ORTEC®

671
Spectroscopy Amplifier

- **High-performance energy spectroscopy with all types of detectors (Ge, Si, scintillation; proportional counters)**
- **Compact, single-width NIM module**
- **Choice of triangular and Gaussian filters effectively doubles the time constants available for optimum resolution**
- **Automatic noise discriminators on both the pile-up rejector and the baseline restorer eliminate screwdriver adjustments**
- **Automatic baseline restorer rate for optimum performance at both low and high counting rates**
- **Differential input for reduction of ground loop noise**
- **Automatically compensates for reset recovery with transistor-reset preamplifiers**

The ORTEC Model 671 high-performance, energy spectroscopy amplifier is ideally suited for use with germanium, Si(Li), and silicon charged-particle detectors. It can also be used with scintillation detectors and proportional counters. The Model 671 input accepts either positive or negative polarity signals from a detector preamplifier and provides a positive 0 to 10-V output signal suitable for use with single-channel or multichannel pulse height analyzers. Its gain is continuously variable from 2.5 to 1500.

Automation of critical adjustments makes the Model 671 easy to set up with any detector, while minimizing the required operator expertise.

A front-panel switch on the Model 671 provides the choice of either a triangular or a Gaussian pulse shape on the UNI output connector (Fig. 1). The noise performance of the triangular pulse shape is equivalent to a Gaussian pulse shape having a 17% longer shaping time constant. In applications where the series noise component is dominant (short shaping time constants), and the pile-up rejector is utilized, the triangular shape will generally offer the same dead time and slightly lower noise than the Gaussian pulse shape. A front-panel switch permits selection of the optimum shaping time constant for each detector and application. Six time constants in the range of 0.5 to 10 µs, and the TRI/ GAUSS switch combine to offer 12 different shaping times. A bipolar output is also provided for measurements requiring zero cross-over timing.

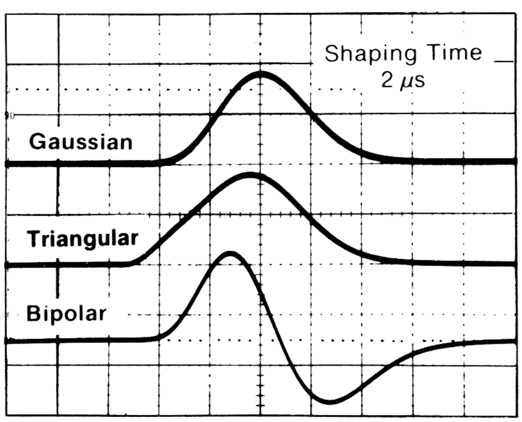

Fig. 1. Gaussian, Triangular, and Bipolar Output Pulse Shapes for a 2-µs Shaping Time. Vertical scale, 5 V per division; horizontal scale, 2 µs per division.

To minimize spectrum distortion at medium and high counting rates (Fig. 2), the unipolar output incorporates a high-performance, gated, baseline restorer with several levels of automation. Automatic positive and negative noise discriminators ensure that the baseline restorer operates only on the true baseline between pulses in spite of changes in the noise level. No operator adjustment of the baseline restorer is needed when changes are made in the gain, the shaping time constant, or the detector characteristics. Negative overload recovery from the reset pulses generated by transistor-reset preamplifiers and pulsed optical feedback preamplifiers is also handled automatically. A monitor circuit gates off the baseline restorer and provides a reject signal for a multichannel analyzer until the baseline has safely recovered from the overload.

Several operating modes are selectable for the baseline restorer. For making a PZ adjustment, the PZ position is selected. This position can also be used where the slowest baseline restorer rate is desired. For situations where low-frequency noise interference is a problem, the HIGH rate can be chosen. On detectors where perfect PZ cancellation is impossible, the AUTO baseline restorer rate provides the optimum performance at both low and high counting rates.

A front-panel limit (LIM) push button is included with the unipolar output to facilitate monitoring the accuracy of the PZ adjustment on an oscilloscope. When pressed, this button inserts a diode limiter in

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series with the unipolar output connector. This prevents overload distortions in the oscilloscope when using the more sensitive amplitude scales required for observing the PZ adjustment.

An efficient pile-up rejector is incorporated in the Model 671 spectroscopy amplifier. It provides an output logic pulse for the associated multichannel analyzer to suppress the spectral distortion caused by pulses piling up on each other at high counting rates (Fig. 3). The fast amplifier in the pile-up rejector includes a gated baseline restorer with its own automatic noise discriminator. A multicolor pile-up rejector LED on the front panel indicates the throughput efficiency of the amplifier. At low counting rates the LED flashes green. The LED turns yellow at moderate counting rates and red when pulse pile-up losses are >70%.

When long connecting cables are used between the detector preamplifier output and the amplifier input, noise induced in the cable by the environment can be a problem. The Model 671 provides two solutions. For low to moderate interference frequencies the differential input mode can be used with paired cables from the preamplifier to suppress the induced noise. At high frequencies a common mode rejection transformer built into the Model 671 input reduces noise pick-up. The transformer is particularly effective in eliminating interference from the display raster generators in personal computers.

All toggle switches on the front panel lock to prevent accidental changes in the desired settings.

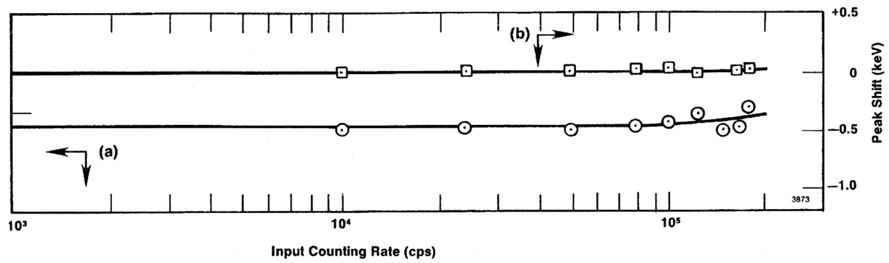

Fig. 2. (a) Resolution and (b) Peak Position Stability as a Function of Counting Rate. See specifications for spectrum broadening and spectrum shift.

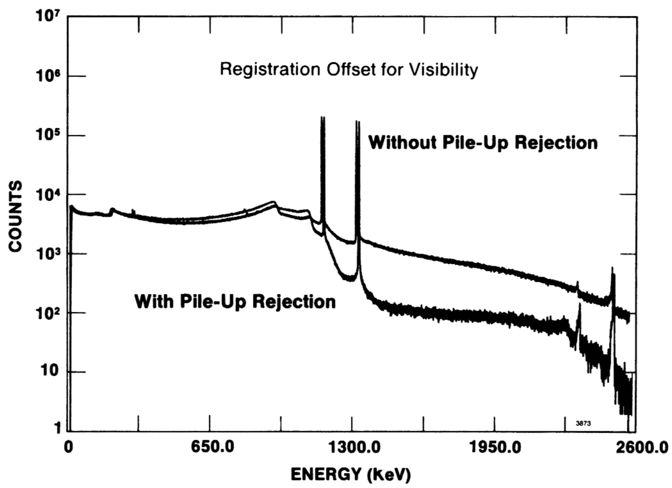

Fig. 3. Demonstration of the Effectiveness of the Pile-Up Rejector in Suppressing the Pile-Up Spectrum. See Pulse Pile-Up Rejector specification.

Specifications

PERFORMANCE

Note: Unless otherwise stated, performance specifications are measured on the unipolar output with 2-µs Gaussian shaping and the AUTO BLR mode.

GAIN RANGE Continuously adjustable from 2.5 to 1500. Gain is the product of the COARSE and FINE GAIN controls.

UNIPOLAR PULSE SHAPES Switch selection of a nearly triangular pulse shape or a nearly Gaussian pulse shape at the UNI output (Fig. 1, Table 1).

BIPOLAR OUTPUT PULSE SHAPE Rise of the bipolar output pulse from 0.1% to maximum amplitude is 1.65 times selected SHAPING TIME. Zero cross-over of the bipolar output pulse is delayed from the maximum amplitude of Gaussian unipolar output by 0.33 times the selected SHAPING TIME.

INTEGRAL NONLINEARITY (UNI Output) <±0.025% from 0 to +10 V.

NOISE Equivalent input noise <5.0 µV rms for gains >100, and <4.5 µV rms for gains >1000.

TEMPERATURE COEFFICIENT (0 to 50°C)
Unipolar Output <±0.005%/°C for gain, and <±7.5 µV/°C for dc level.
Bipolar Output <±0.007%/°C for gain, and <±30 µV/°C for dc level.

WALK Bipolar zero cross-over walk is <±3 ns over a 50:1 dynamic range.

OVERLOAD RECOVERY Unipolar and bipolar outputs recover to within 2% of the rated output from a X1000 overload in 2.5 nonoverloaded pulse widths using maximum gain.

SPECTRUM BROADENING† (Fig. 2) Typically <8% broadening of the FWHM for counting rates up to 100,000 counts/s, and <15% broadening for counting rates up to 200,000 counts/s. Measured on the 1.33-MeV gamma-ray line from a ^{60}Co radioactive source under the following conditions: 10% efficiency ORTEC GAMMA-X PLUS detector, 8.5-V amplitude for the 1.33-MeV gamma ray on the unipolar output.

SPECTRUM SHIFT† (Fig. 2) Peak position typically shifts <±0.018% for counting rates up to 100,000 counts/s, and <±0.05% for counting rates up to 200,000 counts/s. Measured on the 1.33-MeV line under conditions specified for SPECTRUM BROADENING.

†Results may not be reproducible if measured with a detector producing a large number of slow rise-time pulses or having quality inferior to the specified detector.

DIFFERENTIAL INPUT Differential nonlinearity <±0.012% from –9 V to +9 V. Maximum input ±10 V (dc plus signal). Common mode rejection ratio >1000.

PULSE PILE-UP REJECTOR

Threshold Automatically set just above noise level on fast amplifier signal. Independent of slow amplifier BLR threshold.

Minimum Detectable Signal Limited by detector and preamplifier noise characteristics.

Pulse Pair Resolution Typically 500 ns. Measured using the ^{60}Co 1.33-MeV gamma ray under the following conditions: 10% efficiency germanium detector, 4-V amplitude for the 1.33-MeV gamma ray at the unipolar output, 50,000 counts/s (Fig. 3).

CONTROLS AND INDICATORS

FINE GAIN Front-panel, 10-turn precision potentiometer with locking, graduated dial provides continuously variable, direct reading, gain factor from 0.5 to 1.5.

COARSE GAIN Front-panel, eight-position switch selects gain factors of 5, 10, 20, 100, 200, 500, and 1000.

SHAPING TIME Six-position switch on the front panel selects shaping times of 0.5, 1, 2, 3, 6, and 10 µs for the pulse-shaping filter network.

MODE Two-position locking toggle switch on the front panel selects either GAUSS (Gaussian) or TRI (Triangular) pulse shaping for the UNI (unipolar) output.

INPUT POS/NEG Front-panel, two-position locking toggle switch accommodates either positive or negative input polarities.

NORM/DIFF Two-position slide switch mounted on the printed circuit board selects the normal (NORM) or differential (DIFF) input modes. In the NORM position, both front- and rear-panel INPUT connectors function as the same normal input for the preamplifier signal cable. In the DIFF mode the rear-panel INPUT connector becomes a differential ground reference input, and the front-panel INPUT remains the normal input for the preamplifier signal cable. In the DIFF mode the preamplifier signal cable is connected to the front-panel INPUT and a cable having its center conductor connected to the preamplifier ground through an impedance matching resistor is connected to the rear-panel INPUT. The impedance matching resistor must match the output impedance of the preamplifier.

Table 1. Unipolar Pulse Shape Parameters for the Triangular and Gaussian Pulse Shapes.

Time Interval	Shaping Time Multiplier*	
	Triangular	Gaussian
From start of input pulse to maximum amplitude of unipolar output pulse	2.6	2.8
Rise of output pulse from 0.1% to maximum amplitude	2.4	2.0
Width of output pulse at 50% of maximum amplitude	2.5	2.0
Width of output pulse at 1% of maximum amplitude	5.6	5.0
Width of output pulse at 0.1% of maximum amplitude	6.9	6.3

*Time interval equals the selected front-panel SHAPING TIME multiplied by the Shaping Time Multiplier.

BAL (Differential Input Gain Balance) A 20-turn potentiometer mounted on the PC board inside the module allows the gains of normal and differential reference inputs to be matched for maximum common mode noise rejection in DIFF mode.

PZ ADJUSTMENT 20-turn potentiometer on the front panel permits screwdriver adjustment of the PZ cancellation. The adjust-ment covers preamplifier exponential decay time constants from 40 µs to ∞. For transistor-reset preamplifiers or pulsed optical feedback preamplifiers, set the PZ adjustment fully counterclockwise.

LIM PUSH BUTTON Inserts a diode limiter in series with the front-panel UNI output connector. Prevents overload distortions in the oscilloscope when observing the accuracy of the PZ adjustment on the more sensitive oscilloscope ranges.

BLR A front-panel, three-position, locking, toggle switch selects the baseline restorer rate. PZ position offers lowest fixed rate for adjusting PZ cancellation. AUTO position matches the rate of the PZ position at low counting rates, but increases the restoration rate as the counting rate rises. HIGH rate position is provided for suppressing low-frequency interference.

PUR ACCEPT/REJECT LED Multicolor LED indicates percentage of pulses rejected because of pulse pile-up. LED appears green for 0–40%, yellow for 40–70%, and red for >70% rejection.

INPUTS

INPUT (Front Panel) BNC connector accepts preamplifier signals of either polarity with rise times less than the selected SHAPING TIME, and exponential decay time constants from 40 µs to ∞. For the NEG INPUT switch setting, the input impedance is 1000 Ω on a coarse gain of 5, and 465 Ω at coarse gain settings ≥10. For the POS INPUT switch setting, the input impedance is 2000 Ω for a coarse gain of 5, and 1460 Ω for coarse gains ≥10. Input is dc-coupled, and protected to ±25 V.

INPUT (Rear Panel) BNC connector. Identical to front-panel INPUT when PWB-mounted NORM/DIFF slide switch is in the NORM position. When operating in the differential input mode with the slide switch set to DIFF, the rear-panel INPUT is used for the preamplifier ground reference connection. For the DIFF and POS INPUT switch settings, the input impedance is 1000 Ω on a coarse gain of 5, and 465 Ω at coarse gain settings ≥10. For the DIFF and NEG INPUT switch settings, the input impedance is 2000 Ω for a coarse gain of 5, and 1460 Ω for coarse gains ≥10. Input dc-coupled; protected to ±25 V.

INH IN Rear-panel BNC inhibit input connector accepts reset signals from transistor-reset preamplifiers or pulsed optical feedback preamplifiers. Positive NIM standard logic pulses or TTL levels can be used. Logic is selectable as active high or active low via a printed circuit board jumper. Inhibit input initiates the protection against distortions caused by the preamplifier reset. This includes turning off the baseline restorers, monitoring the negative overload recovery at the unipolar output, and generating PUR (reject) and BUSY signals for the duration of the overload. The PUR and BUSY logic pulses are used to prevent analysis and correct for the reset dead time in the associated ADC or multichannel analyzer.

OUTPUTS

UNI Front- and rear-panel BNC connectors provide positive, unipolar, shaped pulses with a linear output range of 0 to +10 V. Front-panel output impedance <1 Ω. Rear-panel output impedance selectable for either <1 Ω or 93 Ω using a printed circuit board jumper. Outputs are dc-restored to 0 ±5 mV and short-circuit protected.

BI Front- and rear-panel BNC connectors provide bipolar shaped pulses with the positive lobe leading. The linear output range is 0 to ±10 V. Front-panel output impedance <1 Ω. Rear-panel output impedance selectable for either <1 Ω or

93 Ω using a printed circuit board jumper. Baseline between pulses has a dc level of 0 ±10 mV. Short-circuit protected.

CRM The Count Rate Meter output has a rear-panel BNC connector and provides a 250-ns wide, +5-V logic signal for every linear input pulse that exceeds the pile-up inspector threshold. Output impedance is 50 Ω.

BUSY Rear-panel BNC connector provides a +5-V logic pulse for the duration that the linear signals exceed the positive or negative baseline restorer thresholds, or the pile-up inspector threshold, or for the duration of the INH IN input signal. Useful for dead-time corrections with an associated ADC or multichannel analyzer. Positive NIM standard logic pulse is selectable as active high or active low via a printed circuit board jumper. Output impedance is 50 Ω.

PUR Pile-Up Reject output is a rear-panel, BNC connector. Provides a +5-V NIM standard logic pulse when pulse pile-up is detected. Output also present for a pulsed reset preamplifier during reset, and reset overload recovery. Output pulse is selectable as active high or active low by means of a printed circuit board jumper. Output impedance is 50 Ω. Used with an associated ADC or multichannel analyzer to prevent analysis of distorted pulses.

PREAMP Rear-panel standard ORTEC connector (Amphenol 17-10090) provides power for the associated preamplifier. Mates with power cords on all standard ORTEC preamplifiers.

ELECTRICAL AND MECHANICAL

POWER REQUIRED The Model 671 derives its power from a NIM Bin supplying ±24 V and ±12 V, such as the ORTEC Model 4001A/4002A Bin/Power Supply. The power required is +24 V at 100 mA, –24 V at 200 mA, +12 V at 325 mA, and –12 V at 180 mA.

WEIGHT
Net 1.5 kg (3.3 lb).
Shipping 3.1 kg (7.0 lb).

DIMENSIONS Standard single-width NIM module, 3.43 X 22.13 cm (1.35 X 8.714 in.) front panel per DOE/ER-0457T.

Ordering Information

To order, specify:

Model	Description
671	Spectroscopy Amplifier

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