

Implementing and Managing 5.1 audio...Avoiding the Pitfalls

Dr. Richard C. Cabot, CTO
Qualis Audio



Market Issues

- Surround penetration is 39% of US homes
- Probably 90% of content is heard in stereo
 - Typical home has surround in family room, stereo in kitchen, bedroom(s), tablet PCs, etc.
- CALM Act and loudness
 - Doesn't legally apply to PBS stations but practical considerations say otherwise



Technical Issues

- Loudness – measured in surround
- Loudness – measured in stereo
- Mixing to a loudness target in real time
- Dialog balance
- Downmix compatibility

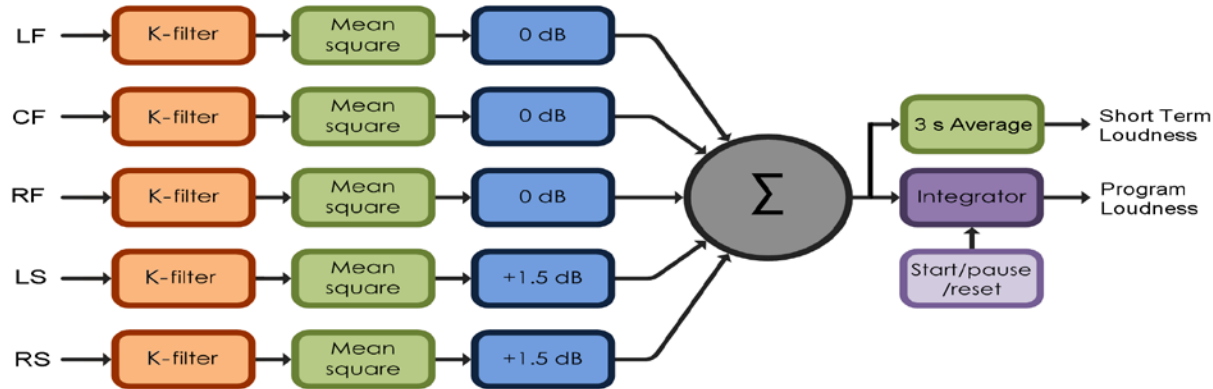


Audio Quality Management

- Content production, Post Production
- Ingest, QC
- Transmission
- Off Air Monitoring
- Forensics
- Process control and improvement



BS-1770 Loudness Measurement



- Channels are filtered, rms conv. and summed
 - Loudness includes all channels except LFE
 - Surround channels have +1.5 dB gain
- Loudness is integrated over time

Implementation Issues

- Measure at ingest and content creation
 - Adjust overall level to compensate
- Measure emitted broadcast stream
 - Control by automation system
 - Derive from as-run logs
- Establish information feedback systems



Automated As-Run Report Logs

- Fully automatic
 - Normally runs once per day, user selectable
 - Reads information from automation system
- Creates report of desired measurements
 - Loudness, True Peak Level, etc.
 - Identified by ID, description, run time, etc
 - All measurements or only exceptions
 - Summary only or include detailed data



Channel CBFT

November 21 2012 04:03:00:02 EST

	Thresh	#	Duration	Min/Max
Unknown	above	-23.0	0	00:00:00:00
	below	-25.0	0	00:00:00:00
Programs	above	-23.0	10	05:07:09:17
	below	-25.0	9	04:23:21:27
Commercials	above	-23.0	39	00:12:49:19
	below	-25.0	7	00:02:20:01

Name	Item id	Start	Duration	Loudness
COMMISSION CHARBONNEAU (REDIFF.	HCCHARBO2	04:03:00:02	00:56:59:29	-25.3
RDI MATIN 5H/RDI MATIN 5H, 753	VCHIP	05:00:00:00	01:30:00:00	-24.7
LES SCHTROUMPFS/0011 - LES SCHTR	K006185	06:30:00:00	00:24:22:00	-25.1
WALTER/0024, LE RECYCLAGE DES VI	K007133	06:54:22:00	00:04:59:29	-24.1
99-A ALORS ON JASE 2012/11/21	HFT0159110	06:59:22:00	00:00:15:00	-23.9
99-B CREUSE/GUERET	HCF0172149	06:59:37:00	00:00:30:01	-23.9
GARFIELD & CIE/0026 - CHARIVARI	HK040435	07:00:07:00	00:12:03:00	-25.8
GARFIELD & CIE/0027 - CHASSE CRO	HK008013	07:12:10:00	00:12:08:00	-24.6
GARFIELD TOUT COURT/0062 - ON VE	E056349	07:24:18:00	00:00:43:29	-24.8
LES GEES/0035 - LES GEES SUR LE	HK039472	07:25:02:00	00:02:59:29	-22.5
LEON/0041 - LA FEVE GRIMPANTE	HI003882	07:28:02:00	00:01:00:00	-25.7
0-A HERAULT/MONTEPELLIER	HCF0173979	07:29:02:00	00:00:30:01	-24.1
0-B OISE/BEAUVAIS	HCF0173981	07:29:32:00	00:00:30:01	-23.9
TOC TOC TOC/0383 - UN BON TOUR!	HRK045426	07:30:02:00	00:23:59:29	-22.6
ROULE-BOULE/0061 - LOLA ET L'HOM	K015703	07:54:02:00	00:03:59:29	-24.2
LEON/0043 - FIDO	HI003882	07:58:02:00	00:01:00:00	-24.7
99-A ALORS ON JASE 2012/11/21	HFT0159110	07:59:02:00	00:00:15:00	-24.0
99-B SEMAINE VERTE 2012/11/24 ET	HFT0159654	07:59:17:00	00:00:15:00	-20.9
99-C INDRE/CHATEAURoux	HCF0173853	07:59:32:00	00:00:30:01	-23.5
A LA FERME DE ZENON/0003 - ADIEU	E058576	08:00:02:00	00:12:00:00	-22.8
ZOUBABU/0098 - ESPADON	HK013201	08:12:02:00	00:02:13:00	-25.4
LES SUPER MECANIMAUX/0068 - L'IL	RE044087	08:14:15:00	00:11:30:01	-24.2
OZIE BOO - PROTEGE TA PLANETE/00	HK006730	08:25:45:00	00:04:38:00	-23.3
MIKE LE CHEVALIER/0038 - MIKE LE	RE068404	08:30:23:00	00:12:10:00	-22.3
BABAR, LES AVENTURES DE BADOU/00	RE068430	08:42:33:00	00:11:57:00	-24.2
G CUISINE/0155 - MARINADE DE ME	E058616	08:54:30:00	00:04:59:29	-23.5
99-A ISN - APP. RADIO-CANADA POU	HFT0159266	08:59:30:00	00:00:30:01	-23.5
L'UNION FAIT LA FORCE/1691 - L'U	E063132	09:00:00:00	00:21:29:28	-21.6
L'UNION FAIT LA FORCE/1691 - L'U		09:00:00:00	00:06:50:00	-22.0
SUITE-L'UNION FAIT LA FORCE/1691		09:10:50:00	00:10:38:29	-21.6
SUITE-L'UNION FAIT LA FORCE/1691		09:25:59:00	00:04:00:29	-21.0
1-A ENFANTS DE LA TELE 2012/11/2	HFT0157526	09:06:50:00	00:00:29:29	-23.4
1-B HAUTS-DE-SEINE/NANTERRE	CF0163387	09:07:20:00	00:00:15:00	-25.5
1-C SEINE-MARITIME/ROUEN	HCF0172784	09:07:35:00	00:00:29:29	-24.0
1-D AUBE/TROYES	HCF0174550	09:08:05:00	00:00:30:01	-24.6
1-E CALVADOS/CAEN	HCF0171454	09:08:35:00	00:00:29:29	-23.8
1-F SAVOIE/CHAMBERY	HCF0174423	09:09:05:00	00:00:30:01	-23.5
1-G MEDEA/MEDEA	HCF0171485	09:09:35:00	00:00:15:00	-23.9
1-H MAYOTTE/MAMOUZOU	HCF0172375	09:09:50:00	00:00:30:01	-24.0
1-I ARIEGE/FOIX	HCF0168696	09:10:20:00	00:00:30:01	-24.7
2-A 30 VIES 2012/11/21	HFT0158961	09:21:29:00	00:00:15:00	-23.6
2-B ADAM & EVE 2012/11/21	HFT0157567	09:21:44:00	00:00:15:00	-23.9
2-C MARNE/CHALONS-EN-CHAMPAGNE	HCF0172786	09:21:59:00	00:00:29:29	-23.9
2-D LOIRE/SAINT-ETIENNE	CF0174126	09:22:29:00	00:00:30:01	-22.9
2-E GERS/AUCH	HCF0173934	09:22:59:00	00:00:29:29	-23.9
2-F HAUTE-MARNE/CHAUMONT	HCF0170669	09:23:29:00	00:00:15:00	-23.8
2-G ILLE-ET-VILAINE/RENNES	HCF0173782	09:23:44:00	00:01:00:00	-23.8
2-H AUBE/TROYES	HCF0174550	09:24:44:00	00:00:29:29	-24.7

As-Run Report Example

- Day summarized on first page
- Numeric results
- Graphic icons augment numeric results



As-Run Reporting (Inc. Peaks)

WKRP-TV

January 17 2013 05:57:20:00 EST

	Thresh	#	Duration	Min/Max	
Programs	above -22.0	2	00:49:18:13	-21.7	█
	below -26.0	0	00:00:00:00		
Commercials	above -22.0	0	00:00:00:00		
	below -26.0	0	00:00:00:00		


Name	Item Id	Start	Duration	Loudness	True Peak
TURKEYS AWAY GENERIC CLOSE HD	010579A0106	05:57:20:00	00:02:40:01	-25.7	-3.7
TURKEYS AWAY HD		06:00:00:02	00:44:14:04	-24.8	0.0
TURKEYS AWAY A SEG. HD	010579A0101	06:00:00:02	00:15:49:00	-24.5	0.0
TURKEYS AWAY B SEG. HD	010579A0102	06:18:19:08	00:08:52:04	-25.3	2.0
TURKEYS AWAY C SEG. HD	010579A0103	06:30:11:15	00:10:58:15	-24.7	0.0
TURKEYS AWAY D SEG. HD	010579A0104	06:43:55:06	00:04:23:00	-25.2	-7.3
TURKEYS AWAY E SEG. HD	010579A0105	06:51:18:12	00:03:01:15	-25.0	-7.3
TURKEYS AWAY REGULAR CLOSE	010579A0107	06:57:20:03	00:01:10:00	-26.2	-8.0
LES MISERABLES	207322	06:15:49:02	00:00:15:00	-25.2	-9.0
VOLVO	207145	06:16:04:03	00:00:30:00	-25.2	-8.0
BAYER ONE-A-DAY	207162	06:16:34:03	00:00:15:00	-24.8	-7.0
SNICKERS	201354	06:16:49:03	00:00:15:00	-24.0	-10.3
HAMPTON INN	207309	06:17:04:06	00:00:15:00	-25.1	-9.3
CHARLES SCHWAB	207231	06:17:19:06	00:00:30:00	-24.9	-6.0
MONEY MUTUAL	200408	06:17:49:06	00:00:30:00	-24.7	-6.0
BRAND/IMAGE/MTM PRODUCTIONS	303803	06:27:11:12	00:00:15:00	-24.7	-8.3
VERIZON WIRELESS	207094	06:27:26:12	00:00:30:00	-25.1	-9.0
KFC	206464	06:27:56:12	00:00:15:00	-25.2	-6.3
AUTOTRADER COM	207160	06:28:11:14	00:00:30:00	-25.3	-10.7
REGUS	203414	06:28:41:14	00:00:15:00	-24.8	-9.7
CINCINNATI NIGHTLIFE	302340	06:28:56:14	00:00:15:00	-25.5	-10.3
GAMEFLY.COM	206793	06:29:11:15	00:00:30:00	-24.6	-7.3
SONOSITE	204126	06:29:41:15	00:00:30:00	-24.9	-9.3
MYERS RUM	202474	06:41:10:03	00:00:05:00	-25.3	-13.0
UPS	207101	06:41:15:03	00:00:30:00	-24.1	-5.3
WICKED TUNA	206804	06:41:45:03	00:00:30:00	-25.3	-8.0
GAZELLE.COM	205593	06:42:15:05	00:00:30:00	-25.0	-8.0
NATIONWIDE	206791	06:42:45:05	00:00:30:00	-24.9	-6.3
GAMEFLY.COM	206793	06:43:15:06	00:00:30:00	-24.6	-7.3
CINCINNATI LINK	302088	06:43:45:06	00:00:10:00	-25.0	-9.0
LLC COM	200058	06:48:18:09	00:01:00:02	-24.9	-8.7
WEATHERTECH	201498	06:49:18:11	00:00:30:00	-24.9	-10.7
BRAND/IMAGE/MTM PRODUCTIONS	303802	06:49:48:11	00:00:30:00	-25.0	-8.7
COLD-EEZE	205475	06:50:18:11	00:00:30:00	-24.7	-8.7
CARRABBA'S GRILL	206821	06:50:48:11	00:00:30:00	-24.9	-7.3













As-Run Reporting (variances only)

WKRP-TV Variances

January 17 2013 05:57:20:00 EST

	Thresh	#	Duration	Min/Max	
Unknown	above -22.0	0	00:00:00:00		
	below -26.0	0	00:00:00:00		
Programs	above -22.0	2	00:49:18:13	-21.7	
	below -26.0	0	00:00:00:00		
Commercials	above -22.0	0	00:00:00:00		
	below -26.0	0	00:00:00:00		

Name	Item Id	Start	Duration	Loudness	
TURKEYS AWAY		19:00:00:18	00:27:05:20	-21.9	
TURKEYS AWAY	001600A0001	19:00:00:18	00:11:19:19	-20.8	
TURKEYS AWAY	001600A0002	19:12:55:09	00:06:05:07	-22.5	
TURKEYS AWAY	001600A0003	19:20:30:18	00:08:46:20	-23.1	
TURKEYS AWAY	001600A0004	19:29:47:11	00:00:54:04	-22.4	
THURSDAY NIGHT SPECIAL		21:16:41:21	00:22:12:23	-21.7	
THURSDAY NIGHT SPECIAL	002020A0001	21:16:41:21	00:03:27:26	-21.0	
THURSDAY NIGHT SPECIAL	002020A0002	21:20:09:17	00:04:00:23	-18.6	
THURSDAY NIGHT SPECIAL	002020A0003	21:25:40:12	00:07:51:14	-22.4	
THURSDAY NIGHT SPECIAL	002020A0004	21:35:32:00	00:06:52:20	-24.8	

WKRP-TV Variances January 17 2013 05:57:20:00 EST

Page 1

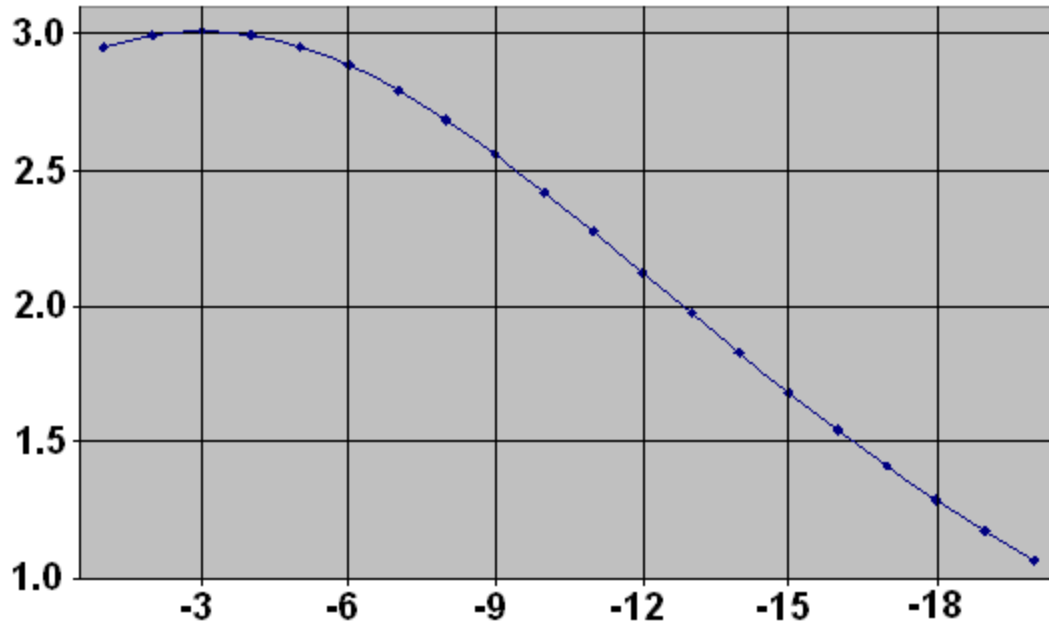


Downmix Loudness Issues

- BS1770 boosts surrounds by 1.5 dB
- Surrounds 3dB or more when downmixing
- Loudness sums individual channel powers, yet downmixing combines channels linearly
- Interchannel phase related cancellation can further reduce amplitude when downmixing



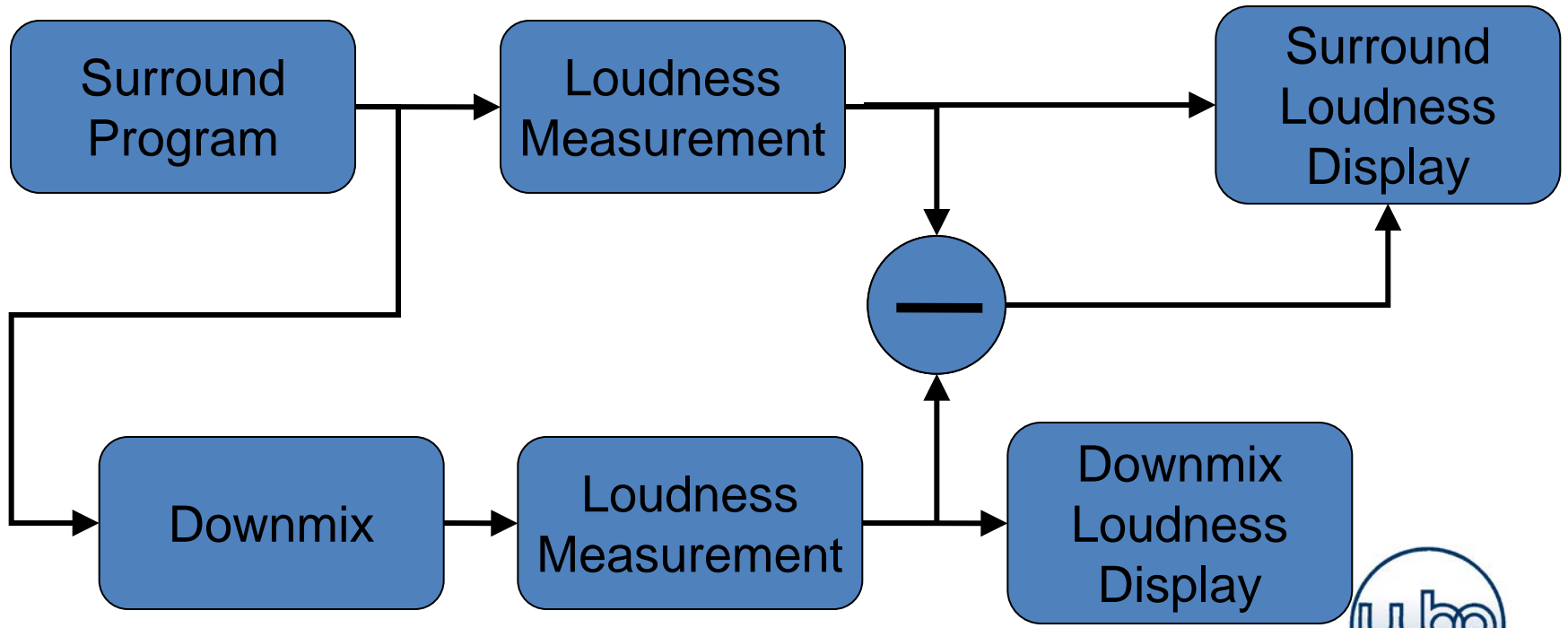
Loudness Change vs CF in LF&RF



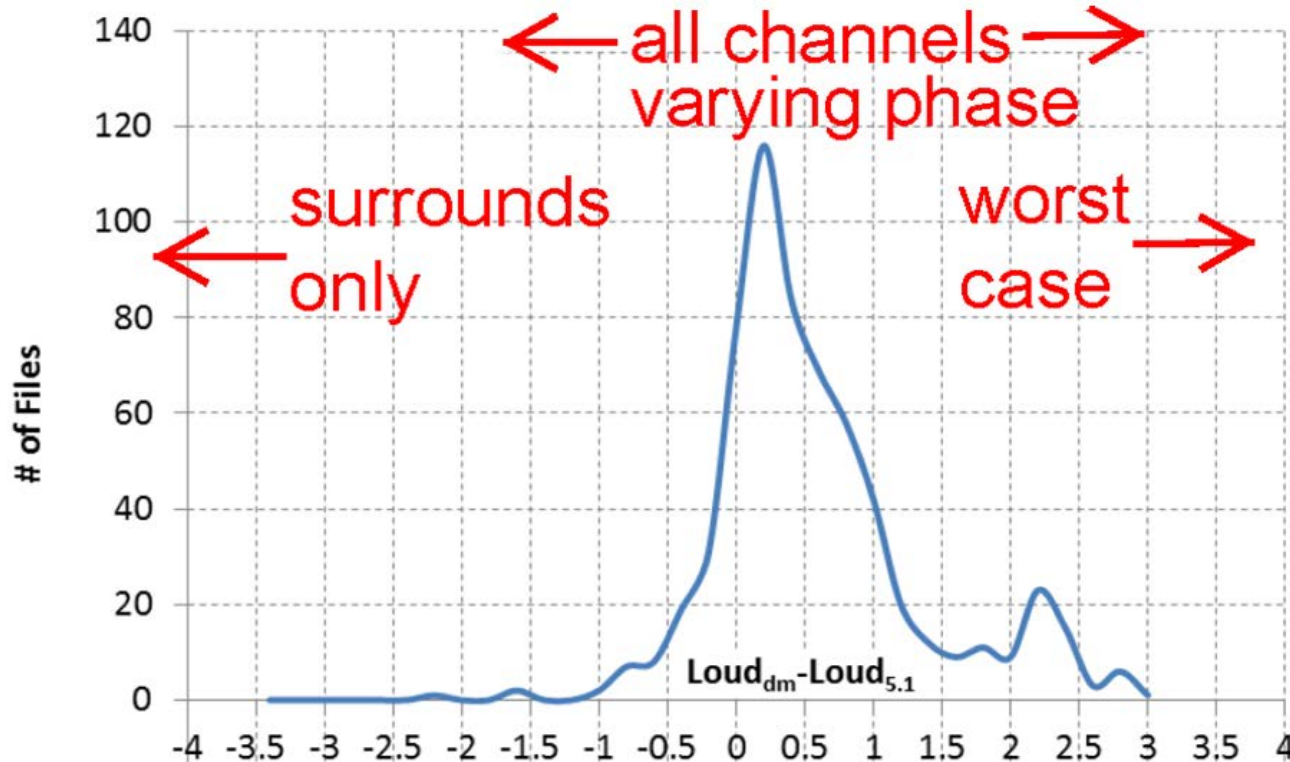
Duplicating CF content in LF & RF impacts downmix loudness even at low levels



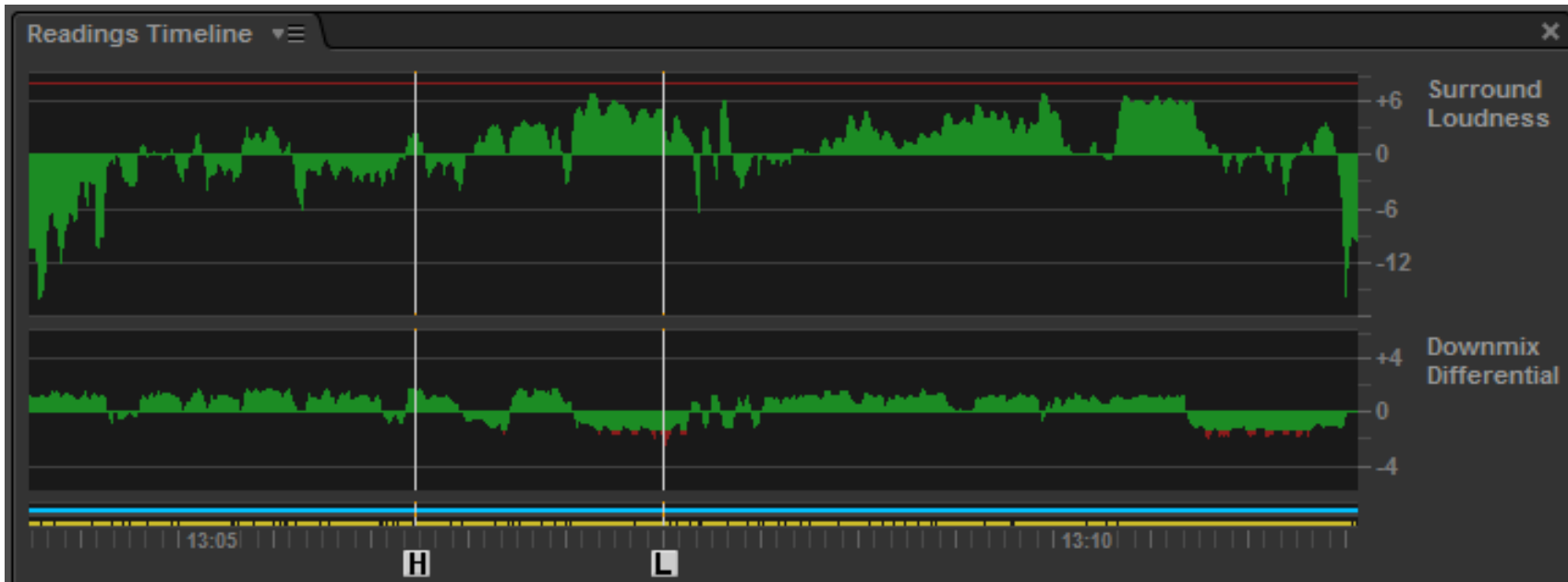
Downmix Loudness Meter



Downmix Loudness (measured)



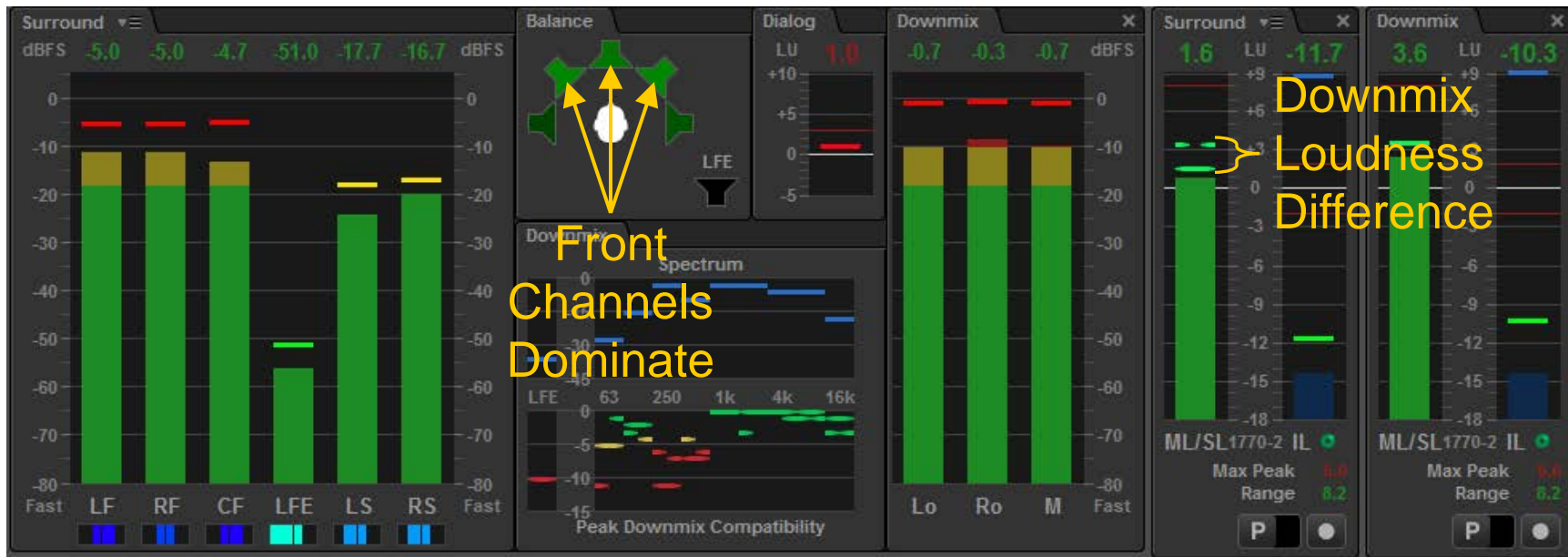
Downmix Loudness vs. Time



Adele Live at the Royal Albert Hall



Downmix Loudness (H cursor)



Adele Live at the Royal Albert Hall

Downmix Loudness (L cursor)



Adele Live at the Royal Albert Hall

Dialog Balance

- Surround mixes must maintain dialog sufficiently louder than other content
- Important for live sports or game shows
- Often specify CF min. 3 to 6 dB > LF&RF
- ! Hard to track 3 meters, mentally subtract
- ! Ignores effect of energy in surrounds

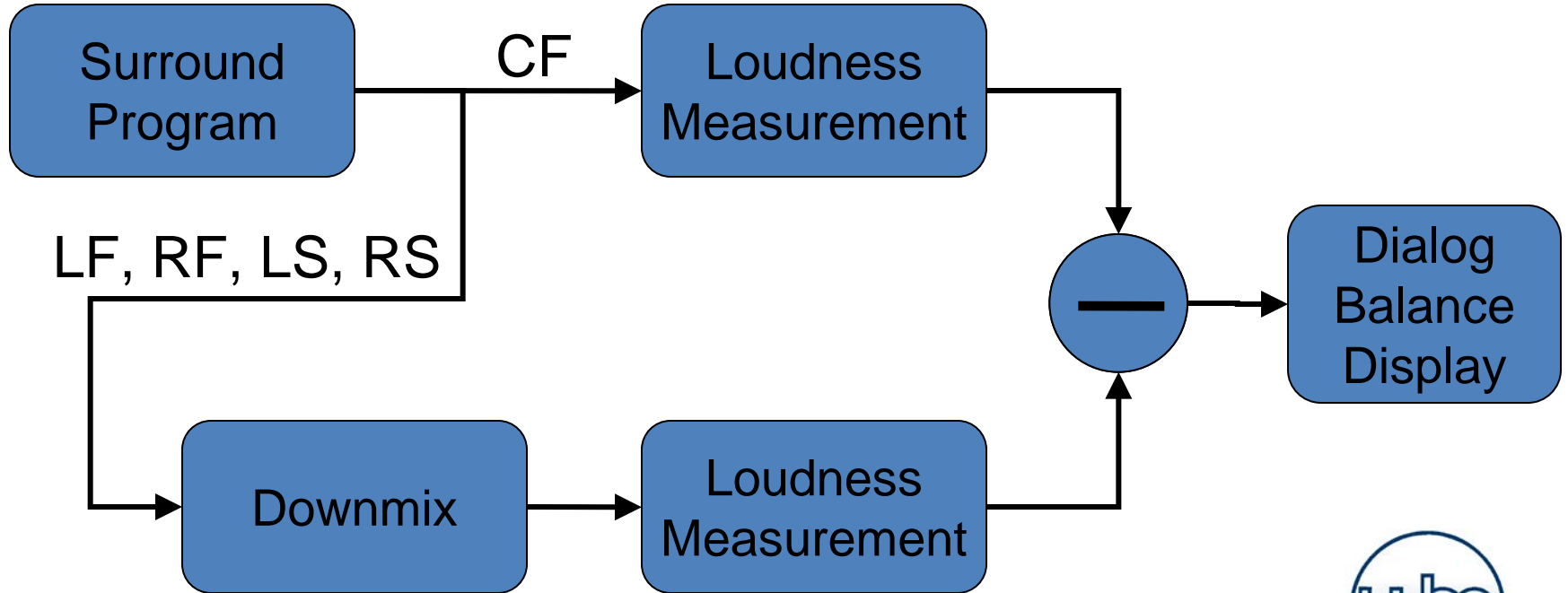


Dialog Balance Measurement

- Measure loudness of dialog
- Compare to loudness of other content
- Suppress measurement if dialog absent
- ! Single meter facilitates monitoring
- ! Numeric result allows alarming
- Masking computation in development



Dialog Balance Meter



The Compatibility Problem

Antiphase signals cancel when downmixed,
reducing level or disappearing completely

Mic-ing issues can make a sound appear in
two (or more) channels out of phase

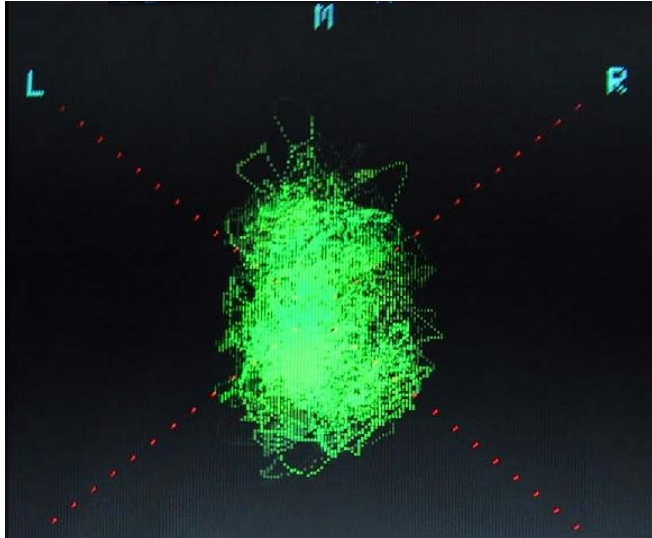
If this happens to an actor, dialog can be
unintelligible, viewers get upset



Downmixing Stereo

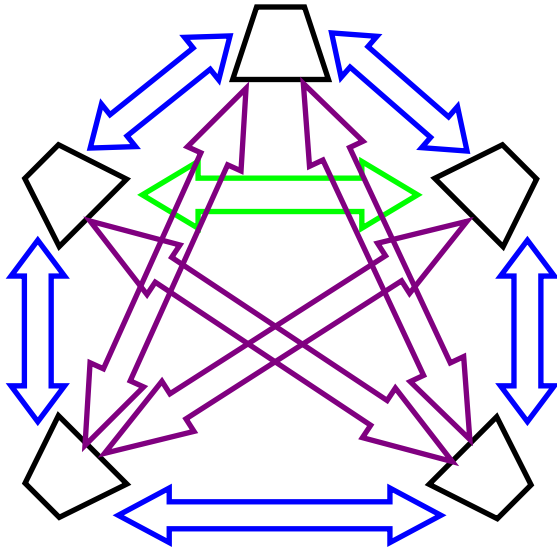
Traditionally monitored with a Lissajous display

L & R drive scope V & H, rotated CCW 45°



- Vertical line: mono, OK
- Horizontal line: mono, BAD
- Vertical oval: stereo, OK
- Horizontal oval: stereo, BAD
- Round: stereo, probably OK
- Some interpretation required

Multidimensional Lissajous



- 5 ch gives 10 pairs
- Many only analyze the 5 neighboring pairs (in blue)
- LF/RF occasionally added (in green) giving 6 pairs
- Including LFE increases these further

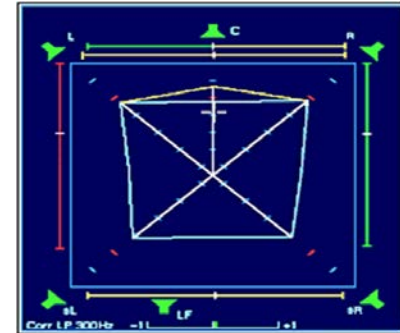
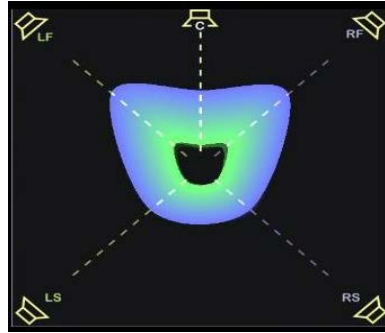
Multidimensional Lissajous

Existing products pack 5 to 10 Lissajous patterns into 1 display. Differences are:

- How many pairs they show
- How they pack them
- If they use color
- Dynamic range control to keep display readable as levels change
- Additional displays on the screen



Representative Displays



- 1 is map of Lissajous to “pie shaped” region
- 2 & 3 map level to radius & phase to curvature
- 1 & 3 add correlation (average phase) indicators
- 1 & 2 analyze 5 ch. pairs, 3 adds LF-RF

The Bigger Problems

- Previous solutions measure phase, the audible effect on program must be inferred
- The displays are subjective, not quantitative
- The best meter is useless if no-one is watching it
- Measure downmix loss directly, not phase
- Produce numeric values based on audibility
- Compare measurements to threshold, allowing alarming and unattended operation

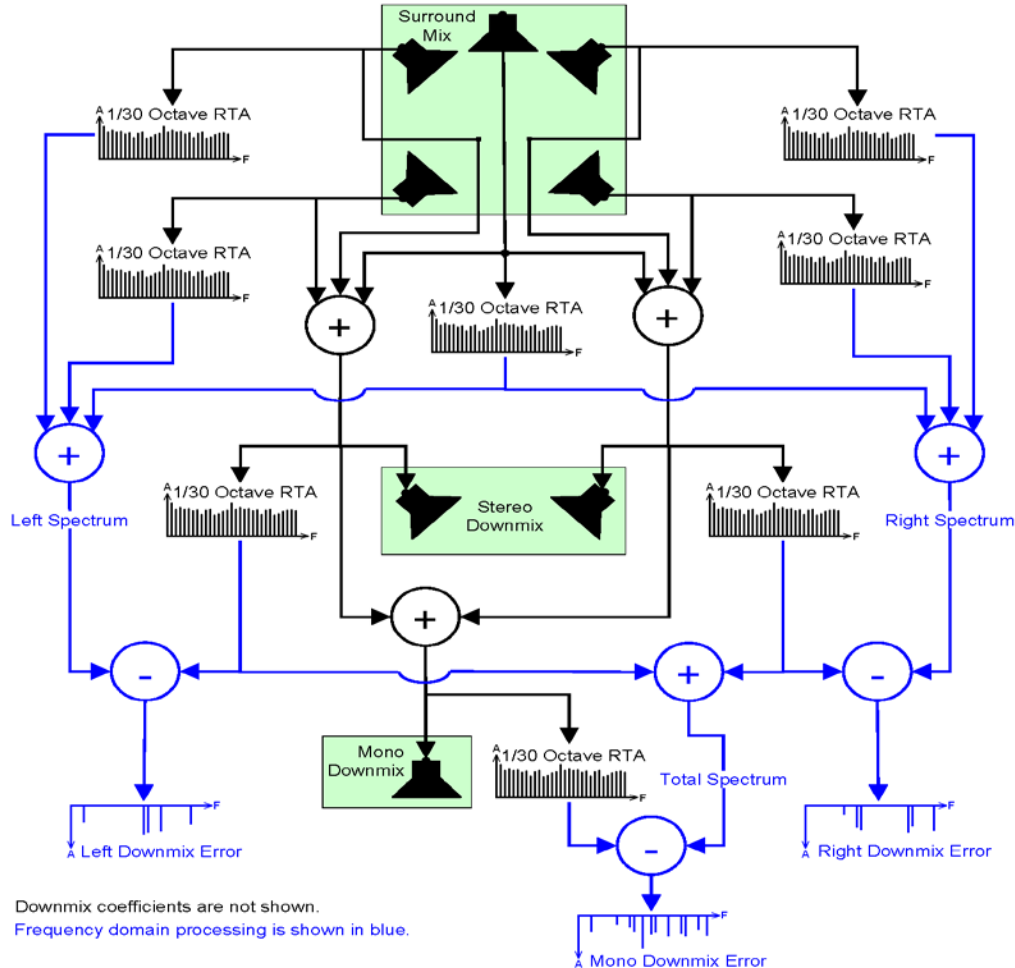


Compatibility Analysis

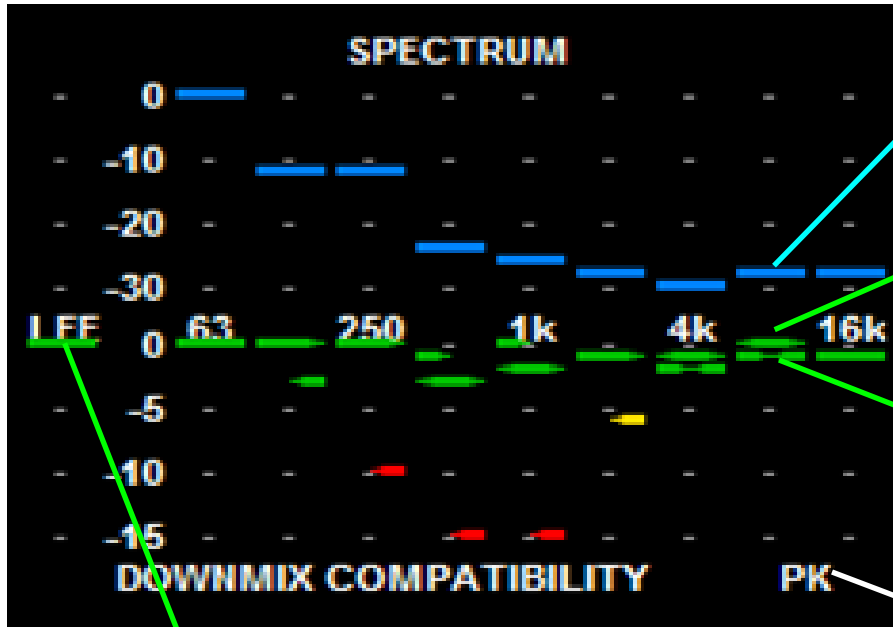
- Downmix signals to stereo and mono
- Meter original, stereo and mono signals
- Perform 1/30th octave analysis on original channels, stereo and mono downmixes
- Sum power spectra of original channels with the same gains as the downmix
- Compare downmixed spectrum: $\Sigma X(f)^2$, to the spectrum of the downmix: $(\Sigma X(f))^2$
- Report largest reduction in each octave



Compatibility Analysis



Compatibility Display



Octave resolution
real-time spectrum

Mono downmix
compatibility

Left & right downmix
compatibility

LFE downmix
compatibility

Display peak or average
values for each octave



Typical Live Mix Application





Typical Ingest Application

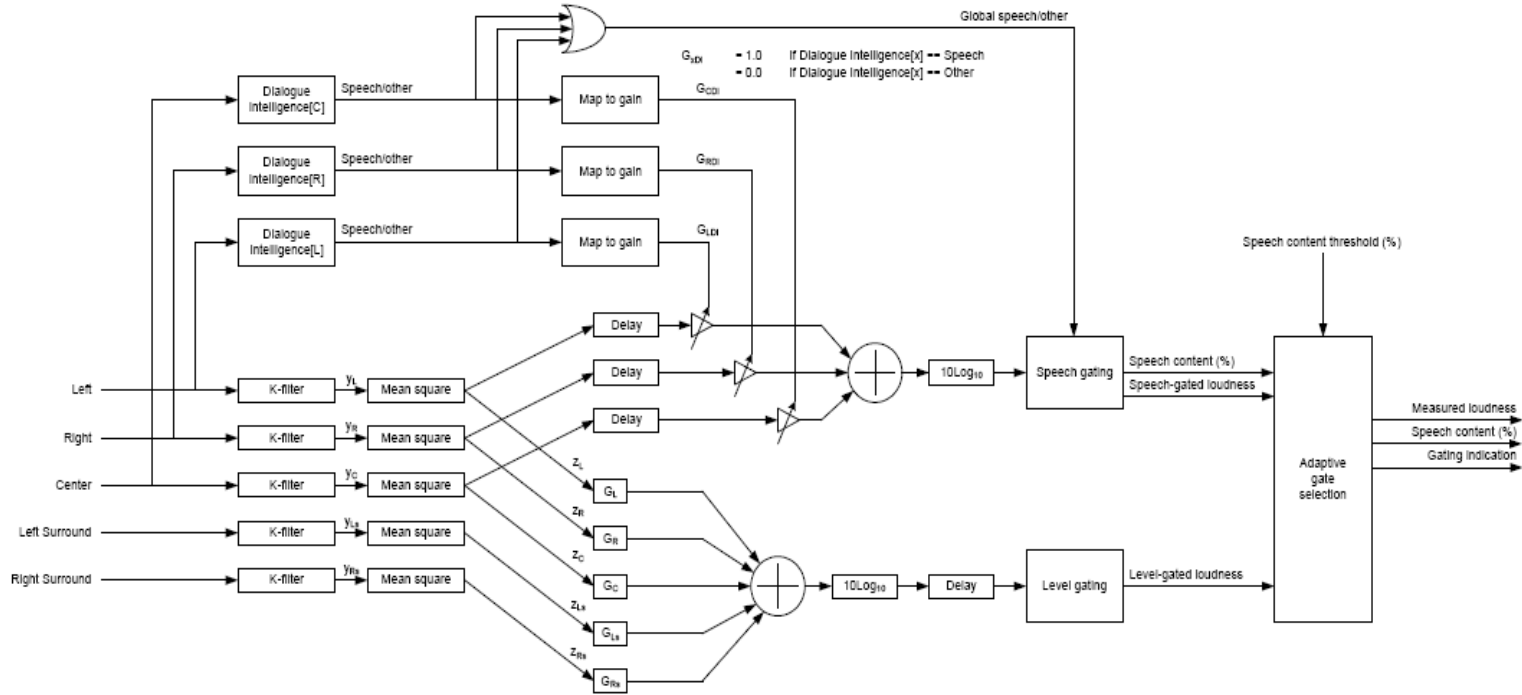


Materials at www.qualisaudio.com

- The CALM Act, the FCC Rules and Order, FCC NPRM and filed comments
- Tech notes on loudness measurement, downmix compatibility, automated QC, etc.
- The loudness meter test suite in file form
- Sentinel Data Sheet and User Manual



Dialog Intelligence in BS.1770-2



Gaming the System

- Downmix loudness differences
 - Put common content in all channels
 - If CF = 0, LF & RF = -3dB, LS & RS = -9dB
 - Your commercial will be 3.8 LU hot for most viewers
- If Dialog Intelligence is used, put dialog in surrounds at high gain
- If Dialog Intelligence is used, add sounds to dialog to disable recognition



Practical Issues

- International programs are leveled to ITU BS.1770-2. If a broadcaster sends or receives material internationally it has to conform.
- Sports and concerts have some of the largest disparities between dialog based and BS1770-2 based measurements.



Related Papers

- Bruce Jacobs “CALM Down!”, HPA Tech Retreat, February 2012
- Scott Norcross and Michael Lavoie “The Effect of Downmixing on Measured Loudness”, AES e–Brief #38



Questions?

