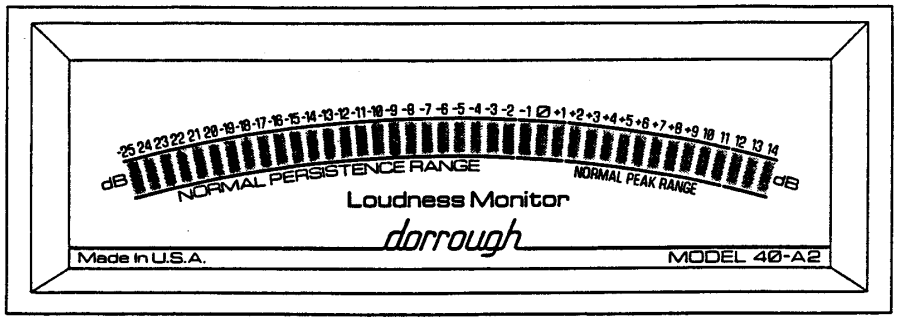
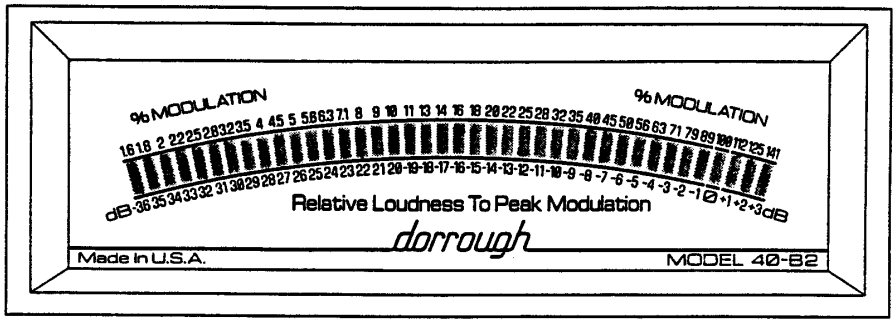
# Technical Instruction Manual

## DORROUGH
## Loudness Monitor
## Model 40-A2




## DORROUGH
## Relative Loudness
## To Peak Modulation
## Model 40-B2




***COVERS MODELS***

**10-A,B,C2 - 12-A,B,C2 - 20-A,B,C2**
**240-A,B,C - 340-A,B,C - 400-A2**

DORROUGH ELECTRONICS
5221 Collier Place
Woodland Hills, CA 91364
(818) 998-2824

# Congratulations,

Thank you for your purchase of a DORROUGH Loudness Monitor. DORROUGH meters are designed to provide the best possible intuitive interface between the user and program material. There are several features and concepts unique to the DORROUGH Loudness Monitor. Please read this instruction manual carefully in order to get the most from this precision instrument.

Those who are already familiar with DORROUGH meters are also advised to read this manual. Your meter is part of a new generation of DORROUGH products with important enhancements. These new features increase efficiency without detracting from compatibility with units already in use.

Newly developed circuitry and a revised system-interface are geared to allow maximum flexibility. The new circuitry is more powerful and *never* requires alignment. Some of the new capablities include:

* Fully Integrated Peak-Hold Function
* XLR Connections
* Enhanced Precision & Stability (+/- .25 dB Accuracy)
* Over-Level Alarm
* Under-Level Alarm
* Computer-Style Interface for Alarms and Peak-Hold Functions

All of this, combined with the patented DPS dynamic metering system, add up to the most comprehensive "picture" of audio ever conceived.

DORROUGH Loudness Monitors are unique products with unlimited possibilities. We hope that you'll keep us posted on your special application!

Thank You,

Mike Dorrough

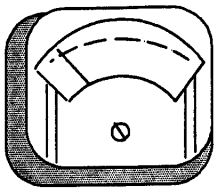
# Contents

# Introduction

Today's audio requires careful attention to precise level control. The consumer now has audio playback systems that stretch the limits of program dynamics. With all this new equipment, the modern listener is able to hear subtle differences in level and distortion within program material and make critical program choices based on the quality of sound.

Now it is more critical for the engineer to obtain the maximum loudness with the minimum distortion components in order to fully utilize the dynamic range available. With the dynamic range that digital audio offers, and the bandwidth now available to film and video productions, it has become of paramount importance that there be a more accurate method of monitoring and establishing the maximum safe level at which the system can operate.

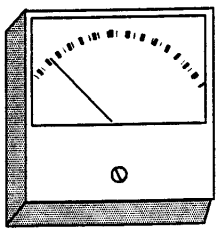
The American Standard... **The Weston (VU) Meter**



The Weston meter, introduced in 1939, was the standard for level monitoring. It met the then new standard for VU (Volume Unit) meters, and those same specifications are still the standard for all VU meters in use today. VU meters were, and are, really nothing more than voltmeters calibrated in power with ballistics chosen to represent program material of the early days of radio and film.

A VU meter is classified as a quasi-average reading device. It almost completely ignores peak waveforms. With the somewhat arbitrary chosen rise time of 300 us, engineers have developed certain compensations, such as riding dialogue 3 to 5 dB below music, to control the peak levels in an attempt to attain consistent listening levels. The standard broadcast practice is to allow for a crest factor of at least 10 dB to cover the peak excursions of the waveform that the VU meter is too slow to indicate. The VU meter was never intended to provide acoustical comparisons between processed and unprocessed program material. Nor was it ever intended to provide indications of peak excursions. Clearly, the VU meter has some dramatic shortcomings when measuring today's dynamic program material.

The International Standard... **The PPM Meter**



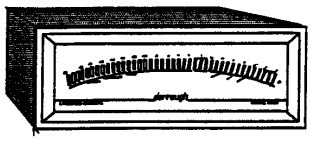
The PPM (Program Peak Meter) meter is not quite as old as the VU meter, being only about a forty-year-old standard, but like the old VU meter was the first answer to the obvious shortcomings of the VU meter, but, because it displays and holds only the peak level of the waveforms, the integration time of the quasi-average program level is almost completely ignored. The PPM also has a scale that does not relate directly to perceived program levels, and only approximates peak levels. The numbers are arbitrary. Modern technology has eliminated the need to stare at a narrow mechanical needle oscillating in an analog motion to set level.

Peak-Hold circuits have been suggested as a solution. While holding a peak reading, they ignore any information that occurs during the decay time. While a useful function, peak-hold cannot compensate for a conventional PPM meter's inherent limitations. The user still can't see the density building behind the peak.

It didn't take long for users to realize that looking only at peaks could be just as deceptive as looking at averages. A sharp, repetitive, percussive sound could easily trick the engineer into cutting the overall levels back too far. In response, engineers combined VU and PPM metering. The resulting Composite-Meter still fell short.

A New Standard...

## *dorrough* Loudness Monitor



Years of hands-on experience and frustration with both VU and PPM metering led to the development of the DORROUGH Loudness Monitors. DORROUGH'S research has established a relationship between integration time, RMS metering and the display of peak levels.

**The DORROUGH Loudness Monitor** displays, in an easy-to-read format, the actual energy content of the program material, regardless of frequency, while also indicating the peak amplitude of the complex audio signal. It allows the operator to ride levels in a manner such that all program material can be adjusted for equal perceived loudness while protecting the peak of the waveform. Now, one meter gives you more complete and more usable information than any combination of peak hold, VU and PPM indicators.

**The DORROUGH Loudness Monitor** integrates on the same scale, two ballistics, showing the relationship between the average and the peak. It simultaneously displays peak and average, and the relative difference, in dB, between these two ballistics is derived from the integration time of the persistence scale. The operator has only to adjust the level until either the peak or persistence reference is reached. This will result in the maximum level, regardless of program content. Material with or without compression can easily be matched for the same listening level.

Each **DORROUGH Loudness Monitor** features Right and Left inputs for use in stereo mixing applications. With one instrument, the operator can easily see the stereo mix and avoid the classic in-phase/out-of-phase problem. Center channel build-up, the addition of in-phase or monophonic material which causes the mix to be perceived as louder, will appear as a sudden increase in level. This is especially important in preparing stereo program material for broadcast, while still being able to maintain monaural compatibility.

# Specifications:

As stated are over temperature, 0-40 Deg. (C)
0 dBu= .775 VRMS at 600 Ohms Line Voltage= 117 VRMS

## Input Parameters

| | |
|---|---|
| Input Z | 20k Ohm balanced, +/- 2%<br>10k Ohm single-ended |
| CMRR | 80 dBu at 60 Hz, 60 dB at 20 kHz (balanced mode) |
| Input Sensitivity | -10 dBu for full-scale display |
| Maximum Input Level | +24 dBu before clipping |

## Signal Path Parameters

| | |
|---|---|
| Signal Path Bandwidth | 10 Hz - 25 kHz, +/- 0.25 dBu |
| Signal Path Distortion | Less than 1% THD at 1 kHz, +24 dBu input |
| Sum Error | Less than 0.1 dBu at 1 kHz |
| Difference Error | Less than 0.1 dBu at 1 kHz |

## Display Parameters

All parameters apply to AVERAGE, PEAK, and PEAK HOLD display elements.

| | |
|---|---|
| Display Resolution | 40 LEDs, 1 dBu /LED except model 60D |
| Step Size Error | +/- 0.25 dBu |
| Absolute Error: | |
| Full Scale -39 dBu | +/- 0.25 dBu model A,B,C |
| -59 dBu | +/- 0.5 dBu model D |
| Drift | +/- 0.25 dBu |
| Average Time Constant | 270 mS, +/- 6% |
| Peak Acquisition Period | 10 uS, to full-scale, sine input 25 kHz |
| Peak Attack Period | Virtually Instantaneous |
| Peak Decay Period | 900 mS, form full-scale to all LEDs off (models A,B,C) |
| Display Update Rate | Approx. 10 mS |
| Display Duty Cycle | Display Time, AVERAGE, PEAK HOLD - 75%<br>Display Time, PEAK - 100% |

## Miscellaneous Parameters

| | |
|---|---|
| Power Supply Input Range | 117/237 VAC RMS, -20% to +10%, 50-60 Hz |
| Calibration Controls | None needed |
| User Controls | Left/Right input sensitivity<br><br>Option DIP Switch-<br>A) Peak Auto ON<br>B) Difference Mode ON/OFF<br>C) Over Level Alarm ENABLE<br>D) Under Level Alarm ENABLE<br>E) Auto ARMP |
| User-Port | DB-9 Connector-<br>A) Alarm relay closure contacts 1 form C, 1A, 30V AC or DC<br>B) Mode control switch (user supplied)<br>C) PEAK function switch (user supplied) |

# Installation

To install your **DORROUGH Loudness Monitor**, perform the procedures described in the following sections.

### Unpacking

Your **DORROUGH Loudness Monitor** was carefully packed at the factory. Take a moment to examine the unit for any signs of shipping damage. If damage is evident, retain the carton and notify the transit carrier and your local distributor about your claim. Once you are satisfied with the physical integrity of the unit, proceed with Initial Set-Up to align the meter to match your operating level requirements.

### Initial Set-Up

You can set the operating level either on the bench or at the installation location.

1. Plug the AC cord into a convenient AC line and observe that the display becomes backlit.

2. While observing polarity, feed a 1000 Hz sine-wave at a standard operating level (i.e.,-10,+4,+8, etc.) into one of the left inputs (rear panel).

3. Adjust the input level control for an indication of "0" on the meter scale (this step applies to all models).

   ***Note:*** *The peak excursion and the persistence amplitude are equal under steady state sine-wave conditions.*

4. Next, remove the signal from the left channel and feed the signal in the same polarity to the right input, making the same adjustment.

5. Following the adjustments for both the left and right inputs feed the signal to both inputs simultaneously. The summing amplifier will algebraically add the two inputs for an indication of +6, as read on the PEAK scale. This action applies only to an "A" Type meter; a "B" Type meter would be "off scale" for the same summing condition.

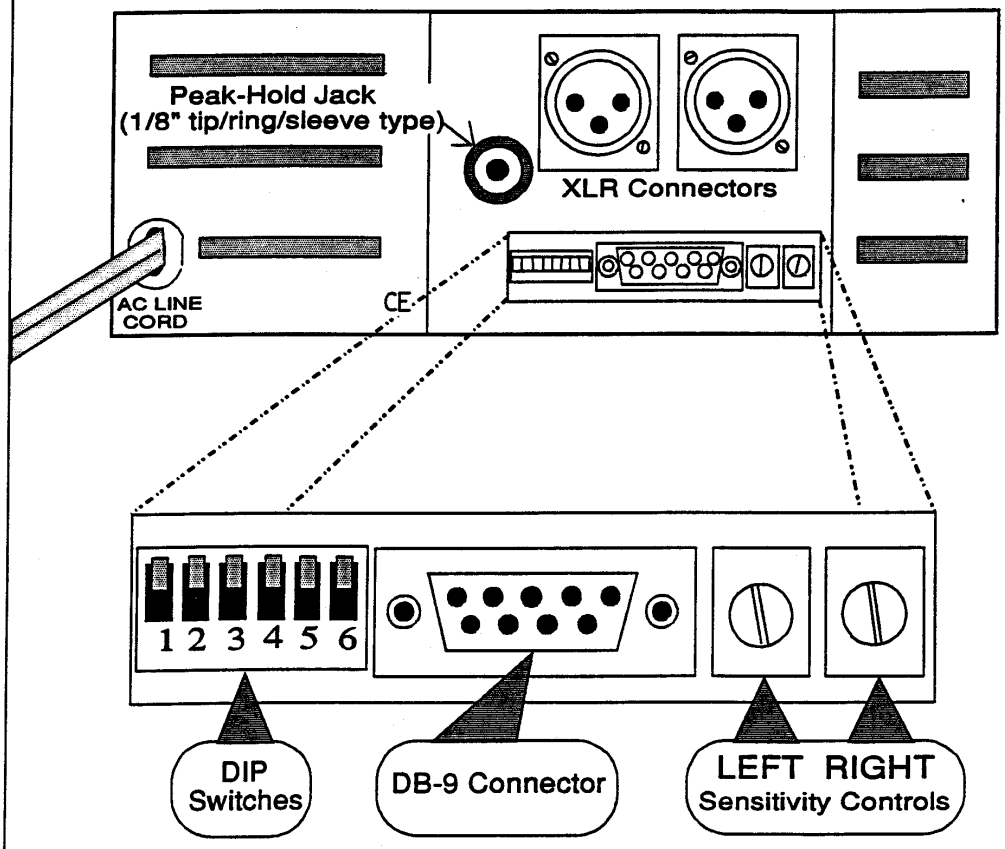
***Continued on Page 6...***

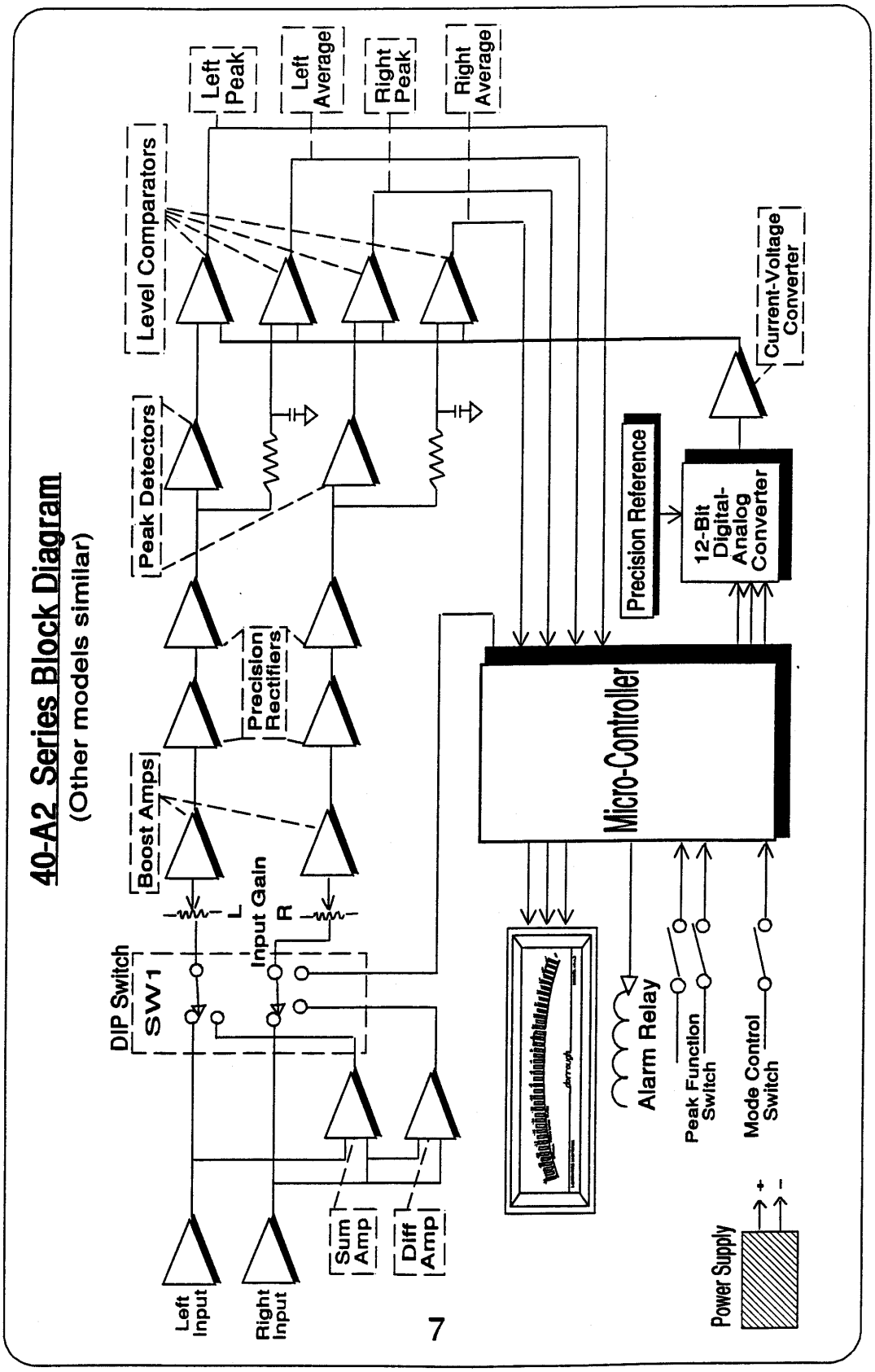
*...Continued from Page 5*

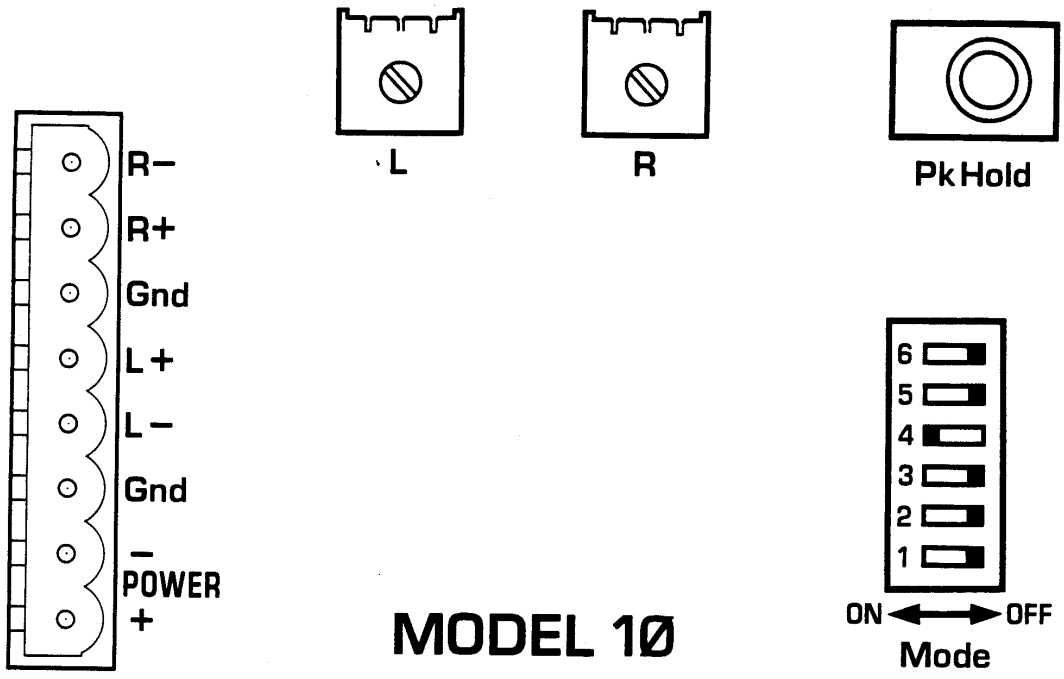
In actual practice, a "B" Type meter is generally used as a discrete monitor to indicate either a left or right channel. However, for Sum and Difference monitoring, repeat steps 3 and 4 (previous page), and adjust each input level control for a -6 dB indication on the meter scale for an individual channel. This action will result in a proper sum of "0" on the "B" Type meter scale.

*NOTE: Different amplitudes and phase angles between the left and right input signals will produce different algebraic sums. This display is essential in indicating center channel build-up in some program material and will aid an operator in making the proper adjustment to program operating level. For mono signals, use the suggested connections shown in the APPLICATIONS section.*

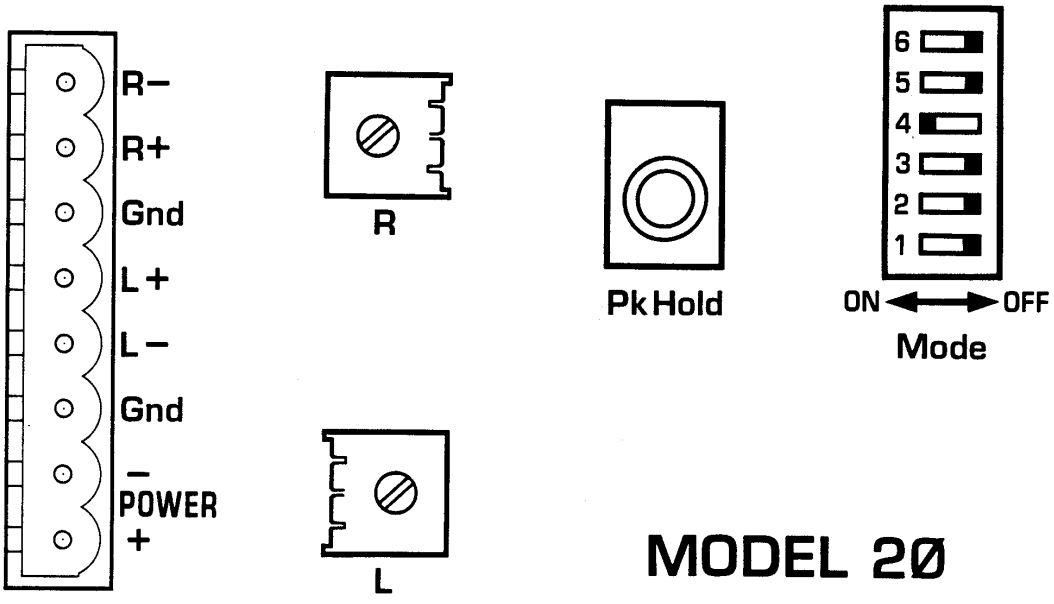
## 40 Series back panel




40-A2 Series Block Diagram
(Other models similar)
Left Peak
Left Average
Right Peak
Right Average
Level Comparators
Current-Voltage Converter
Peak Detectors
Precision Reference
12-Bit Digital-Analog Converter
Precision Rectifiers
Micro-Controller
Boost Amps
L
Input Gain
R
DIP Switch
SW 1
Alarm Relay
Peak Function Switch
Mode Control Switch
Sum Amp
Diff Amp
Left Input
Right Input
Power Supply
+
-
7



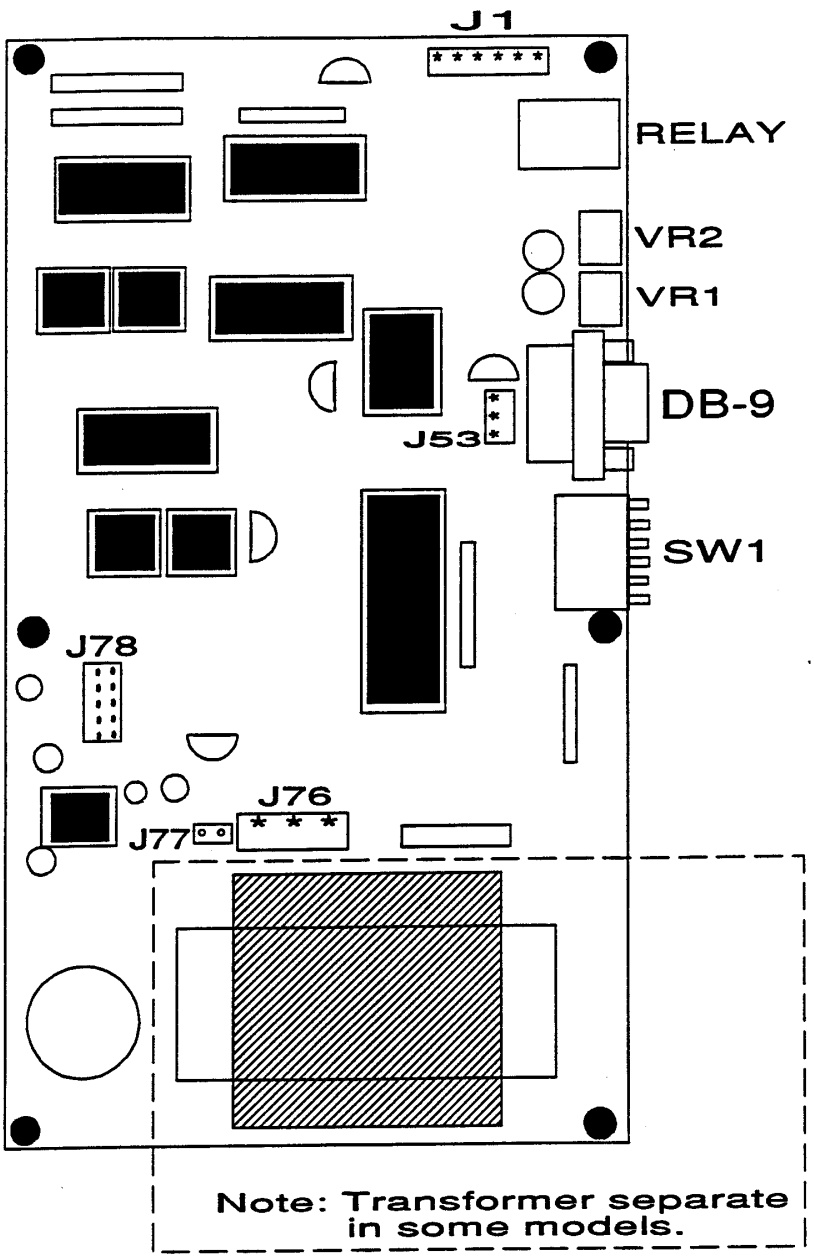

## MODEL 10




## MODEL 20

# 40-A2 Circuit Board

(Other models similar)



# Circuit Theory

**Second Generation DORROUGH Monitors**, though functionally identical to their predecessors, have been redesigned to take full advantage of progress in state-of-the-art electronics. The result are meters that provide, not only the trademark multi-dimensional "picture of sound", but even greater reliability, enhanced capabilities and an improved system interface.

Channel 1 (Left) and channel 2 (Right) audio enters at the Differential Line Receivers. The input source can be either balance or single-ended to accommodate most professional and consumer sources. The outputs of the line receivers are then routed to the precision "Sum" and "Difference" detectors. The Sum/Diff detectors are highly accurate by virtue of monolithic matched resistors integrated into the amplifier substrate. The outputs of the Sum/Diff detectors are then applied to the Input Multiplexor along with the outputs of the line receivers. The Input Multiplexor is configured as a dual selector switch, controlled by the Micro-Controller. In one position, the Multiplexor selects discrete Left/Right signals. In the other position it selects the outputs of the Sum/Diff detectors.

The Input Multiplexor then feeds Input Sensitivity Controls (VR1 and VR2). The Sensitivity Controls in turn, feed the Boost Amps which are set with a nominal gain of 22. The gain is chosen to allow full-scale display with a -10 dB input typical of consumer audio sources. The Boost Amps are then coupled to the Precision Rectifiers which perform full-wave positive rectification of the audio signals. The rectifier outputs are then split; one output to the Peak Detectors and the other to the Averaging Network. The Peak Detectors capture the most positive audio peak and holds it until it can be analysed by the Micro-Controller. After the peak is read, it is reset and allowed to capture the next most positive peak. Patented DPS Peak Ballistics are determined by software in the Micro-Controller. Likewise, Average Ballistics are determined by the Averaging Network and are set at the DPS standard of 270 mS.

The four signals, Channel 1(L) and 2(R) Peak, Channel 1(L) and 2(R) Average, are then fed to Level Detect Comparators for analog-to-digital conversion by the Micro-Controller. The Micro-Controller unit directs a 12-bit digital-to-analog convertor which has a current output converted to a voltage by the Current To Voltage Convertor. This voltage is, in turn, fed to the Comparator Array. The voltage to the comparators, determined by software in the Micro-Controller, varies between zero and 2.5 volts, as established by the Precision Reference. A primary subroutine, residing in the Micro-Controller, performs a "logarithmic successive approximation conversion" on each of the four inputs to the Comparator. The resulting number from this conversion represents the amplitude applied to each Comparator in 1 dB steps. The conversions are then further processed by the Micro-Controller, decoded and then shifted, serially, to the Display Board. Some of the secondary software functions performed are: Peak Acquisition, Peak Control, Peak Ballistics, Peak Hold, "Out Of Parameter" alarms, Mode Control (Left/Right or Sum/Diff), and Average Processing. Connected to the Micro-Controller are switches to control operation of the meter's Peak Hold, Peak Auto and Mode Control. Proper voltage for the various models is supplied via on-board or external transformation circuitry.

# Operation

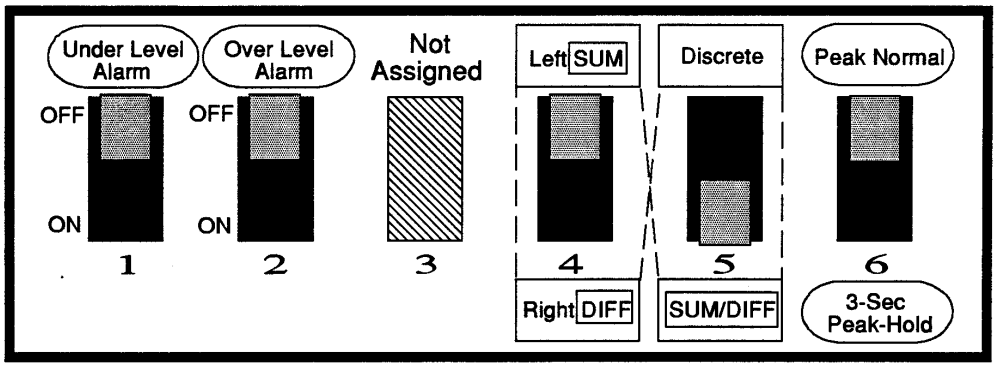
Stereophonic material, in the form of left and right inputs, is fed to the meter at XLR connectors located at the rear of the meter, as shown on page 6. The meter is shipped with each individual input set for +4 dB as referenced to "0" on the meter face. ***Users are advised to verify these initial settings (see pages 5 & 6).*** Other values can be set via the two input Sensitivity-Controls also located on the back panel.

## Special Options and Modes

Access to the various modes is through the meter's DIP switches and the DB-9 User-Port. **Alarm, Peak-Hold** and **Sum/Diff** modes can be set via the bank of built-in switches or through user-provided controls interfacing through the User-Port*. The monitor's response options can be chosen by remote control. This capability provides convenience and versatility to those building or customizing consoles.

***Note: When accessing modes through the DB-9, ALL DIP SWITCHES must be UP.**

### DIP SWITCH PANEL




DIP Switch **Position 1**
***Function*** **Under Level Alarm Enable**. When **ON** (DOWN), the alarm relay will de-energize if the displayed input peak level is less than 0 scale for a period of 10 seconds or more (No LEDs are lit).

DIP Switch **Position 2**
***Function*** **Over Level Alarm Enable**. When **ON** (DOWN), alarm relay will de-energize if the displayed input peak level exceeds full scale for a period of 1 second or more (Full scale, LED #40 lit).

DIP Switch **Position 3** Not currently assigned.

DIP Switch **Position 4**
***Function*** **Channel SUM/DIFF Select.** Selects **Left** (UP) or **Right** (DOWN) channel input in DISCRETE mode. Selects **SUM** (UP) or **DIFF** (DOWN) function in SUM/DIFF mode.

DIP Switch **Position 5**
***Function*** **Mode Switch.** **UP** position selects **DISCRETE** channel measurement. **DOWN** position (inputs parallel) selects **SUM/DIFF** mode.

***RECAP OF POSITION 4 & 5 SETTINGS****

**4 UP/ 5 UP=** Left channel audio level is displayed.
**4 DOWN/ 5 UP=** Right channel audio level is displayed.
**4 UP/ 5 DOWN=** SUM of Left and Right channels is displayed.
**4 DOWN/ 5 DOWN=** DIFF of Left and Right channels is displayed.

***Note: Units are shipped with Position 5 in the DOWN position**

DIP Switch- **Position 6**
***Function*** **Meter Auto Peak Enable**. When **DOWN**, the meter will display a third element, **3-Second Auto Reset Maximum Peak. Auto Reset Maximum Peak** is also available through the DB-9 User-Port.

# Peak-Hold Feature

Second Generation DORROUGH Monitors provide a trio of Peak functions:

1) Normal Operation- Audio peaks are displayed in "real time" and are not held.
2) 3-Second Peak-Hold- Audio peaks are held for 3 seconds before automatically resetting.
3) Indefinite Peak-Hold- Audio peaks are held until the user switches to one of the other Peak-Hold modes.

Without any external connections, the **3-Second Peak-Hold** function can be activated by turning **ON** position 6 of the Dip Switch. Turning position 6 **OFF**, allows Peaks to be read in real time. A three position toggle or rotary switch, connected through the DB-9 User-Port or 1/8" stereo mini-plug (adjacent to XLR connectors), selects any one of the three Peak-Hold modes regardless of DIP Switch condition **(see page 14 for DB-9 wiring diagram).**

# Alarm Feature

Second Generation DORROUGH Monitors also feature a multi-function Alarm. This new capability allows the user to customize installations so that states of complete audio drop-out or overload can trigger user-designated warning indicators to forcefully inform of such unwanted conditions.

The alarm is a dry type relay which changes state when certain signal parameters are exceeded.
**The relay rating is: 1 Form C, SPDT, 1 Amp, 30 Volt, AC or DC**

The relay contact set is terminated into the DB-9 User-Port connector located at the rear of the unit. Please refer to the User-port diagram (page 14) to facilitate connection of the special features to outside-world devices. The relay is operated in the deadman mode, that is, the relay is normally energized and de-energizes on an alarm condition. Presently, two alarm conditions are supported and are enabled by the user DIP switch also located at the rear of the unit. They function as follows:

DIP Switch **Position 1**
***Function*** Under Level Alarm Enable. When **ON**, the alarm relay will de-energize if the displayed input peak level is less than 0 scale (A-Type) or -11 scale (B-Type), for a period of 10 seconds or more (No LEDs are lit).

DIP Switch **Position 2**
***Function*** Over Level Alarm Enable. When **ON**, the alarm relay will de-energize if the displayed input peak level exceeds full scale for a period of 1 second or more (Full scale, LED #40 lit).

***Note:** If the relay opens on an alarm condition, it will stay open for a minimum of one second, even if the alarm condition clears. This assures that externally connected equipment has sufficient time to respond to the alarm condition.*

# DB-9 User-Port Diagram

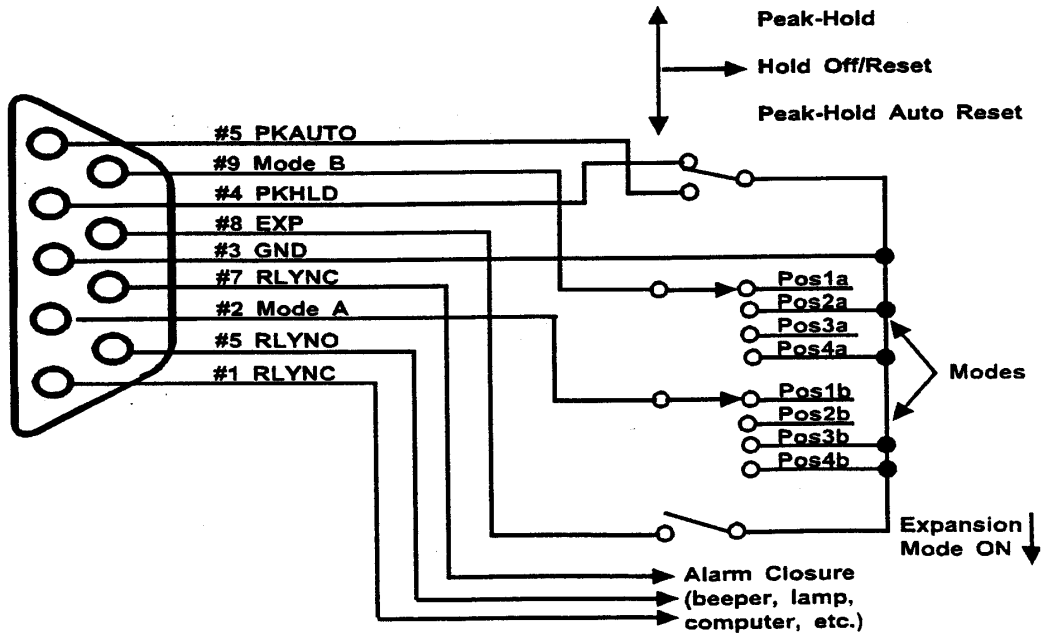
**Peak-Hold Modes** are selected through Pins #4 & 5 in relation to Ground Pin #3. An SPDT switch can be used to select **"Max Peak-Hold"** by grounding Pin #4 or **"Auto-Reset Peak-Hold"** by grounding Pin #5. Floating Pins #4 & 5 (switch center position) deactivates Peak-Hold function and resets Max Peak Hold.

**Meter Modes, LEFT, RIGHT, SUM and DIFFERENCE** can be controlled by alternately grounding and floating Pins #2 & 9 in relation to Pin #3 through a 4-position rotary switch:

| | | | |
|---|---|---|---|
| *POS-1* | *LEFT Channel-* | *Float #2* | *Float #9* |
| *POS-2* | *RIGHT Channel-* | *Float #2* | *Ground #9* |
| *POS-3* | *SUM of LEFT & RIGHT-* | *Ground #2* | *Float #9* |
| *POS-4* | *DIFF of LEFT & RIGHT-* | *Ground #2* | *Ground #9* |

**Expanded Range Mode** (Select Models) can be activated by grounding Pin #8 to Pin #3 via an SPST switch.

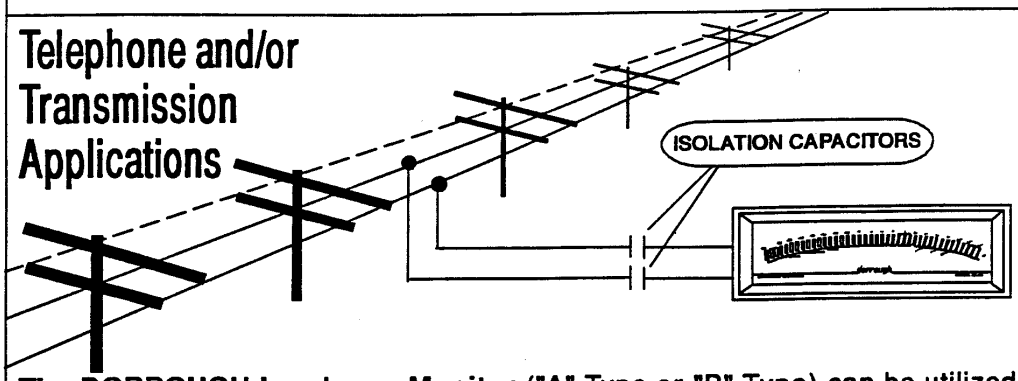
**Alarm Relay Contacts** are accessed through Pins #1, 5 & 7. #1 is "Common", #5 is "Normally Open" and #7 is "Normally Closed".



# Applications

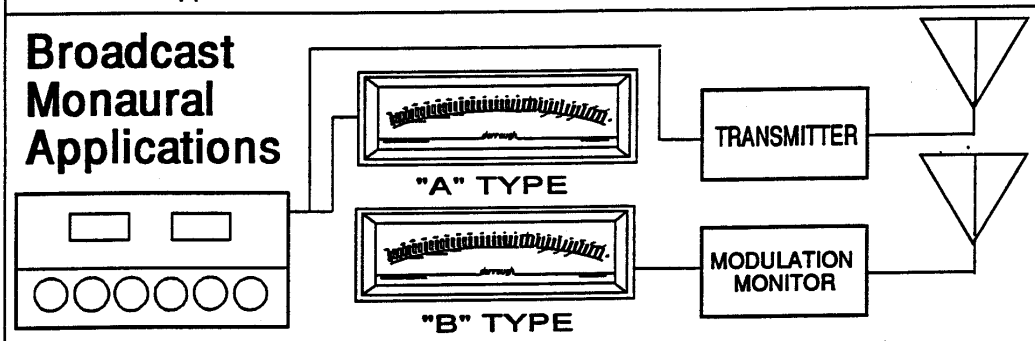
**DORROUGH Loudness Monitors** can be used in a number of applications including: Telephone/Transmission, AM Mono Broadcast, Analog/Digital Tape Saturation Analysis, Sum & Difference Metering, Stereo Television Broadcasting, CD Mastering, and Sound Reinforcement.

## Telephone and/or Transmission Applications



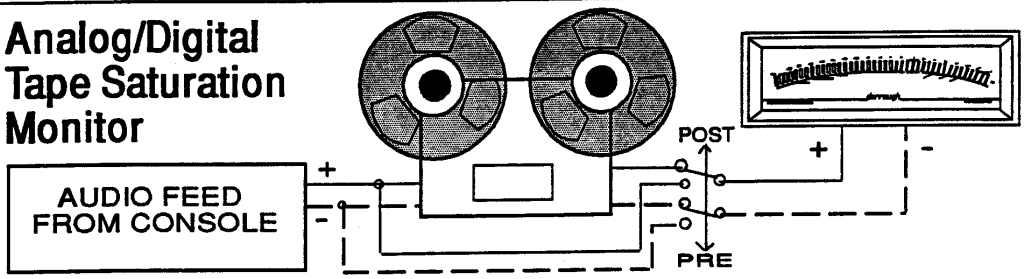

**The DORROUGH Loudness Monitor** ("A" Type or "B" Type) can be utilized to monitor power line condition or telephone line signal, as shown in the above line drawing. Make sure that some form of isolation, either transformers or capacitors, is used in this application.

## Broadcast Monaural Applications



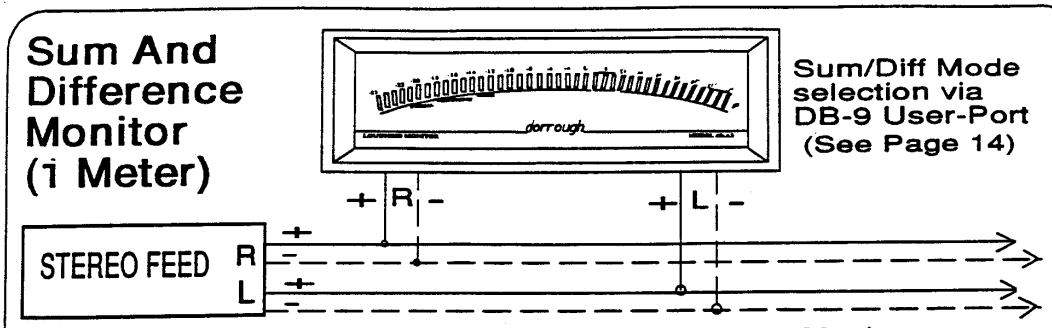

This line drawing shows a typical broadcast application. most stations use an "A" Type DORROUGH Loudness Monitor to monitor the "unprocessed" transmitter signal and either an "A" or "B" Type DORROUGH Loudness Monitor to verify the "Off-Air" signals in real time.

## Analog/Digital Tape Saturation Monitor



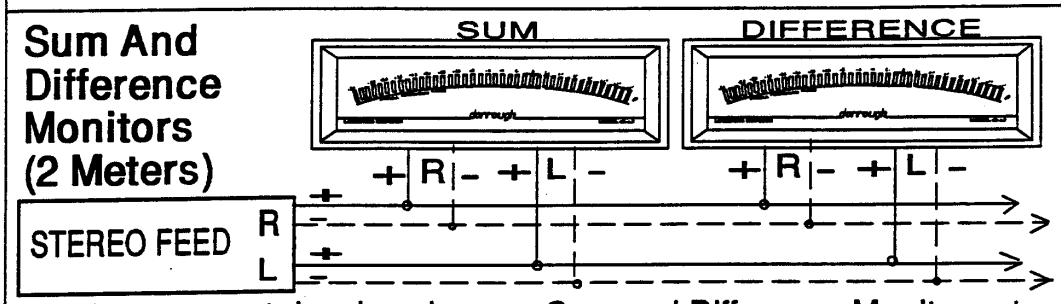

This interconnect drawing shows an example of monitoring "tape saturation" by comparing pre- & post-tape signal levels. Once saturation is reached, the post-tape readings will no longer track increases in pre-tape signal levels. Although a "B" Type DORROUGH Loudness Monitor is preferred, an"A" Type is acceptable.

## Sum And Difference Monitor (1 Meter)



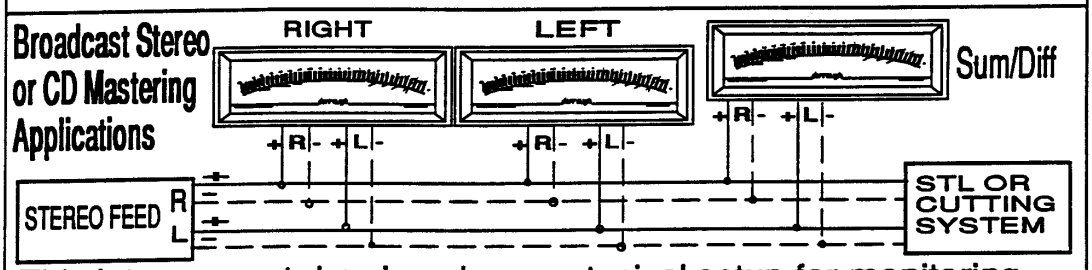

This interconnect drawing shows a Sum and Difference Monitor setup by utilizing a single "A" or "B" Type DORROUGH Loudness Monitor.

## Sum And Difference Monitors (2 Meters)



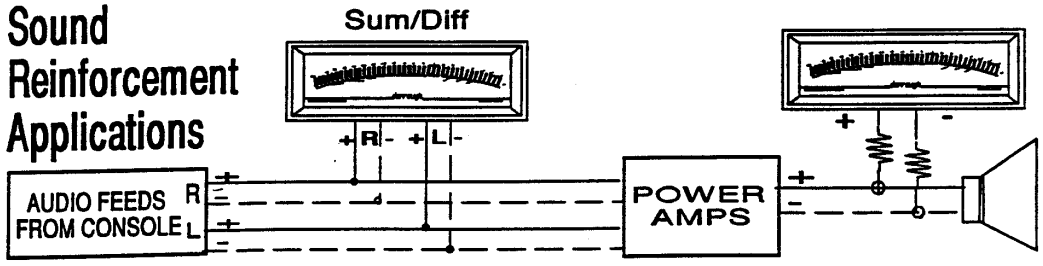

This interconnect drawing shows a Sum and Difference Monitor setup utilizing two "A" or "B" Type DORROUGH Loudness Monitors. In this application, Sum and Difference signals can be monitored in real time.

## Broadcast Stereo or CD Mastering Applications




This interconnect drawing shows a typical setup for monitoring stereo signals in real time. In addition, a selectable Sum or Difference Monitor allows the operator to check the critical phase integrity of the monitored signals. Use either "A" or "B" Type Dorrough Loudness Monitors.

## Sound Reinforcement Applications




An "A" Type DORROUGH Loudness Monitor can be utilized to verify phase integrity of signal pairs feeding a bank of power amplifiers. In addition a "B" Type DORROUGH Loudness Monitor can be used (with bridging resistors) to monitor amplifier failure.

# DORROUGH Generation 2 Loudness Monitors

**The 40-A,B,C2 series Loudness Monitors** are considered the standard models with built-in power supplies. They are the large, arc-style, tri-color LED display single meters with inputs for single channel or Left plus Right channel operation. The 40-A2 has a scale showing 14 dB headroom in 1 dB steps The "C" model features a 20 dB headroom scale. The "B" model is a variation of the "A" model calibrated in percent modulation with a lower scale in dB from +3 dB to -36 dB. Dual, rack-mount versions are available.

**The 20-A,B,C2 series Loudness Monitors** are conventional versions of the 40-2 series. The LED display is physically linear, not curved. The 20-2 series monitors are also available in a single or dual, rack-mount configuration.

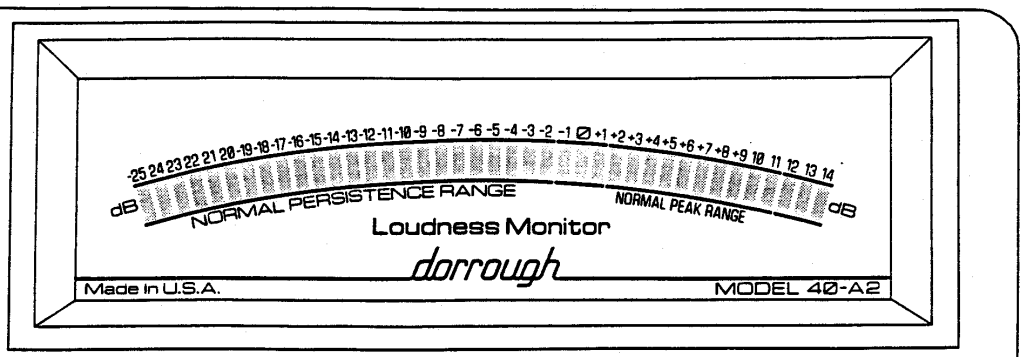
**The 10-A,B,C2 series Loudness Monitors** are smaller versions of the 40-2 series. They feature the distinctive arc-style, tri-color LED display. The compact size of this unit makes it the ideal choice for panel mounting. Multiple rack-mount versions are also available.

**The 12-A,B,C2 series Loudness Monitors** are dual versions of the 40-2 series, similar to the 10-2, but mounted in pairs. A dual rack (four meter) version is also available. This model is ideally suited to multi-channel monitoring.

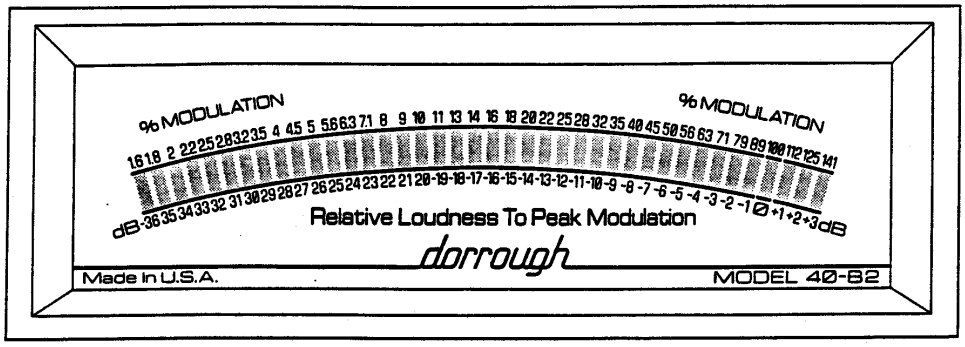
**The 400-2 series Loudness Monitors** are a giant version of the 40-2 series. This model, also known as "Big Led", is ideally suited to theatrical or concert environments. This unique product allows performers to see their levels where high, ambient noise might prevent analysis strictly by ear.
**The 400-2 "Big Led" measures 23"(L) x 8"(H) x 5"(D).**

**The 240/340-A,B,C Single Channel Meters** are simple, linear versions of the Dorrough Loudness Monitor. The 240 is the horizontal version. The 340 is vertically oriented. These economical units are ideal for applications requiring several meters, such as Surround Sound. A wooden cabinet is available

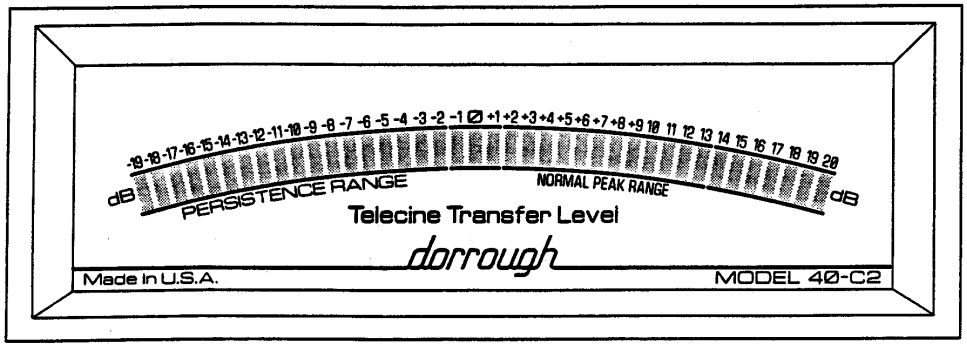
**The 40-P Balance Meter** displays the comparison, in amplitude, between two signals. This unique product is also a Generation 2 meter, featuring a modified Micro-Controller.



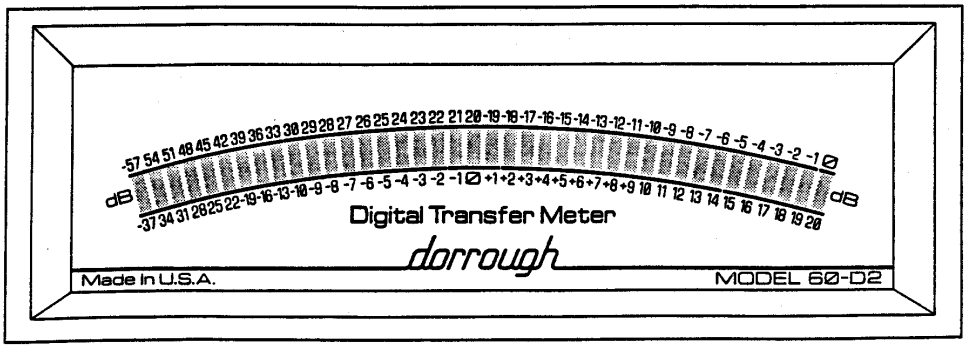

MODEL 40-A2




MODEL 40-B2




MODEL 40-C2




MODEL 60-D2