APS series of 4-quadrant amplifiers

4-QUADRANT VOLTAGE / CURRENT AMPLIFIER

Fig. 1: 4-quadrant amplifier APS 1000

The relating standards:
IEC/EN 61000-3-2
IEC/EN 61000-3-3
IEC/EN 61000-3-11
IEC/EN 61000-3-12
IEC/EN 60146-1-1
IEC/EN 61000-2-2
IEC/EN 61000-4-8
IEC/EN 61000-4-11
IEC/EN 61000-4-13
IEC/EN 61000-4-14
IEC/EN 61000-4-17
IEC/EN 61000-4-27
IEC/EN 61000-4-28
IEC/EN 61000-4-29
IEC/EN 61000-4-34
IEC/EN 61131-2
IEC/EN 61496-1
IEC/EN 61800-3
IEC/EN 62040-2
RTCA DO-160
SEMI F47-0706
German. Lloyd

NEW: Constant current mode

The adjustable and desired output current is automatically regulated and stabilized according to the user's preferences, the only limitation is the amplifier's performance characteristic.

- ✓ Touch panel operation 7" (800x480)
- ✓ Very high peak-load ability (up to 2 … 3ms)
- ✓ Very low internal resistance
- ✓ Very fast slew rate > 52V/µs (rise time < 5µs at 230V_{rms} acc. IEC/EN 61000-4-11)
- ✓ Extremely low harmonic distortion - even under very non-linear load conditions
- ✓ Operates from DC up to 10kHz large signal bandwidth (-3dB) - optional up to 30kHz
- ✓ Small signal bandwidth up to 50kHz
- ✓ High long-term overload characteristic (up to 1 hour)
- ✓ High short-term overload characteristic (up to 2 min)
- ✓ Sink operation mode included – real 4-quadrant operation mode
- ✓ Current and voltage limitation adjustable
- ✓ Optical link for easy PHIL interface

VOLTAGE AND CURRENT MODE OPERATION
REFERENCE SOURCE FOR ALL APPLICATIONS

VERY FAST RISE AND FALL TIME

Due to the very fast slew rate of >52V/µs the APS is fully compliant according to the requirements of IEC/EN 61000-4-11 in practice.

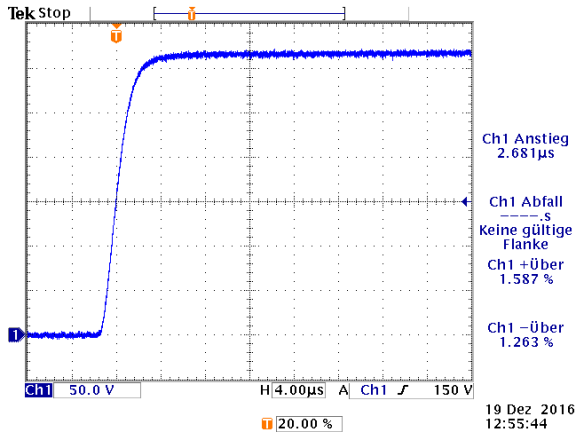

Fig. 2: rise time of the output voltage

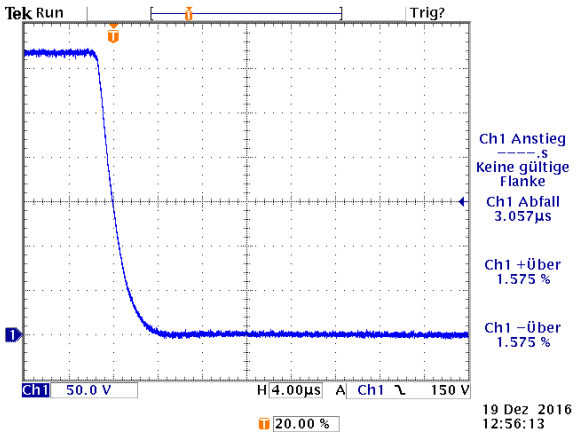

Fig. 3: fall time of the output voltage

EXTREMELY HIGH LOADABILITY

150% of rating is available in the case of a real load. Amplifier stability is absolutely assured when operating with either inductive or capacitive loads.

The sink mode power capability is approx. 30% of the source mode capability.

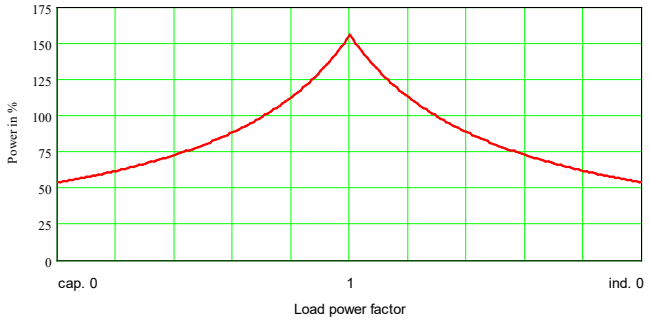

Fig. 4: APS performance characteristic

DC SIMULATION

DC signals can easily be generated using the directly coupled ironless amplifier output stage.

All test devices requiring a DC content within their input current can be supplied without problems.

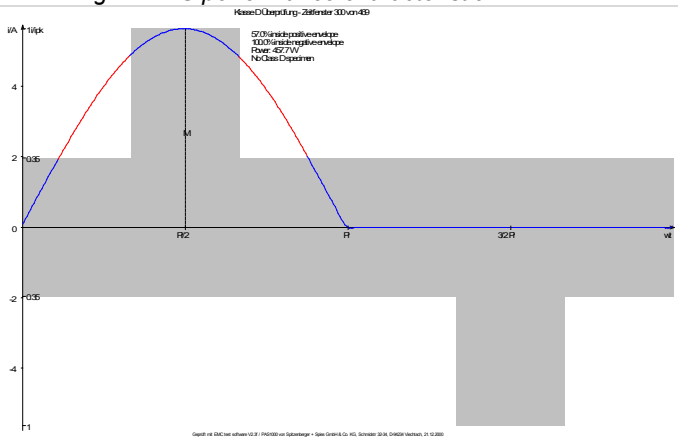

Fig. 5: APS DC characteristic

TOUCHSCREEN USER INTERFACE

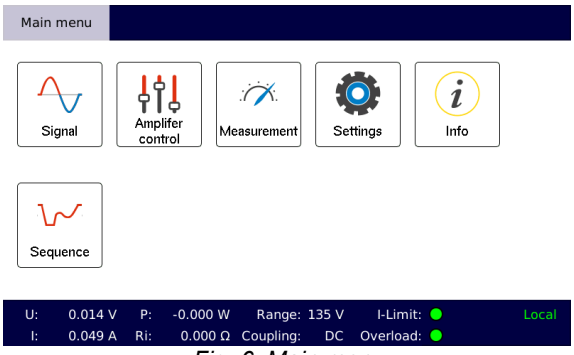

Fig. 6: Main menu

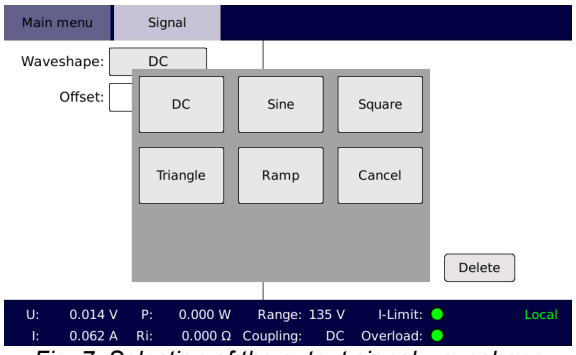

Fig. 7: Selection of the output signal waveshape

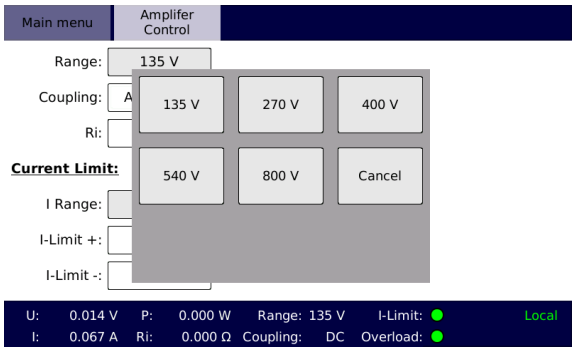

Fig. 8: Selection of the output voltage range

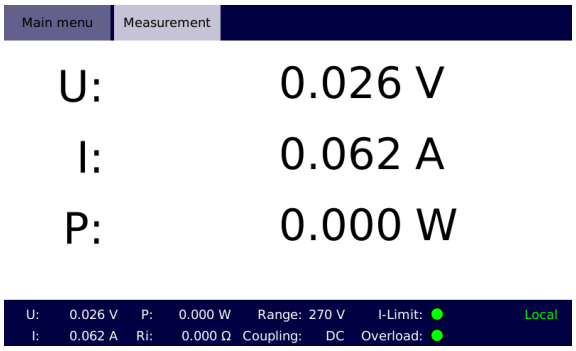

Fig. 9: Measurement unit display

TECHNICAL DATA - GENERAL

		APS series
Nominal voltage ranges[1)]	*AC (DC)*	135V_{rms} (±191V_{DC}) / 240V_{rms} (±339V_{DC}) / 270V_{rms} (±382V_{DC}) / 300V_{rms} (±424V_{DC})
Load regulation		Range: 135V_{rms} — DC … 450Hz: 0.4% — 450Hz … 5kHz: 5.0% — 5kHz … 10kHz: 15.0% 240V_{rms} — 0.2% — 2.5% — 8.0% 270V_{rms} — 0.2% — 1.0% — 5.0% 300V_{rms} — 0.2% — 1.0% — 5.0%
Stability (1h)		gain: <0.1% / offset: <0.02% of range value at constant load and temperature
Line regulation		<1.5x10^{-4} per 10V line-voltage change
Frequency bandwidth		large signal: DC … 10kHz (-3dB) small signal (10%): DC … 50kHz (-3dB)
Slew rate		>52V/µs (rise time <5µs at 230V_{rms} according to IEC/EN 61000-4-11)
Harmonic distortion (max.)		Range: 135V_{rms} — DC … 450Hz: 0.3% — 450Hz … 5kHz: 3.0% — 5kHz … 10kHz: 5.0% 240V_{rms} — 0.2% — 2.0% — 3.0% 270V_{rms} — 0.1% — 1.0% — 2.5% 300V_{rms} — 0.1% — 1.0% — 2.5%
Floating output		max. voltage between earth and the amplifier's ground output: <300V_{rms}
Internal resistance compensation		<8V_p (ground and each phase line)
Protection circuits		overload / short circuit / over temperature
External input	*Max. voltage*	0 … V_{ExtMax} (V_{ExtMax} is adjustable between ±2V_p … ±25V_p)
	Impedance	approx. 10kΩ
	Delay time	Signal delay between amplifier's external input and amplifier's output <5µs
Interface		Ethernet 100MBit
Internal oscillator unit		
	Type	4-channel synthesizer
	Wave forms	DC, sine, square, triangle, ramp, arbitrary
	Amplitude resolution	17Bit
	Frequency range	DC … 1MHz
	Frequency resolution	1µHz
	Frequency accuracy	25ppm
	Phase range	0° … 360°
	Phase resolution	0.001°
	Memory depth	1MSample
	Synthesizer functions	ADD, AM, FM, PM, PWM
	Sequence memory	1024 steps

Internal control unit					
Display		7.0” Touchscreen (17.8cm, resolution 800x480)			
Sequencer		Integrated sequences: amplitude pulse, frequency pulse (lin/log) User defined sequences memory			
User interface		Touchscreen / front-panel button / incremental encoder			
Digital I/O		8 digital inputs: +5V_{DC} … +24V_{DC} 8 digital outputs: +5V_{DC} (internal V_{CC}), I_L=40mA (external V_{CC} input: +5V_{DC} … +24V_{DC}, I_L=500mA)			
Digital instrument					
	Voltage measurement ranges	112.5V_p / 225V_p / 450V_p / 900V_p (auto ranging)			
	Voltage accuracy	± (% of measured value + % of voltage measurement range value)			
		DC 45Hz … 450Hz	10Hz … 45Hz 450Hz … 5kHz	5kHz … 15kHz	15kHz … 30kHz
		0.1 + 0.02	0.2 + 0.2	0.4 + 0.4	0.8 +0.8
	Current measurement ranges	depending on peak current of the amplifier range 1: $\frac{I_{peak}}{8.8}$ range 2: $\frac{I_{peak}}{4.4}$ range 3: $\frac{I_{peak}}{2.2}$ range 4: I_{peak}			
	Current accuracy	± (% of measured value + % of current measurement range value)			
		DC 45Hz … 450Hz	10Hz … 45Hz 450Hz … 5kHz	5kHz … 15kHz	15kHz … 30kHz
		0.2 + 0.04	0.4 + 0.4	0.8 + 0.8	1.6 +1.6
Monitoring unit[2)]		voltage		current	
Max. output		±10V_p			
Scaling factor ‘sf’ (adjustable)		sf: 0.2 … 1000		sf: 0.1 … 1000	
Bandwidth		300kHz		200kHz	
Monitoring accuracy		± (% of measured value + % of voltage measurement range value + error(sf))			
frequency		DC 45Hz … 450Hz	10Hz … 45Hz 450Hz … 5kHz	5kHz … 15kHz	15kHz … 30kHz
voltage monitor		0.12 + 0.02 + 2mV*sf	0.3 + 0.2 + 2mV*sf	0.7 + 0.4 + 2.2mV*sf	1.4 +0.8 + 2.3mV*sf
current monitor		0.22 + 0.04 + 2mA*sf	0.5 + 0.4 + 2mA*sf	1.1 + 0.8 + 2.2mA*sf	2.2 + 1.6 + 2.3mA*sf
Noise of ADC measurement		<20mV_{rms} (DC … 300kHz)		<1.5mA_{rms} (DC … 300kHz)	
Noise DAC output		<0.2mV_{rms} (DC … 300kHz)			
Delay time		<1µs			
Output impedance		47Ohm			
Isolation		earth / remaining electronics / each other			
Protection		short circuit			
Insulation resistance		>1MOhm			
Withstand voltage		>2000V_{DC}			
Ambient temperature		0°C up to 40°C			
Relative Humidity (non-condensing)		max. 80% for temperatures <31°C, decreasing linearly to 50% at 40°C			
System of protection		IP20			

Remarks:

1) 240V_{rms} range not available at APS 1000
2) See application note: “Technical information monitoring unit”
3) At cosine phi = 1

TECHNICAL DATA – APS 1000 / 2500 / 5000

		APS 1000	APS 2500	APS 5000
Power AC	*- continuous* *- approx. 1h[3)]*	1000VA 1500VA	2500VA 3750VA	5000VA 7500VA
Power DC	*- continuous* *- approx. 1h*	1000W 1500W	2500W 3750W	5000W 7500W
Short-time power		2000VA	5000VA	10000VA
Peak current		26.4A_p	88A_p	176A_p
Power Supply *(±10%, 50/60Hz)*		230V Schuko	230V/400V CEE	
Protection		16A	3 x 16A	3 x 20A
Housing	*Amplifier*	19”, 4U	19”, 5U	19”,7U
	approx. dimensions (mm)	178x483x650	222x483x650	311x483x650
	Power Supply	included	19”, 5U	19” 5U
	approx. dimensions (mm)	-	222x483x650	222x483x650
Weight	*Amplifier (approx.)*	50kg	30kg	45kg
	Power Supply (approx.)	-	85kg	100kg

TECHNICAL DATA – APS 7500 / 10000 / 15000

		APS 7500	APS 10000	APS 15000
Power AC	*- continuous* *- approx. 1h[3)]*	7500VA 11250VA	10000VA 15000VA	15000VA 22500VA
Power DC	*- continuous* *- approx. 1h*	7500W 11250W	10000W 15000W	15000W 22500W
Short-time power		15000VA	20000VA	30000VA
Peak current		264A_p	440A_p	616A_p
Power Supply *(±10%, 50/60Hz)*		230V/400V CEE		
Protection		3 x 32A	3 x 40A	3 x 63A
Housing	*Amplifier*	19”, 10U	19” 17U	19”, 23U
	approx. dimensions (mm)	444x483x650	755x483x650	1022x483x650
	Power Supply	19”, 10U	19”, 12U	19”, 12U
	approx. dimensions (mm)	444x483x650	533x483x650	533x483x650
Weight	*Amplifier (approx.)*	60kg	80kg	120kg
	Power Supply (approx.)	200kg	220kg	240kg

TECHNICAL DATA – APS 20000 / 25000 / 30000

		APS 20000	APS 25000	APS 30000
Power AC	*- continuous* *- approx. 1h*[3)]	20000VA 30000VA	25000VA 37500VA	30000VA 45000VA
Power DC	*- continuous* *- approx. 1h*	20000W 30000W	25000W 37500W	30000W 45000W
Short-time power		40000VA	50000VA	60000VA
Peak current		$880A_p$	$1056A_p$	$1150A_p$
Power Supply *(±10%, 50/60Hz)*		230V/400V CEE		
Protection		3 x 63A	3 x 80A	3 x 100A
Housing	*Amplifier*	19”, 33U	19”, 39U	19”,46U
	approx. dimensions (mm)	1467x600x850	1733x600x1050	2044x600x1050
	Power Supply	19”, 12U	19”, 22U	19”, 22U
	approx. dimensions (mm)	533x600x850	978x600x1050	978x600x1050
Weight	*Amplifier (approx.)*	160kg	200kg	240kg
	Power Supply (approx.)	300kg	500kg	600kg

TECHNICAL DATA – APS 40000 / 50000 / 60000

		APS 40000	APS 50000	APS 60000
Power AC	*- continuous* *- approx. 1h*[3)]	40000VA 60000VA	50000VA 75000VA	60000VA 90000VA
Power DC	*- continuous* *- approx. 1h*	40000W 60000W	50000W 75000W	60000W 90000W
Short-time power		80000VA	100000VA	120000VA
Peak current		$1760A_p$	$2112A_p$	$2300A_p$
Power Supply *(±10%, 50/60Hz)*		230V/400V		
Protection		3 x 130A	3 x 160A	3 x 200A
Housing	*Amplifier*	19”, 2 x 33U	19”, 2 x 39U	19”, 2 x 46U
	approx. dimensions (mm)	1467x1200x1050	1733x1200x1050	2044x1200x1050
	Power Supply	19”, 42U	19”, 46U	19”, 46U
	approx. dimensions (mm)	1866x600x1050	2044x600x1050	2044x800x1050
Weight	*Amplifier (approx.)*	On request	On request	On request
	Power Supply (approx.)	On request	On request	On request

APS SERIES ADD-ONS AND OPTIONS

Options		
OPT.01	IEEE488	
OPT.02	RS232	RS232, RS485
		USB Host, USB Device on request
OPT.05	U/I monitor	Galvanically isolated BNC plugs for monitoring voltage and current (includes OPT.14.5)
NT.11.33	Additional voltage range	0 … 33V_{rms} (±47V_{DC})
NT.11.36	Additional voltage range	0 … 36V_{rms} (±51V_{DC})
NT.11.56	Additional voltage range	0 … 56V_{rms} (±79V_{DC})
NT.11.60	Additional voltage range	0 … 60V_{rms} (±85V_{DC})
NT.11.150	Additional voltage range	0 … 150V_{rms} (±212V_{DC})
NT.11.570DC	Additional DC-voltage range	0 … +570V_{DC}
NT.11.630DC	Additional DC-voltage range	0 … +630V_{DC}
OPT.13.30	Special frequency range	DC … 30kHz (-3dB)
OPT.14	External input	0 … V_{ExtMax}
		V_{ExtMax} is adjustable between ±2V_p … ±25V_p
		OPT.14 includes a digital input filter: type Bessel or Butterworth, order 1 … 6 (adjustable) Filter frequency selectable 100Hz … 10MHz
NT.18	Special line voltage	available on request in the range of 110V_{rms} … 300V_{rms}
OPT.21	Common output	Common output plugs for parallel operation
OPT.24	Programmable internal impedance	Model / Ri max. (Ohm) / Li max. (mH): APS 1000: 30000 / 400 APS 2500: 9000 / 120 APS 5000: 4500 / 60 APS 7500: 3000 / 40 APS 10000: 1800 / 24 APS 15000: 1286 / 17 APS 20000: 900 / 12 APS 25000: 750 / 10 APS 30000: 643 / 9 APS 40000: 450 / 6 APS 50000: 375 / 5 APS 60000: 321 / 4
OPT.25	Constant current mode	
OPT.30	Optical link	Optical interface to real time simulator LC duplex interface / Aurora 8B/10B protocol / 2Gb/s data rate
UT.540.C	Voltage transformer	Output voltages 400V_{rms} / 540V_{rms} Other voltages on request