

Galileo

Loudspeaker Management System



Digital Loudspeaker Management Processor Compose Control Software



Galileo Loudspeaker Management System



"With careful design, digital audio now can finally realize its potential for audio quality, and it permits us to do things we couldn't achieve in the analog domain. Galileo 616 demonstrates both of these things and represents Meyer Sound taking our next step into the world of digital audio."

OVERVIEW

The Galileo loudspeaker management system is a hardware/software system providing all of the facilities required to drive and align sound reinforcement systems employing multiple zones. The system consists of the Galileo 616, a six-input/16-output, 2U, fully digital matrix processor and Compass software for comprehensive control of the Galileo 616 through a graphical environment running on a remote computer. Galileo 616 can also be controlled directly from its front panel for maximum flexibility.

Designed as the perfect complement to Meyer Sound's self-powered loudspeakers, the Galileo system includes array compensation for M Series array products, presets for Meyer Sound systems of various sizes and types, and digital implementations of popular features developed over years by Meyer Sound for its acclaimed analog processors, including air absorption compensation filters and equalization from the CP-10, VX-1, and LD-3.





Front panel input channel meters



Compass Composite EQ

Алау 1	Enabled	MILO
Алтау 2	Enabled	MILO
Алтау 3	Enabled	M2D
Array 4	Bypassed	M1D
Array 5	Bypassed	M1D
Алтау 6	Bypassed	M1D
Алтау 7	Bypassed	M1D
Алтау 8	Bypassed	Ma

Array compensation setup

Benefits and Features

- DSP-based processing.
- Six inputs analog, AES/EBU or a mixture and 16 analog outputs with full matrix mixing and routing for driving systems from small to very large.
- Fixed latency across all output channels regardless of processing applied.
- Direct connection to Meyer Sound's SIM 3 audio analyzer.
- Digital implementation of popular Meyer Sound processing features, including air absorption compensation filters and equalization from the CP-10, VX-1 and LD-3.
- Presets for setups of Meyer Sound line array and point-source systems from small to very large.
- Array compensation for Meyer Sound M Series products.
- Ethernet connection for remote control from laptop computers (Windows or Macintosh) and wireless tablets.
- Front panel operation for stand-alone control.
- Highest quality audio: A/D/A conversion with 24-bit resolution at 96 kHz, digital input signals sample rate converted to 96 kHz.
- All internal processing performed at 96 kHz, 32-bit floating point resolution.
- Full bidirectional communication between unit and remote control devices insures that parameter settings are always current in both.
- Up to 2 seconds of delay on inputs and outputs.
- Robust output line drivers easily drive Meyer Sound self-powered systems over long cable runs.
- TruShaping EQ and Composite EQ filtering provide an innovative approach to system equalization that yields appropriate correction with the least impact on phase response.



A standard Ethernet connection allows remote control and networking for the Galileo 616.

HARDWARE

Audio Inputs and Outputs

Galileo 616's audio I/O features six analog inputs on balanced XLR connectors feeding state-of-the-art A/D converters operating at 24-bit resolution, 96 kHz sample rate. Three of the inputs can be individually switched to operate as standard stereo AES/EBU digital audio inputs, accepting signals at sample rates up to 96 kHz. Since all internal processing is performed at 96 kHz, 32-bit vector floating point, any signals entering at lower sample rates are upsampled using state-of-the-art hardware sample rate converters. The six input channels can consist of a combination of analog and digital inputs.

The 16 outputs feature high-resolution 96 kHz, 24-bit D/A converters, and offer the same robust line driving capabilities as those of Meyer Sound's analog line driver products, up to +26 dBu, allowing the Galileo 616 to easily drive Meyer Sound self-powered loudspeakers to full output at all frequencies, even over long lines.

Communications

The digital world is about networking devices together. Galileo 616 provides exceptional capabilities in this regard. Its Ethernet connection allows Galileo 616 to be remotely controlled from a computer or wireless tablet running Meyer Sound Compass control software under either the Macintosh or Windows operating system. Full bidirectional communication ensures that the user is always viewing current settings, whether operating the unit remotely or from the front panel.



SIM

Connect to SIM

3022 or 3088 only

SIM 3 Integration

The rear panel also includes a direct connection to Meyer Sound's SIM 3 audio analyzer which allows Galileo 616 to act as a line switcher for the analyzer. This means that users can measure across any selection of Galileo 616's inputs and outputs without any patching beyond a single cable connection to the analyzer, providing maximal flexibility with no extra setup.

The Galileo 616 is designed to afford a broad upgrade path for future interfacing options, which can include popular existing or future digital audio networking protocols.



Front Panel Control

In addition to its remote control capabilities, Galileo 616 features a comprehensive and intuitive set of front panel controls and an LCD screen, allowing it to be operated without the use of a computer. Crucial information is available at a glance and hardware controls make quick adjustments easy.

A carefully-crafted user interface gives Galileo 616 the quick, intuitive operation required for live use. Each input sports a 26-segment LED ladder meter, plus mute and select buttons/indicators, while each output has a bi-color level LED and mute and select buttons. Three high-resolution encoder knobs are used to make parameter adjustments, which are shown on the 128 x64 pixel liquid crystal display.

"The Galileo 616 is a vector supercomputer in a 2U box with great analog-to-digital and digital-to-analog converters. Users can apply an incredible number of filters with the assurance of fixed latency to maintain stability in the sound and imaging."

Perrin Meyer



Powerful DSP Architecture

Galileo 616 is built around a monolithic, 1 GHz vector DSP architecture employing a direct DMA audio path to maximize processing power and guarantee fixed low-latency performance, no matter how much processing is applied. High-quality algorithms at 96 kHz sampling rate, 32-bit floating-point resolution are used to implement a large assortment of processing. Even when applying all available processing to every channel, Galileo 616's DSP engine retains substantial processing headroom. This design demonstrates how Meyer Sound looks towards the future as much as to the present.

Real-World Protection

Meyer Sound knows that sound reinforcement requires expecting the unexpected. Galileo 616 offers protection against inadvertent changes that can result in serious problems. The AC power switch is software-activated, so that accidental button-pushes cannot turn off the unit's power. A locking PowerCon AC connector ensures the power cable cannot be yanked out by an errant foot. And user-programmable lockout of all front panel controls offers four levels of protection to keep curious fingers from changing things best left untouched.



PROCESSING

Processing Functions

Providing up to two seconds of delay for each input and output represents just the beginning of Galileo 616's power; it is the unit's filtering that truly sets it apart in the realm of DSP-based loudspeaker management systems. Each input and output includes a careful digital implementation of Meyer Sound's famous CP-10 complementary phase parametric equalization (five bands on inputs, ten bands on outputs), coupled with our new TruShaping program filters. This unique combination gives users the ability to treat acoustical problems appropriately and accommodate subjective needs without creating excessive phase shift that can degrade intelligibility and signal clarity.

Also supplied in Galileo 616 are digital implementations of the subwoofer crossover, air absorption compensation, and M Series array compensation filters first realized in the LD-3 compensating line driver.

Galileo 616's all-digital design also enables Meyer Sound to give users entirely new capabilities, like low frequency coverage shaping for widening low-frequency dispersion patterns. A library of coverage-shaping presets is provided for large-scale M Series products, such as the MILO high-power curvilinear array loudspeaker and M3D line array loudspeaker.



Galileo 616 supplies a powerful signal processing arsenal incorporating delay and many forms of filtering. Shown above is the Compass screen that configures Galileo 616's Composite EQ, available on each input and output.



This partial signal flow diagram shows Galileo 616's extensive collection of processing features.

Composite EQ Filter Architecture

Proper sound system design, implementation and alignment can avoid a host of problems in system response, and this should always be the first line of pursuit in sound reinforcement. When all possible measures in these areas have been taken, however, there are usually some problems that remain. Equalization is a primary tool for dealing with such problems.

Tuning a modern sound system with equalization is a complex task breaking down to a few basic needs: subjective shaping of the system frequency response, compensating for air attenuation and correcting for some anomalies resulting from interactions between loudspeakers or between loudspeakers and the acoustical environment. (This last category would include low-frequency buildup, for example.) But there are fundamental differences in character between some of these needs, which define a requirement for different tools to do the jobs appropriately. Failing to account for these distinctions can result in severe degradation of system phase response, with corresponding reductions in intelligibility and clarity of the sound.

Galileo 616's Composite EQ filter architecture is intended to address this issue and provide the most potent equalization system available in any current digital loudspeaker management system, while keeping phase shift to the lowest amount practically attainable.

Let's take a closer look at the problem and how Composite EQ solves it.

Interaction-based effects are, classically, second-order phenomena that produce ripple in the measured frequency response of a system. Using Meyer Sound's SIM 3 audio analyzer, these artifacts can be clearly seen. In practice, there are many interactions for which equalization is not the most effective approach, but for those that do yield to equalization, the best tool for attacking them is a fully parametric equalizer producing both amplitude and phase responses complementary (that is, equal and inverse) to the characteristics of the interaction artifact being treated. Meyer Sound's CP-10 complementary phase parametric equalizer's second-order filters were created for this purpose, and Galileo 616 incorporates a careful digital implementation of a CP-10 filter set on each input and output. When such an equalizer is properly configured, the effect of treatable interactions can be essentially removed from the system response, leaving both amplitude and phase responses quite flat.

Subjective shaping and interaction effects like low-frequency buildup, on the other hand, tend to be much broader in shape. High-order filters are ill suited to this sort of gentle amplitude response shaping and, as well, generate considerably greater phase shift than low-order filters.



White line indicates phase.

Galileo 616's Composite EQ provides the right tool for these jobs, too: the TruShaping equalizer. The TruShaping equalizer (patent pending) is a digital implementation of Meyer Sound's acclaimed VX-1 program equalizer, extended to contain four first-order interactive filters in an innovative

configuration. Since the TruShaping EQ's filters are low-order, they keep phase shift to a minimum, preserving the integrity of the signal. In fact, the unique cascading topology used to create the TruShaping equalizer allows the bands to overlap, which results in slopes as low as 3 dB per octave and response curves so smooth they could not be obtained any other way. Even with extreme settings, the TruShaping equalizer will rarely result in even so much as 45 degrees of phase shift. No other device currently on the market offers this approach.

This technique is so successful for system frequency response shaping applications that the Array Compensation filters in Meyer Sound's Galileo 616 are based on the TruShaping filter topology.

As Meyer Sound self-powered systems are optimized to produce flat frequency and phase response when they ship from the factory, the TruShaping equalizer provides a powerful tool for adding "warmth," "presence" or other subjective qualities.

Composite EQ, by providing both CP-10 complementary phase parametric and TruShaping low-order shaping equalization, gives the user the right tools to deal with both acoustical anomalies and subjective needs. Best of all, the Composite EQ user interface in the Galileo system's Compass control software presents a clear picture of the resulting equalization by overlaying the CP-10 and TruShaping responses being applied, both amplitude and phase, in a single editable graphical display. EQ parameters can be edited directly by simply dragging in the display, or edited numerically for greater precision.

Air Absorption Compensation

As sound waves travel long distances through air, high frequencies are absorbed, a fact important to consider when setting up highpowered loudspeakers for a long-throw application. But the effect of air absorption on sound is complex to describe, as it depends on a number of factors, including distance, temperature, humidity and altitude. The equations shown here are used to calculate the sizable tables upon which Galileo 616 draws to provide its atmospheric compensation filtering.

$$f_{\rm rO} = \frac{p_a}{p_r} \left(24 + \frac{(4.04 * 10^4 h)(0.02 + h)}{0.391 + h} \right) \tag{1}$$

$$f_{\rm rN} = \frac{p_a}{p_r} \left(\frac{1}{T_f r}\right)^{-2} * \left(9 + 280 h \exp\left[-4.170\left(\left(\frac{1}{T_r}\right)^{-3} - 1\right)\right]\right) \tag{2}$$

$$Oxygen = \left(0.01275 \left[exp\left(\frac{-2239.1}{T}\right) \right] \left[\frac{f_{rO}}{f_{rO}^2 + f^2} \right] \right)$$
(3)

Nitrogen =
$$\left(0.1068 \left[\exp\left(\frac{-3352.0}{T}\right)\right] \left[\frac{f_{\rm rN}}{f_{\rm rN}^2 + f^2}\right]\right)$$
 (4)

$$\alpha(f) = 8.686 f^2 \left(\left[1.84 * 10^{-11} \left(\frac{p_a}{p_r} \right)^{-1} \left(\frac{T}{T_r} \right)^{\frac{1}{2}} \right] + \left(\frac{T}{T_r} \right)^{-\frac{5}{2}} \left[\text{Oxygen + Nitrogen} \right] \right)$$
(5)

Method for calculating frequency dependent air absorption from ANSI S1.26 – 1995.

COMPASS CONTROL SOFTWARE

Intuitive Interface

With all the features and power offered by Galileo 616, giving the user a comprehensive, intuitive way to control them is paramount. Meyer Sound's Compass software fulfills this requirement. Running under either the Macintosh or Windows operating system, Compass provides a graphical user interface that is the result of years of experience optimizing complex systems.

Compass' System Map lets users see signal flow at a glance. The unique filter display shows and allows direct editing of the composite response created by the CP-10 and TruShaping filters. Filter parameters can be edited graphically or by direct text or numeric entry. Seeing the frequency shaping curve is not the full story, however, so Compass' filter display also shows the composite phase response.

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Device Type: Galileo 616	SETTINGS	METERS	PROCESSING	0.0 NORMAL	6.00ms		2 L MILO Zu
IP Address: 255.255.255.255	5 M Series Array Compensation	OUTPUT	PROCESSING	0.0 NORMAL	6.00ms		- 3 L MILO Zo
Sille Bus Address: 10	CREATE SNAPSHOT	LIBRARY			6.00ms		4 R MIL0.7
INPUTS	DELAY GAIN =	ENABLED		0.0 NORMAL	6.00ms		R MILO Z
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B RIGHT MAIN MUTE	0.00ms - 0.0 - • •		PROCESSING	0.0 NORMAL	3.00ms		7 C M2D Zo
CENTER MUTE	0.00ms - 0.0 - • •		PROCESSING	0.0 NORMAL	3.00ms		8 C M2D Zo
D SUBS	0.00ms - 0.0 - • P			0.0 NORMAL	3.00ms -		9 C M2D Zo
E DELAY MUTE	0.00ms 0.0 0.0		PROCESSING	0.0 NORMAL	15.00me	-2.0 MUTE	10 M3D-Sub
F Input F MUTE	0.00ms 0.0	ROCESSING	PROCESSING	0.0 NORMAL	13.00ms	-2.0 MUTE	11 700-HP
123456	7 8 9 10 11 12 13	14 15 16	BYPASSED	0.0 NORMAL	35.30ms		12 L MSL-4
			PROCESSING	U.U NORMAL	35.31ms -		13 K MSL-4
c state				0.0 REVERSE	12.22ms	+3.0 MUTE	14 L CQ-2 S
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F B B B B B B B B					3.00mx		16 M1D Fun

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		SUBS	-60	-45	-30	-20 -1	5 -10	-5	°r	Delay 0.00ms	Gain 0.0	MUTE	1
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Presets for Every Size System

A large library of presets is included for systems ranging from two small Meyer Sound loudspeakers all the way up to complex, multi-zone systems built around M Series line array products. No more building processing chains one block at a time; Galileo users can get right to the starting line and make modifications as needed from there.

ett	work <u>P</u> roj	ects <u>E</u> ait <u>E</u>	ayout <u>M</u> atrix	<u>w</u> indows											
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Galileo's matrix provides routing and mixing functionality for any combination of inputs to outputs. Each output can receive its own mix of the six inputs.

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3	Array 3	Bypassed	M2D	\$	1	1	2	3	4	5	6	7	8	9	10	11	12	
4	Array 4	Bypassed	M1D	\$	1	1	2	3	4	5	6	7	8	9	10	11	12	5
5	Array 5	Bypassed	M1D	\$	1	1	2	3	4	5	6	7	8	9	10	11	12	
6	Array 6	Bypassed	M1D	\$	1	1	2	3	4	5	6	7	8	9	10	11	12	
7	Array 7	Bypassed	M1D	\$	1	1	2	3	4	5	6	7	8	9	10	11	12	^
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3	Group 3	Enabled	Mutes Linked	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
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The Link Groups feature allows up to eight groups of outputs to be defined. Once grouped, output processing is linked for all outputs in the group, so that changing a parameter of one output also changes that parameter in all of the group's outputs.

THE BOTTOM LINE

Audio professionals take their jobs seriously and demand equipment that can stand up to the high standards they require and the intense demands they experience. After 25 years of servicing the needs of professionals, Meyer Sound has proven itself just as serious about making equipment that satisfies their needs.

With the Galileo system, Meyer Sound moves fully into the age of digital audio and shows, once again, why we provide "A Great Performance in Every Box."



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