A is used as a load resistor for the microphone’s transformer secondary. The gain ranges from 0.25 to 54.

The signal is then processed through an active band pass filter, IC3 to amplify the desired frequency. The center frequency of the filter is selected with the

FREQUENCY switch, SW2. Position 1 is 3.3 KHz, position 2 is for 1 KHz, and position 3 is for a custom frequency.

The full wave precision rectifier consists of a half wave rectifier (IC4 -a) and in inverting amplified (IC4-b).

The voltage at the anode of D2 will be zero when the signal is negative. When the input is positive the voltage will be the inverted input.

Therefore, the output of IC4-b will always be positive when the OFFSET voltage is zero. The output of IC4 -b can be doubled with GAIN B. This signal can be seen at the Blue test point TP3, (V in). This voltage varies fro m 0 to 10 VDC for an input signal level of 1 to 100%.

'V in' is connected to an amplifier whose output is offset by a voltage of –10V. This signal is a 0 to 10 VDC signal proportional to the load of the mill and is available at the Yellow test point TP2, (V out).

'V out' is converted to an analog mA output signal with ZERO and SPAN adjustments. The circuitry will maintain a stable current output signal referenced to COMMON throughout the rated load.

The circuitry is basically a closed loop regulating f eedback system. 'V out', which has SPAN adjustment, is summed at the input IC6 -a with the feedback signal, which is proportional to the current flow. IC6 -a acts as a very high gain comparator. There is an offset current adjustment via the ZERO potentiom eter at this summing junction. Any error between the two signals will cause the output current flowing through sensing resistor R65 to vary in a direction to reduce the error to zero. IC6-b functions as a unity gain inverter driving the level shifting ci rcuitry consisting of Q1 and R64 which drives the current output transistor Q2.

It is important to note that the output voltage developed across the current sensing resistor, R65, will float with respect to COMMON, a varying amount dependent on the extern ally connected op amp with a very high common mode rejection ratio, and ensures that the floating current signal is sensed accurately.

In order to achieve the required high common mode rejected, it is necessary to observe the design requirement that the r atio of R63 to R73 is the same ratio of R77 to R75. The requirement is achieved by using 1% resistors and inserting a small trim -pot, P9, which may be adjusted to achieve the required exact ratio. P9 is a sealed factory adjustment.

The output of IC6 -c is connected to a voltage follower, IC6 -d, to give a voltage signal representing the current output with ZERO and SPAN adjustments.

CALIBRATION

SS – 50 Set-up Procedure

The following setting are preset at the factory:

P1	Gain A	CCW
P2	Offset	CCW
P3	Gain B	CCW
P4	Limit	CW
P5	Rate	CW
P7	Zero	Do Not Adjust
P8	Span	Do Not Adjust
SW1	Gain	Position 1
SW2	Frequency	Select Position from Table Below

Device	Position
Cement – Finish	1
Cement – Raw, Dry	1
Cement – Raw, Wet	2
Coal	1
Aerofall	3
Autogeneous	3
Rod Mill	3

Dynamic Adjustment to First Compartment
(With mill running at normal levels)

1.1 Connect a jumper wire between V IN test point TP-3 (Blue) on the SS-50 card to the SIGNAL test point TP-2 (Red) on the MC-50 meter card.
1.2 Adjust coarse GAIN switch (SW1) until the meter card reads between 1 and 5 VDC.
1.3 Adjust fine GAIN A (P1) potentiometer clockwise until meter card reads 5 VDC.
1.4 Connect the jumper from TP-2 (Red) on the meter card to V OUT test point TP-2 (Yellow) on the SS-50 card. The reading should be 5 VDC +/- 0.5.
1.5 Adjust the RATE potentiometer (P5) on the SS-50 card until the meter reading has about a 0.5 to 0.75 volt short term bounce.
1.6 ZERO (P7) and SPAN (P8) have been factory set to provide a 4-20 mA output with a V OUT change of 0 to 10 VDC.

Dynamic Adjustment to Second Compartment

2.1 Connect a jumper wire between V IN test point TP-3 (Blue) on the SS-50 card to the SIGNAL test point TP-2 (Red) on the MC-50 meter card.
2.2 Adjust coarse GAIN switch (SW1) until the meter card reads between 1 and 5 VDC.
2.3 Adjust fine GAIN A (P1) potentiometer clockwise until meter card reads 5 VDC.
2.4 Adjust GAIN B (P3) potentiometer clockwise 10 turns. The meter reading should now be less than 5 VDC.
2.5 Adjust the OFFSET (P2) potentiometer until the meter card reading is 5V.
2.6 Connect the jumper from TP-2 (Red) on the meter card to V OUT test point TP-2 (Yellow) on the SS-50 card. The reading should be 5 VDC +/- 0.5.
2.7 Adjust the RATE potentiometer (P5) on the SS-50 card until the meter reading has about a 0.5 to 0.75 volt short term bounce.

Increasing Sound Sensitivity to Load Changes (When required)

The need for this adjustment will be determined during actual automatic start-up and automatic operation.

3.1 Follow steps 2.1 – 2.3
3.2 Instead of following step 2.4, turn GAIN B (P3) potentiometer clockwise 5 turns.
3.3 Observe sound change results.
3.4 If sound changes are deemed not to be significant enough, increase GAIN B two turns at a time until results are satisfactory.
3.5 Complete steps 2.5 – 2.7

4-20 mA Trace Relocation

There are occasions when the trace created by the 4-20 mA output on a recorder may not be located correctly or interferes with another trace on a multi-trace recorder. The 4-20 mA potentiometers may be adjusted to match the recorder trace.

4.1 Jumper terminals 1 and 2 on the TB 1 through 5 associated with the correct SS-50 card.
4.2 This will cause the V OUT signal to go to 10 VDC (or close to it).
4.3 Adjust the SPAN (P8) until the desired output current or recorder trace position is achieved.

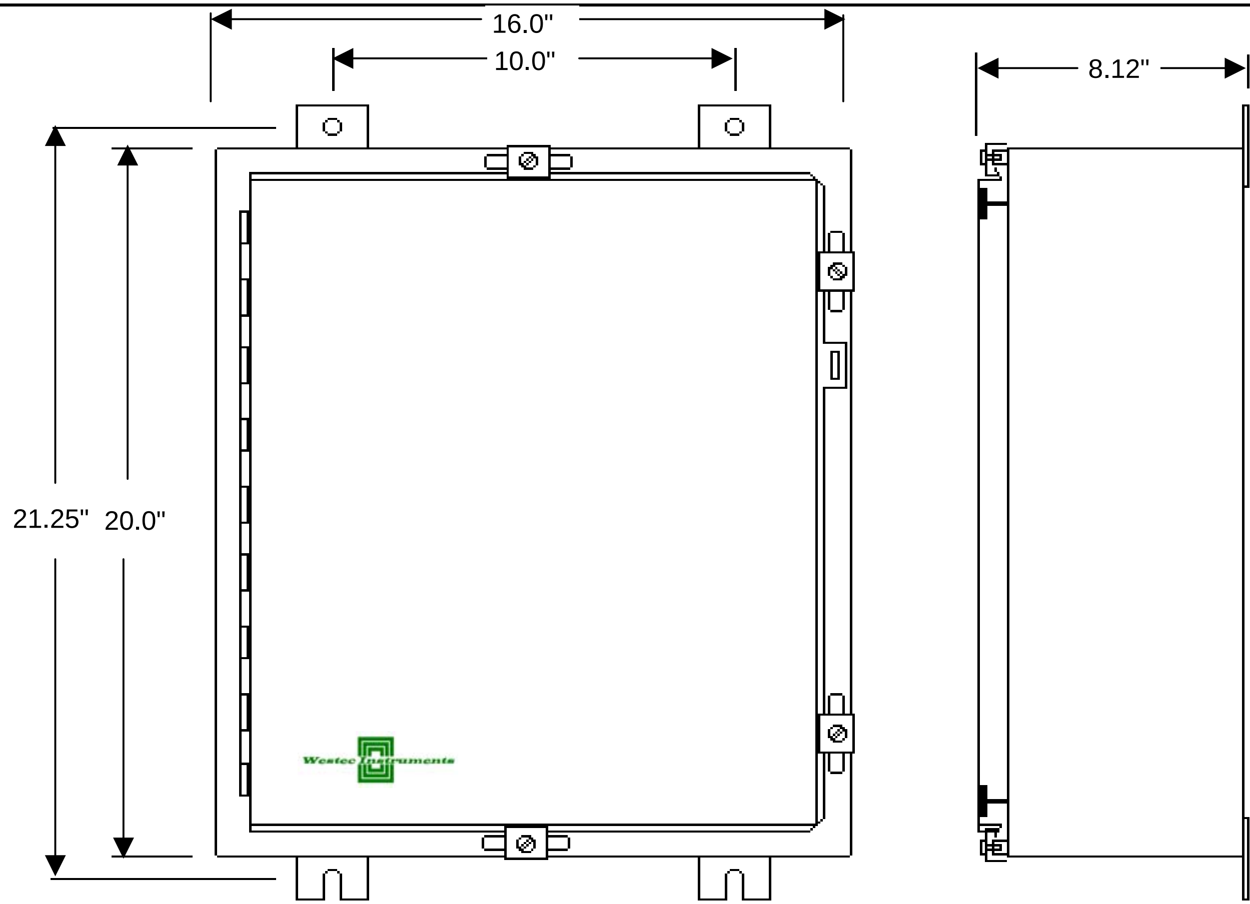
Fine Tuning from the Frequency Chart

Center frequencies may be adjusted by bridging various value resistors across RA and RB plug points. Refer to the following chart for correct values:

Device	Frequency (Hz)	RA & RB Values
Cement - Finish	3300	10 K
	2500	12.9 K
Cement - Raw, Wet	1000	32.4 K
Cement - Raw, Dry	3300	10 K
	1000	32.4 K
	750	42.5 K
Aerofall	3300	10 K
	2100	15.2 K
	1750 (Wet)	18.2 K
Coal	3300	10 K
Rod Mill	8000	
	1800	17.8 K
	350	90 K
Cascade	1000	32.4 K
	1750	18.2 K
	2100	15.2 K
	3300	10 K
Regrind Mill	3300	10 K
	1000	32.4 K
	350	90 K

Appendix A

Drawings



ENCLOSURE,
NEMA 4,
HOFFMAN,
A-20H16-ALP
PART # 22000065

NO	DESCRIPTION	DATE

REVISIONS

SCALE	NTS	DATE
DRAWN	WWC	2/22/1999
CHECKED	WWC	2/22/1999
APPROVED	WWC	2/22/1999

TITLE

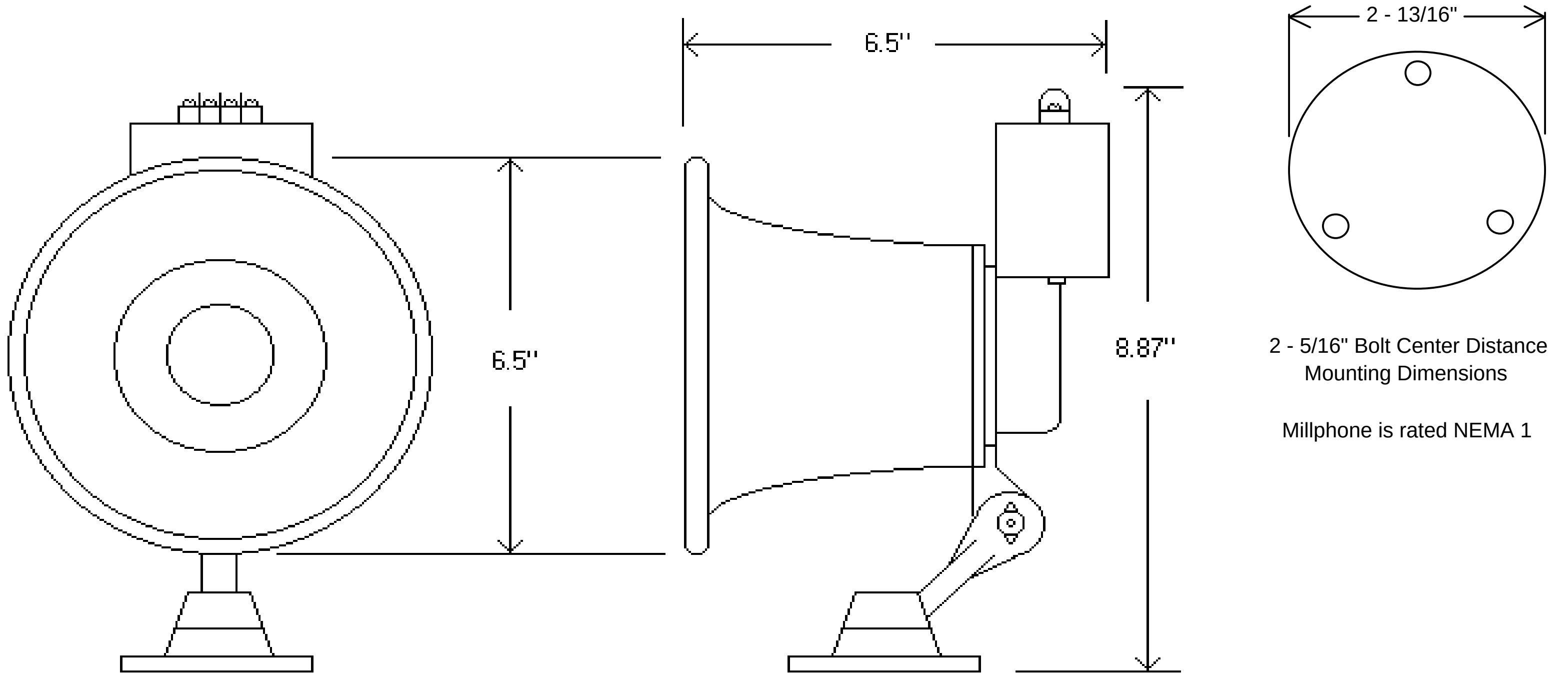
MILLMINDER ENCLOSURE
OUTLINE DIMENSIONS

Westec Instrumentation

		DRAWING NO.	REV
FILE	20153500		
PLOT	1 = 1		
JOB NO.		1-11111Z-DU-B	0

FIGURE 1

MILLPHONE



NO	DESCRIPTION	DATE

REVISIONS

SCALE	NTS	DATE
DRAWN	WWC	2/22/1999
CHECKED	WWC	2/22/1999
APPROVED	WWC	2/22/1999

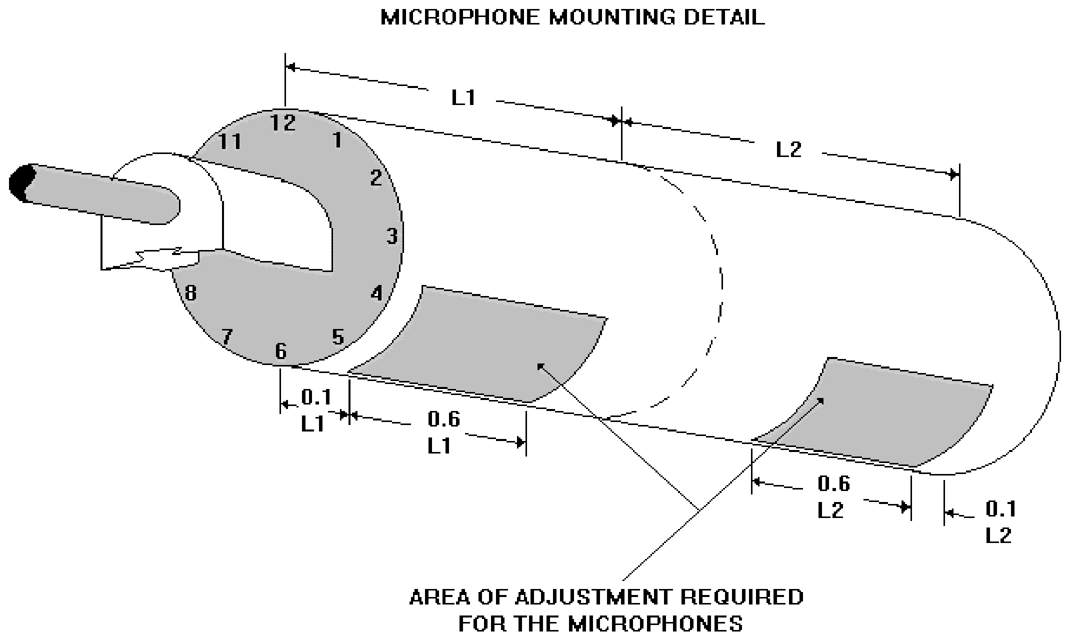
TITLE

MILLPHONE ASSEMBLY
OUTLINE DIMENSIONS

Westec Instrumentation

FILE	20153600	DRAWING NO.	REV
PLOT	1 = 1		
JOB NO.		1-20001Z-DU-B	0

FIGURE 2



NO.	DESCRIPTION	DATE

REVISIONS

SCALE	NTS	DATE
DRAWN	WWC	May 24, 1998
CHECKED	WWC	May 24, 1998
APPROVED	WWC	May 24, 1998

TITLE

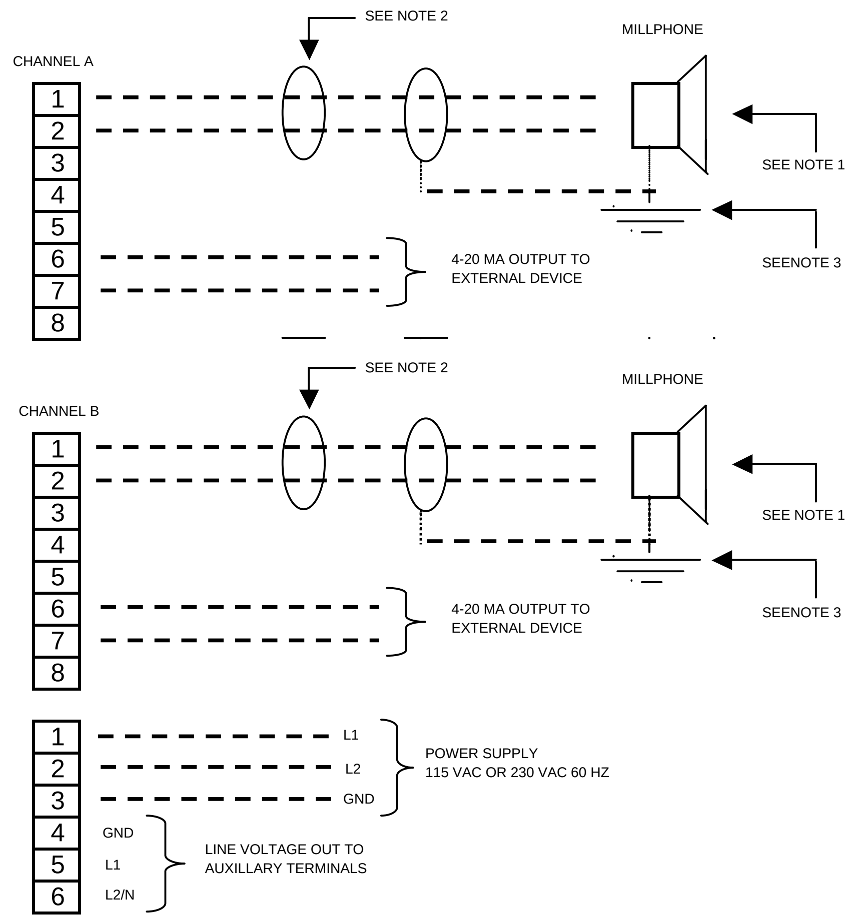
MILLPHONE MOUNTING DETAILS
MOUNTING DIMENSIONS

FILE	DRAWING NUMBER	REV
PLOT 1 = 1	10A758	
JOB NO.		

FIGURE 3

NOTES:

1. NON - POLARIZED UNIT
2. BELDEN 8760 OR EQUAL (MAXIMUM 1000 FEET)
3. SHIELD GROUNDED AT MILLPHONE
4. MICROPHONE ASSEMBLY IS RATED NEMA 1
5. INTERCONNECTION CABLE IS PROVIDED BY CUSTOMER
6. CHANNELS A - E ARE DETAILED ON MODULE RACK DRAWING



THE AUXILLARY TERMINALS ARE POWER FOR AN EXTERNAL DEVICE SUCH AS A CIRCULAR CHART RECORDER LOCATED NEXT TO THE MILLMINDER TO TRACK A BALL MILL. THIS VOLTAGE OUTPUT IS CREATED BY THE MODULE RACK.

NO	DESCRIPTION	DATE
1	Added notes	6/4/2000

REVISIONS

SCALE	NTS	DATE
DRAWN	WWC	6/4/2000
CHECKED	WWC	6/4/2000
APPROVED	WWC	6/4/2000

TITLE

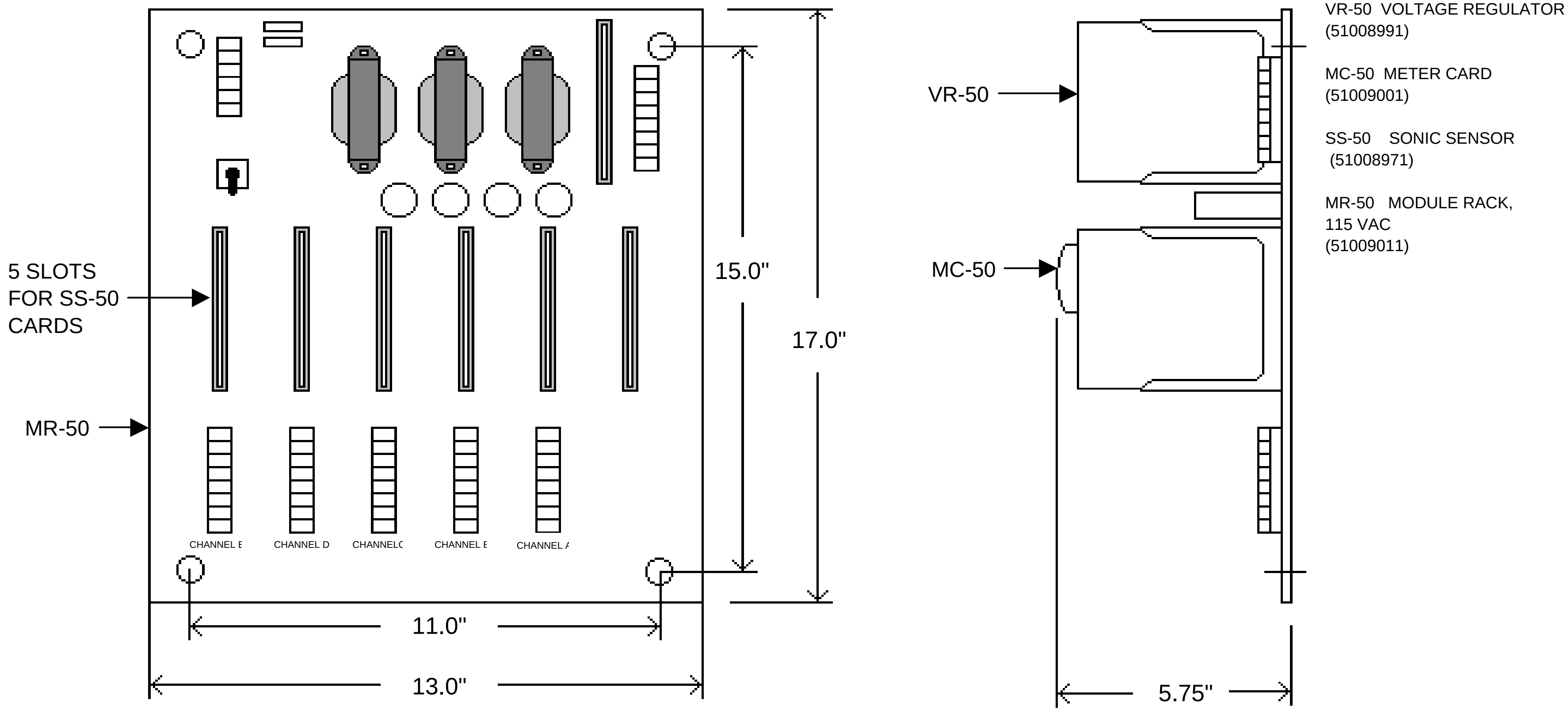
MILLMINDER W / 2 MILLPHONES

INTERCONNECTION DIAGRAM

Westec Instrumentation

FILE 20290900	DRAWING NO.	REV
PLOT 1 = 1		
JOB NO.	1-11112Z-DI-B	1

FIGURE 4



NO	DESCRIPTION	DATE

REVISIONS

SCALE	NTS	DATE
DRAWN	WWC	2/22/1999
CHECKED	WWC	2/22/1999
APPROVED	WWC	2/22/1999

TITLE

MODULE RACK - OPEN STYLE

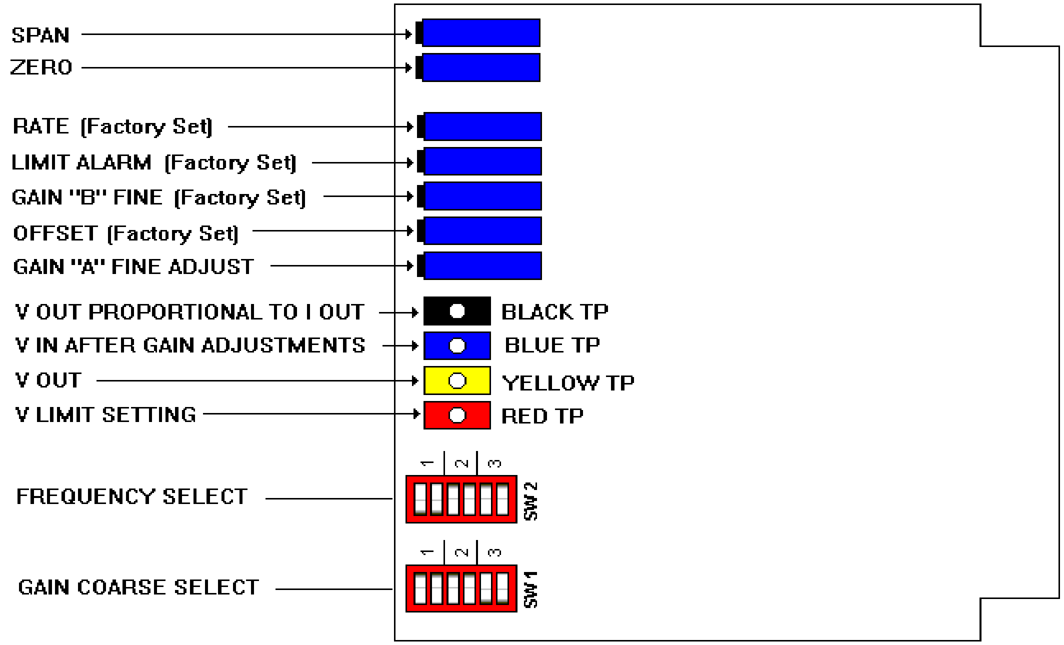
OUTLINE DIMENSIONS

Westec Instrumentation

FILE	20074301	DRAWING NO.	REV
PLOT	1 = 1		
JOB NO.		1-10111Z-DU-B	0

FIGURE 5

SONIC SENSOR CARD SS-50 OUTLINE DIAGRAM



SW2	POSITION	CLOSE	OPEN	FREQUENCY
	1	1,2	3,4,5,6	3.3 KHZ
	2	3,4	1,2,5,6	1.0 KHZ
	3	5,6	1,2,3,4	CUSTOM

SW1	POSITION	CLOSE	OPEN	GAIN
	1	1,2	3,4,5,6	.25 TO 1.62
	2	3,4	1,2,5,6	1.25 TO 8.12
	3	5,6	1,2,3,4	8.31 TO 54

NO.	DESCRIPTION	DATE
2	Corrected SW2 Label	06/16/05
1	Changed SW1 & SW2	09/20/02

REVISIONS

		DATE
SCALE	NTS	
DRAWN	WWC	09/20/02
CHECKED	WWC	09/20/02
APPROVED	WWC	09/20/02

TITLE

SS-50 SONIC SENSOR CARD
ADJUSTMENT DETAILS

Westec Instrumentation

FILE

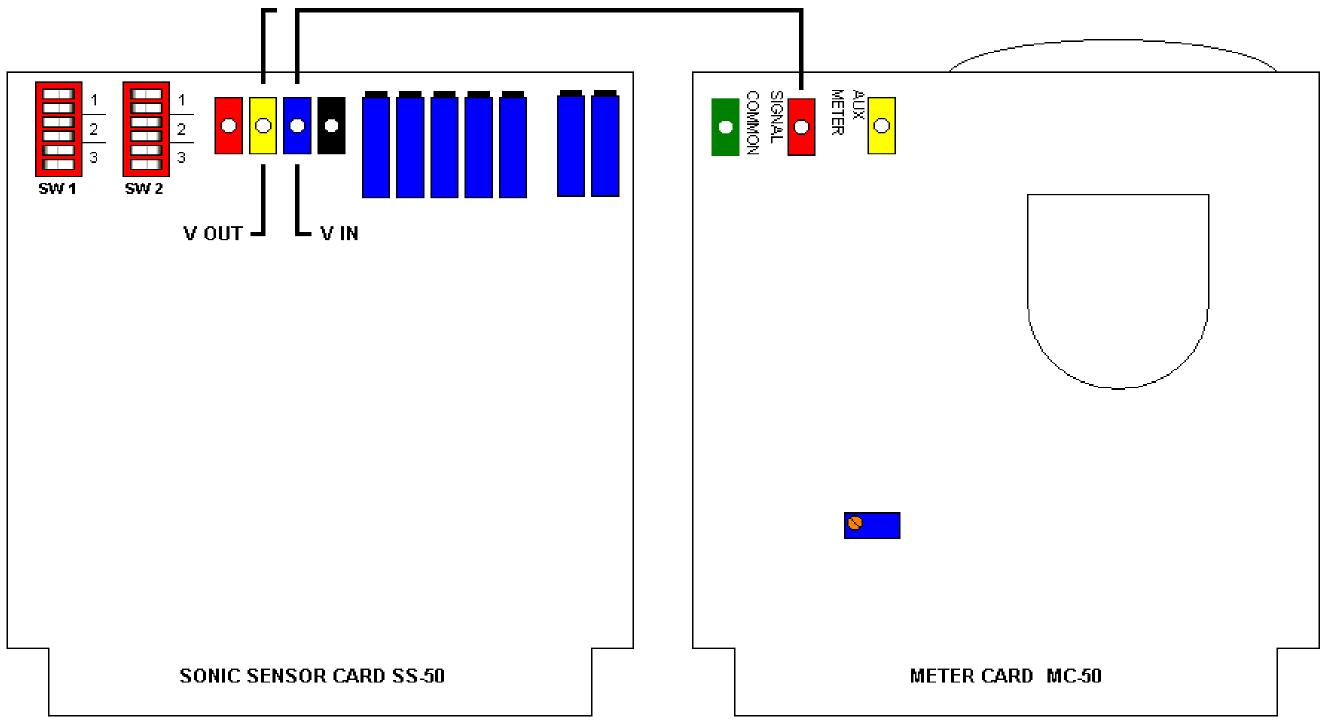
PLOT 1 = 1

JOB NO.

DRAWING NUMBER 1-10111Z-DT-B

REV 1

FIGURE 6



NO.	DESCRIPTION	DATE

REVISIONS

SCALE	NTS	DATE
DRAWN	WWC	08/07/08
CHECKED	WWC	08/07/08
APPROVED	WWC	08/07/08

TITLE

MILLMINDER SET-UP
SS-50 / MC-50 SETUP

Westec Instrumentation

FILE	DRAWING NUMBER	REV
PLOT 1 = 1	1-20111Z-DT-B	0
JOB NO.		

Figure 7

Appendix B

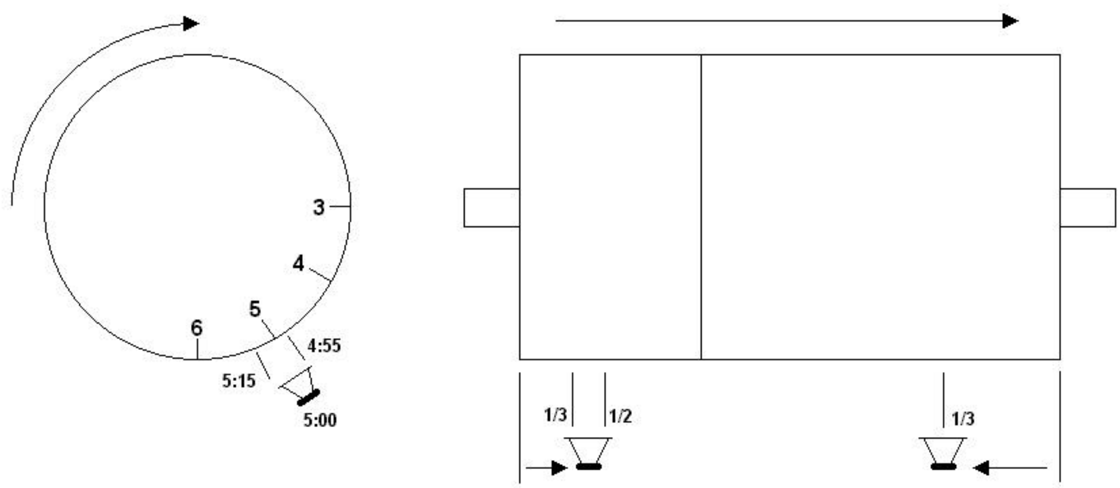
Application Bulletins

Application Bulletin

Cement Finish Mill – Dual Compartment

Microphone Location:

The Microphone on the first compartment in this instance is the most critical and important element. This microphone should be placed about 1/3 of the way from the feed end. If it is too far forward, the sound will not be responsive to recirculating load changes. If it is too far back, the sound will not be responsive to new feed changes. The discharge microphone should be mounted approximately 1/3 of the way from the discharge end. However, if problems of plugging with the discharge grate occur, move this microphone to within three bolt rows of the discharge end.



Sonic Sensor Amplifier Frequency: 3300 Hz
2500 Hz

Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

Equipment Required: MillMinder ASC-2
Two Channel
Two Millphone Microphones

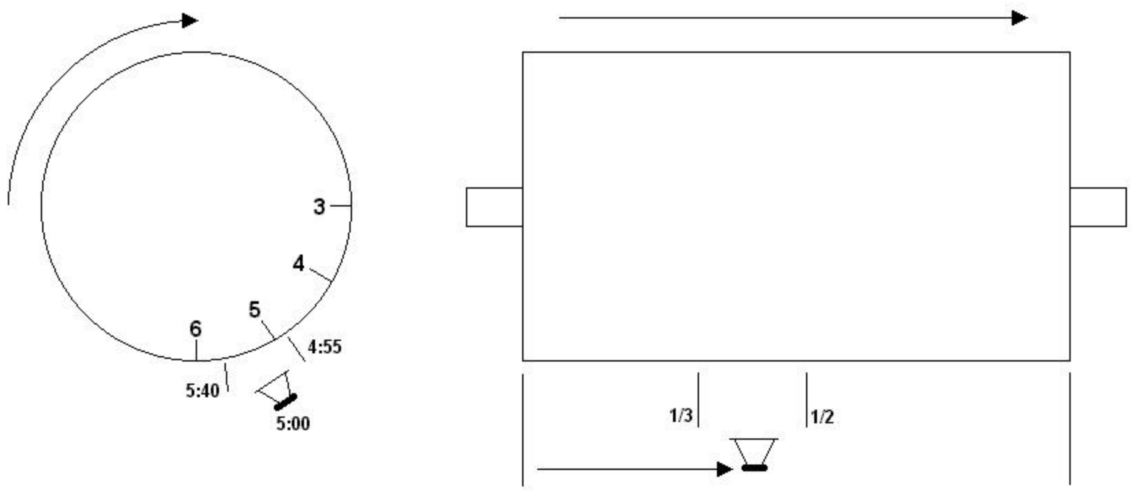
Optional Equipment: Nema 4 Steel Enclosure
Nema 4 Stainless Steel Enclosure

Application Bulletin

Cement, Rock (Wet and Dry) Mill – Single Compartment

Microphone Location:

On this type of mill, the microphone position is not extremely critical, however, experience indicates that the microphone should be mounted just forward of the center of the mill. Mounting between 1/3 and 1/2 from the feed end should easily prove this. In general, with high re-circulating loads, move the microphone towards the feed end and with low re-circulating loads, move the microphone towards the discharge end.



Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

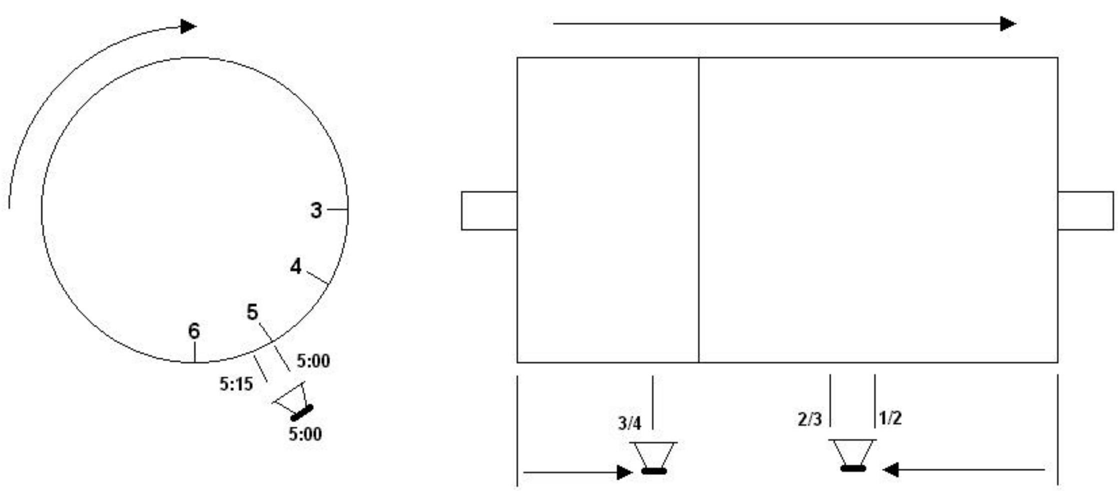
Equipment Required:	MillMinder ASC-2 Single Channel One Millphone Microphone
Optional Equipment:	Nema 4 Steel Enclosure Nema 4 Stainless Steel Enclosure

Application Bulletin

Cement Raw Mill (Wet) – Dual Compartment

Microphone Location:

On these mills, the feed end microphone should be placed fairly close to the discharge end of the primary compartment. This is required because of "water" noise signals caused when the surface area presented by the coarse feed to absorb the water is very small. As a result the water flushes through the area before the rock is broken down giving erroneous signals. The feed end microphone is primarily used to prevent plugging of this discharge grate into the second or succeeding compartments. The microphone on the discharge compartment should be located between 1/3 and 1/2 of the compartment length from the feed end. Here a good homogeneous mixture of slurry should exist and a normal sound signal should result if density is held constant.



Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

Sonic Sensor Amplifier Frequency: 1000 Hz
3300 Hz

Equipment Required: MillMinder ASC-2
Dual Channel
Two Millphone Microphone

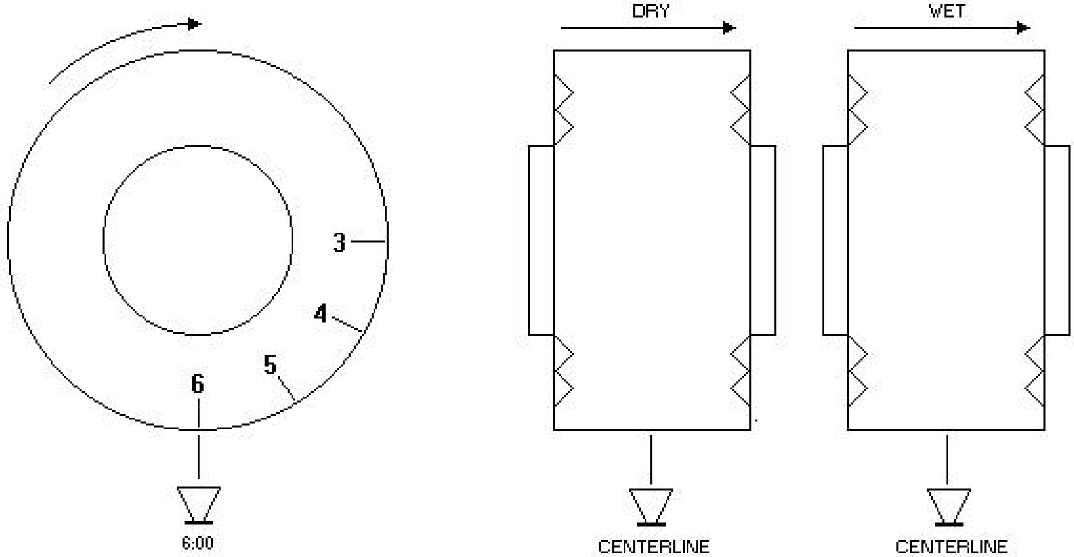
Optional Equipment: Nema 4 Steel Enclosure
Nema 4 Stainless Steel Enclosure

Application Bulletin

Aerofall (Sag) Mill – Single Compartment

Microphone Location:

Microphone should be mounted at the 6 o'clock position with the midpoint along the length of the grinding area. Wet mills may have a lifting chamber which will add to mill length. However, do not include this section when centering microphone. Place microphone as close as possible to the mill shell. Beware of flanges which are used to bolt the mill shell together. If ambient noise level is high, shield microphone.



Sonic Sensor Amplifier Frequency:	3300 Hz as supplied
	2100 Hz best dry/wet
	1750 Hz wet, small feed

Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

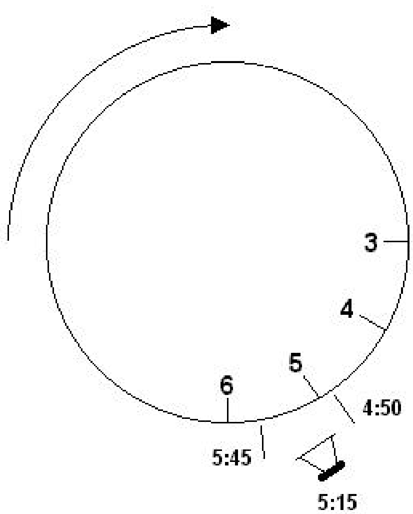
Equipment Required:	MillMinder ASC-2
	Single Channel
	One Millphone Microphone
Optional Equipment:	Nema 4 Steel Enclosure
	Nema 4 Stainless Steel Enclosure

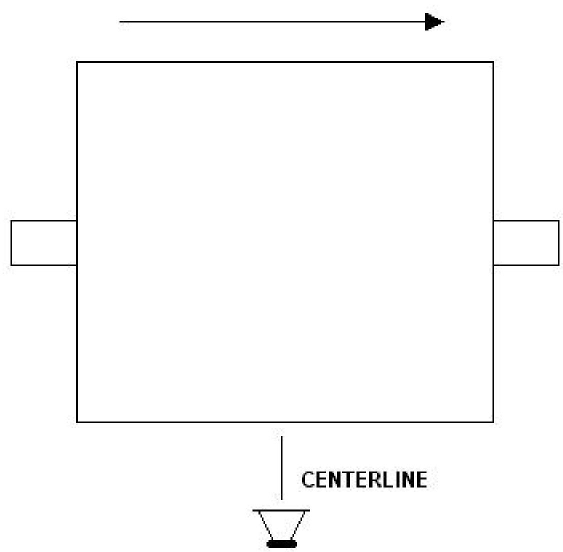
Application Bulletin

Cascade Type Mill – Single Compartment

Microphone Location:

The Microphone on these types of mills should be placed below the toe of the charge. The exact position being defined as a result of how much the mill charge volume changes. The microphone must be at least 0.5 hours below the lowest charge "TOE". Trial and error will be the final judge as to whether the microphone should be lower.





Sonic Sensor Amplifier Frequency:	3300 Hz as supplied 2100 Hz – probable 1000 Hz – probable

Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

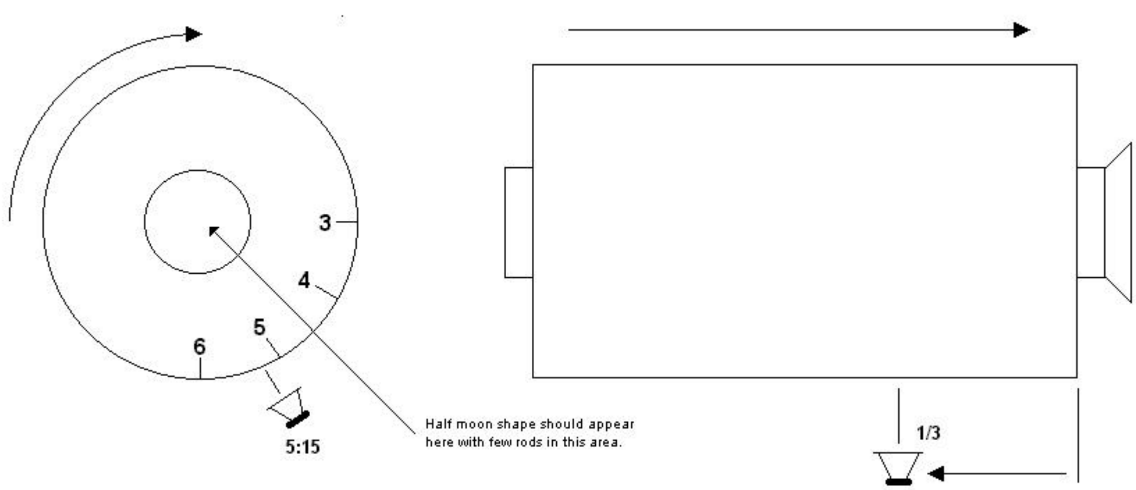
Equipment Required:	MillMinder ASC-2 Single Channel One Millphone Microphones
Optional Equipment:	Nema 4 Steel Enclosure Nema 4 Stainless Steel Enclosure

Application Bulletin

Rod Mill – Single Compartment

Microphone Location:

The Microphone on these types of mills should be placed roughly 1/3 of the way from the discharge end. However, trial and error selection should also include observation at 1 row of bolts either side of the 1/3 position. The microphone should be mounted well down and not higher than 5 o'clock, with 5:15 to 5:30 being the preferable location, especially if rod mill speeds are around 75% critical.



Sonic Sensor Amplifier Frequency:	350 Hz 1800 Hz 8000 Hz

Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

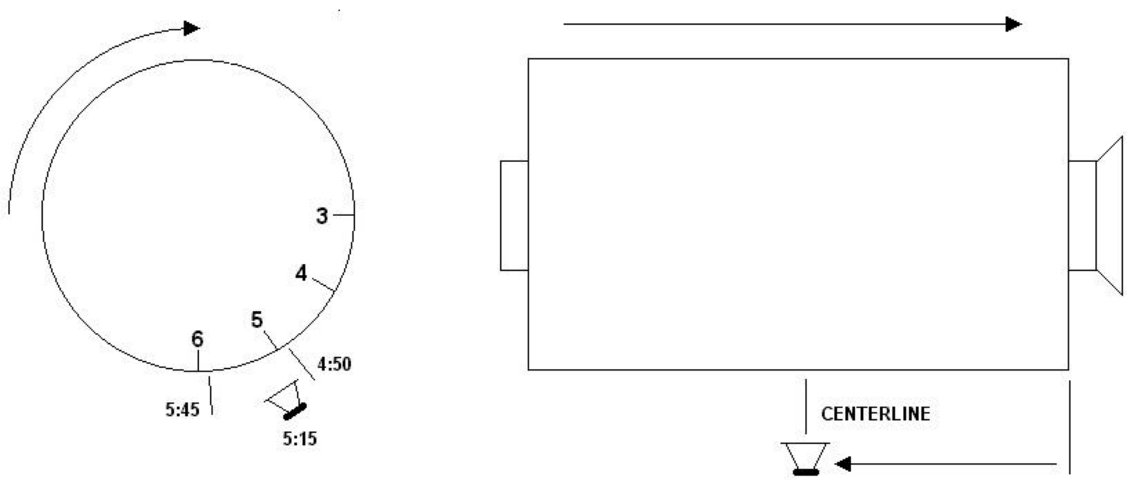
Equipment Required:	MillMinder ASC-2 Single Channel One Millphone Microphones
Optional Equipment:	Nema 4 Steel Enclosure Nema 4 Stainless Steel Enclosure

Application Bulletin

Regrind Mill – Single Compartment

Microphone Location:

The Microphone should be placed approximately ½ way along the mill length slightly toward the discharge end. The microphone should be placed between 4:30 and 5:45 depending on the mill speed and charge. Generally, approximately 5:15 should be the optimal position.



Sonic Sensor Amplifier Frequency: 3000 Hz
1000 Hz
350 Hz

Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

Equipment Required: MillMinder ASC-2
Single Channel
One Millphone Microphones

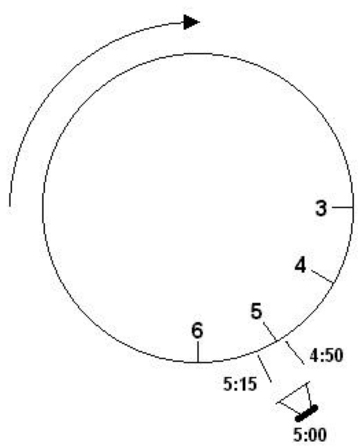
Optional Equipment: Nema 4 Steel Enclosure
Nema 4 Stainless Steel Enclosure

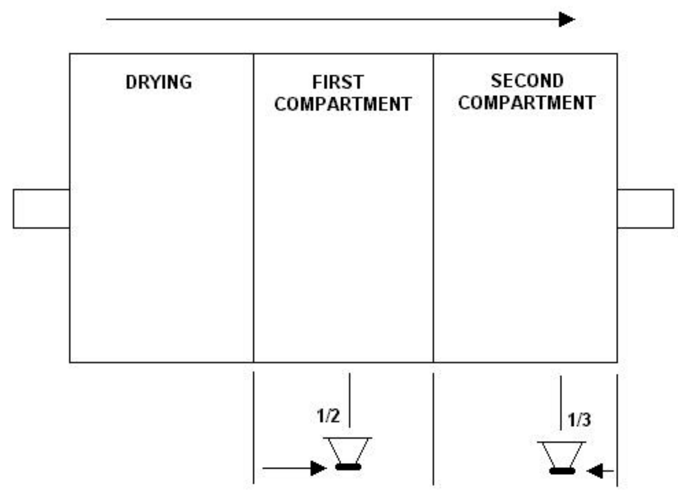
Application Bulletin

Coal Mill, Air Swept, Single Discharge – Dual Compartment

Microphone Location:

The Microphone should be placed approximately in the center of the first grinding compartment. The discharge microphone should be located about 1/3 of the way from the mill discharge.





Sonic Sensor Amplifier Frequency: 3300 Hz

Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

Equipment Required: MillMinder ASC-2
Two Channel
Two Millphone Microphones

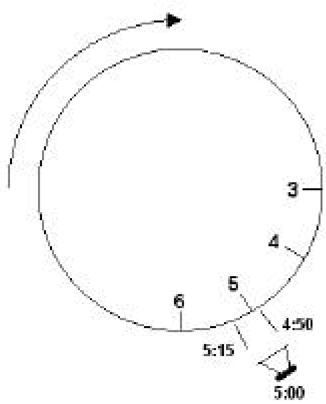
Optional Equipment: Nema 4 Steel Enclosure
Nema 4 Stainless Steel Enclosure

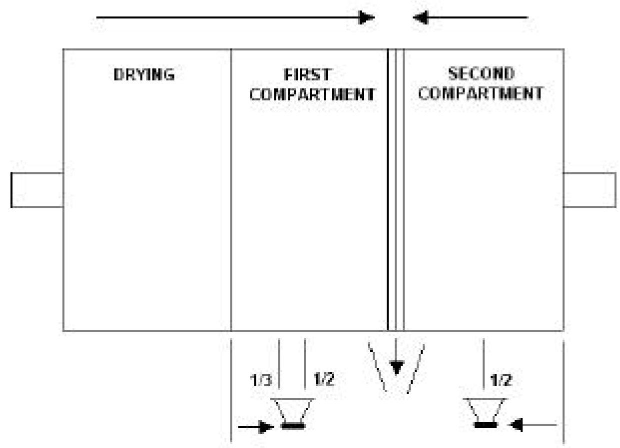
Application Bulletin

Center Discharge, Airswept – Dual Compartment

Microphone Location:

The Microphone on the feed end should be mounted approximately 1/3 to 1/2 distance from the feed end of the primary grinding compartment. the microphone on the secondary grinding compartment should be located about the center of that compartment.





Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

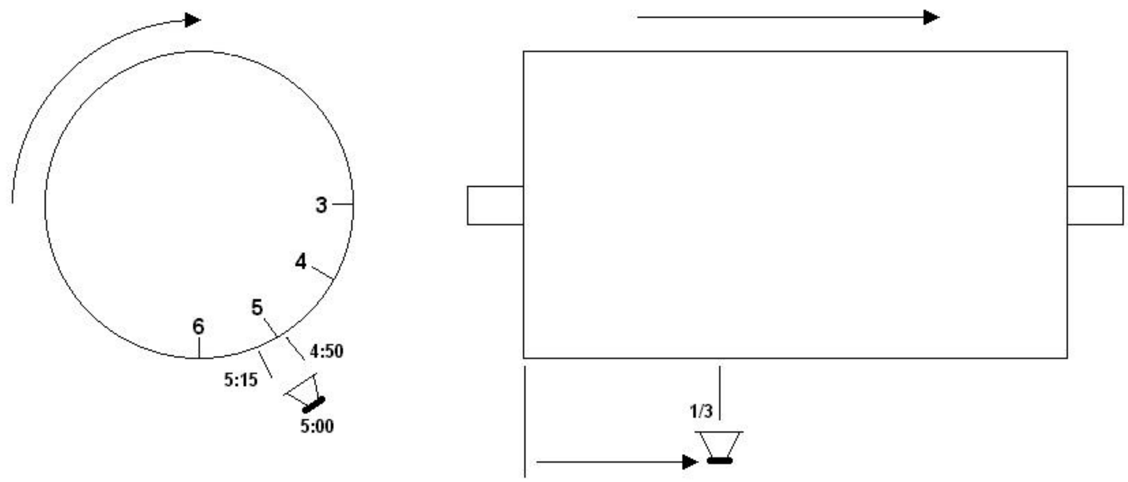
Equipment Required:	MillMinder ASC-2 Two Channel Two Millphone Microphones
Optional Equipment:	Nema 4 Steel Enclosure Nema 4 Stainless Steel Enclosure

Application Bulletin

Airswept – Single Compartment

Microphone Location:

The Microphone should be located about 1/3 of the distance from the feed end of the mill.



Note: These are the most likely locations from which to start. The mounting stands should allow for complete flexibility per drawing 10A758.

Equipment Required: MillMinder ASC-2
Single Channel
One Millphone Microphones

Optional Equipment: Nema 4 Steel Enclosure
Nema 4 Stainless Steel Enclosure