ALENNTRONICS

SINEWAVE FILTER

ATA-AP1S-82

ALENNTRONICS TEKNO ASIA

JAKARTA
INDONESIA

PT. ALENNTRONICS TEKNO ASIA

SINEWAVE

PROBLEMS WITH PWM INVERTER OPERATION

The Pulse Width Modulated (PWM) output voltage from inverter-equipped Adjustable Speed Drive (ASD) systems can stress standard induction or permanent magnet motors due to rapid voltage changes (high dV/dt). This can cause a reflective wave phenomenon at motor terminals, increasing voltages up to 2-3 times nominal levels and potentially exceeding insulation ratings, leading to insulation stress, partial discharges, and failure. These issues are exacerbated by longer cable runs. Common problems include motor and winding failure, motor noise, cable insulation degradation, premature ASD failure, common-mode and reflected wave phenomena, and high EMI/RFI.

SINEWAVE DIFFERENTIAL MODE

The AP1S-82 is engineered to solve problems caused by pulse width modulation. This low-pass filter has a cutoff frequency significantly below the inverter's switching frequency.

The AP1S-82 offers more than just dV/dt filtering and will:

- Significantly reduce voltage rise time (dV/dt)
- Convert the output voltage to an almost sinusoidal waveform (<3%)
- Prevent transient overvoltages at motor terminals
- Lower harmonic losses in the motor
- Decrease motor noise
- Alleviate stress on motor and cable insulation
- Prolong the lifespan of the motor and ASD

SINEWAVE COMMON-MODE OPTION

Common-mode voltage is the phase-to-ground voltage that arises when the instantaneous sum of the 3-phase voltages from a PWM inverter is not zero, even though the average sum of the 3-phase voltages is zero. This common-mode voltage induces common-mode currents to flow through the parasitic capacitance in the motor and motor feeder cable. High-frequency capacitive coupling occurs across the motor bearings and between the feeder conductor or motor winding and ground. These common-mode currents can cause premature motor bearing failure and cable insulation breakdown.

The AP1S-82 Common-mode Filter option will:

- Reduce shaft voltage and bearing currents
- Reduce cable leakage currents
- Reduce common-mode voltages throughout the power system

KEY FEATURES

- Low insertion loss and voltage drop (<3% of rated voltage)
- No damping resistors required
- Power delivered to motor >96%
- Efficiency >99%
- Improves power factor of the motor to near unity
- Provides reactive power compensation to motor
- Prevents transient overvoltages at motor terminals
- Reduces motor noise
- Filters out IGBT switching frequency currents

Reliable and proven performance

SINEWAVE APPLICATIONS

- When the motor does not have adequate insulation for ASD duty
- Using multiple parallel motors
- Long motor cable length
- When a step-up/step-down transformer is used between ASD and motor
- Specific requirements for peak voltage level and dV/dt rise time
- Motor noise needs to be reduced
- Maximum safety and reliability are needed in hazardous environments
- Submersible pumps with long motor cables used in the oil & gas industry or irrigation systems

THE SINEWAVE ADVANTAGE

Exceptional Filtering Performance (<3% VTHD)
The Sinewave filter effectively converts the PWM waveform output of a variable speed drive to a sinusoidal waveform with less than 3% VTHD. Competing sinewave filters often result in VTHD levels of 5-10% or more, especially at frequencies above the 50th harmonic.

Voltage drop lower than with an output line reactor (<3%)
Voltage drop is a crucial factor when selecting motors and drives. The Sinewave filter ensures a voltage drop of less than 3%, requiring the inverter to provide only a slight increase in voltage or current. Other sinewave filters typically cause a voltage drop of around 10%, reducing motor power delivery to as low as 81% of the nominal value.

Lower kVA requirement of the inverter (Improves the power factor to 0.97-1.00)
The Sinewave filter's capacitor bank design improves the motor's power factor to near unity at the inverter output. This reduces the RMS current that the inverter must supply, significantly easing the inverter's load.

Highest efficiency (>99%)
Thanks to its inherently damped design that doesn't need damping resistors and its low-loss reactor design, the Sinewave filter achieves higher efficiency compared to other sinewave filters.

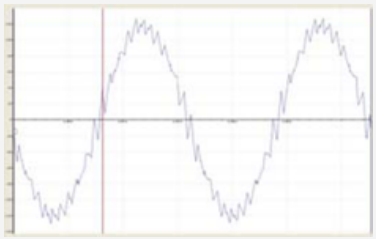
Available for Operating Frequencies up to 400Hz
For motors such as permanent magnet types that operate at frequencies well above the standard 50 or 60Hz, the Sinewave filter provides effective filtering. These applications require unique designs and higher minimum inverter switching frequencies, and Sinewave models are ideal for these high-frequency scenarios.

VOLTAGE DISTORTION

Typical PWM Variable Speed Drive (VSD) Output Voltage Waveform

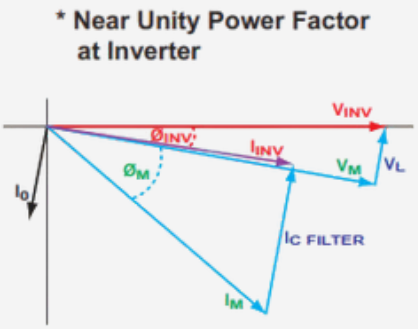
Output VSD Voltage Waveform with Inversine (V_{THD} <3% Typical)

CURRENT DISTORTION



Typical VSD Output Current Waveform

Output VSD Current Waveform with sinewave ITHD <8% Typical



V_{INV} = Voltage at Inverter output
V_M = Voltage at motor
V_L = Voltage drop across filter and cables
I_{INV} = Current at Inverter output
I_M = Current at motor
$I_{C\ FILTER}$ = Capacitive current of Inversine Filter

SINEWAVE

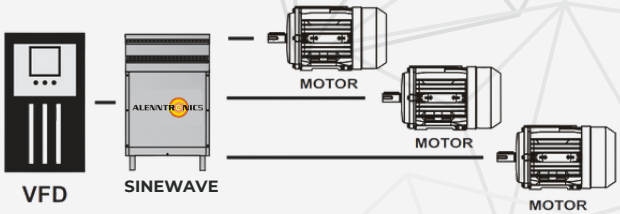
APPLICATION EXAMPLES :

Long Cable Length Between Drive and Motor

Long cable lengths combined with a high dV/dt PWM waveform can cause overvoltage spikes at the motor terminals due to the reflective wave phenomenon, resulting from impedance mismatch between the cables and the motor. Without a sinewave filter, these overvoltage spikes can exceed 2x the maximum DC bus rated voltage. The Sinewave filter can be used for cable lengths up to 15,000 feet (4,572 meters) depending on motor size.

Drive Feeding Multiple Motors in Parallel

A sinewave filter is recommended to reduce capacitive leakage currents between the cables to ground and the motors to ground. A Sinewave filter with a common mode option is advisable.



Step-up or Step-down Transformer Between Drive and Motor

To prevent insulation stress and overheating of the transformer, a sinewave filter should be installed between the drive and the transformer, ensuring the transformer receives a sinusoidal waveform.

Retrofit Drive Installation

Sinewave filters are recommended when installing variable speed drives on older motors not designed for inverter PWM output waveforms (not rated to Mg1 Part 31). Without a sinewave filter, the motor's insulation may be inadequate, even in applications with shorter cable runs. An additional common-mode option can further extend motor life.

Motor Noise Needs to be Reduced

Sinewave filters reduce motor noise, vibration, and heat caused by drive switching frequencies. This extends motor life by reducing bearing and insulation stress. Adding a common mode option is beneficial if motor bearing failure is a concern.

ATTACHMENT

SINEWAVE Rating Table [60Hz]						
Motor Size		Output Amps [A] 3Ph/60Hz			Case*	Weight**
HP	kW	480V	600V	690V	Style	lbs [kg]
5	3.75	7.6	6.1	5.5	SU1	36 [16]
7.5	5.5	11	9	7.6	SU1	43 [20]
10	7.5	14	11	10	SU1	50 [23]
15	11	21	17	15	SU1	64 [29]
20	15	27	22	19	SU2	77 [35]
25	18.5	34	27	24	SU2	90 [41]
30	22	40	32	28	SU2	103 [47]
40	30	52	41	36	SU3	128 [58]
50	37.5	65	52	45	SU3	151 [68]
60	45	77	62	54	SU4	173 [78]
75	55	96	77	67	SU4	205 [93]
100	75	124	99	86	MT3	253 [115]
125	90	156	125	109	MT3	296 [134]
150	110	183	146	128	MT3	335 [152]
175	132	216	173	151	MT3	370 [168]
200	150	244	195	171	MT3	405 [184]
250	185	302	242	212	MT4	468 [212]
300	220	361	289	254	MT4	526 [239]
350	250	416	337	296	MT4	581 [264]
400	315	488	395	360	MT4	634 [288]
450	355	550	445	403	MT4	681 [309]
500	400	617	499	452	MT4	728 [330]
600	450	694	562	493	LT1	978 [444]
700	500	805	644	575	LT1	1109 [503]
800	560	920	736	653	LT1	1278 [580]
900	630	1035	828	735	LT1	1375 [624]
1000	710	1137	920	817	LT2	1533 [695]
1100	800	1250	1012	898	LT2	1650 [748]
1200	900	1371	1110	985	LT2	1769 [802]
1300	970	1478	1182	1050	LT3	1937 [879]
1400	1000	1591	1273	1130	LT3	2000 [907]
1500	1120	1706	1365	1212	LT3	2059 [934]
1600	1200	1828	1463	1299	LT3	2114 [959]

SINEWAVE Rating Table [50Hz]					
Motor Size		Output Amps [A] 3Ph/50Hz		Case*	Weight**
HP	kW	400V	440V	Style	lbs [kg]
5	3.75	9.7	8.8	SU1	58 [26]
7.5	5.5	13	12	SU1	67 [30]
10	7.5	17	16	SU2	78 [35]
15	11	25	23	SU2	90 [41]
20	15	33	30	SU2	118 [54]
25	18.5	41	37	SU2	130 [59]
30	22	48	44	SU2	142 [65]
40	30	63	58	SU3	154 [70]
50	37.5	78	72	SU3	186 [84]
60	45	93	85	SU4	218 [99]
75	55	115	106	SU4	304 [138]
100	75	160	137	MT3	323 [147]
125	90	186	170	MT3	345 [156]
150	110	222	204	MT3	365 [166]
175	132	262	240	MT3	390 [177]
200	150	296	271	MT3	415 [189]
250	185	368	337	MT4	578 [262]
300	220	441	404	MT4	585 [266]
350	250	515	471	MT4	651 [295]
400	315	625	572	MT4	700 [318]
450	355	700	641	MT4	783 [355]
500	400	785	718	LT1	865 [392]
600	450	856	784	LT1	980 [445]
700	500	998	914	LT1	1165 [528]
800	560	1135	1039	LT2	1380 [626]
900	630	1277	1169	LT2	1591 [722]
1000	710	1419	1299	LT3	1788 [811]
1100	800	1560	1429	LT3	1895 [860]
1200	900	1711	1567	LT3	1978 [897]
1300	970	1823	1669	LT3	2056 [933]
1400	1000	1963	1797	LT4	2408 [1092]
1500	1120	2105	1927	LT4	2540 [1152]
1600	1200	2255	2065	LT4	2613 [1185]

* Case style may vary one size up or down depending on voltage model/frequency of filter
** Estimated values.

General Specifications:

Voltage :
Standard voltage up to 690V, 3-phase, 60 or 50Hz models

Overload Capability :
Suitable for overload of 150% for 60 seconds every 60 minutes

Switching Frequency :
1kHz to 16kHz model dependent (see Selection/Sizing)

Motor Frequency :
Up to 400Hz model dependent (see Selection/Sizing)
*Contact factory for higher motor frequency, up to 400Hz

Voltage Distortion (THD) :
3% typical (Max. 5%)
(at full load and at rated frequency)

Input Current Distortion :
<8% at full load

Efficiency :
3 to 15HP: >99%
20 to 700HP: >99.3%
800 to 1600HP: >99.5%

Winding Material :
Copper

Operating Ambient Temperature :
-20C to +40C (-4F to 104F)

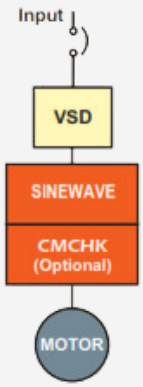
Elevation :
< 1000m (3300ft) above sea level

Ventilation :
Convection air cooled

Enclosure :
Type: Nema-3R, ventilated
Paint: Polyester powder coated
Colour: ANSI 61 Grey
Wall Mtg. Capability: 5 to 75HP

Options :
Nema-3R Enhanced Outdoor Ventilated

SINEWAVE CONFIGURATION



ORDERING INFORMATION

Selection / Sizing

- **Filter Rating:** Choose the AP1S-82 filter size such that its rated current matches or exceeds the nominal motor current. Alternatively, select the filter based on the motor's HP/kW rating, provided the motor's current is equal to or lower than the NEC motor ratings table.
- **Isolation Transformer:** For applications where the filter feeds an isolation transformer, ensure the filter's amp rating equals or exceeds the transformer's primary rated current.
- **Operating Frequency:** Select the filter model based on the operating frequency, considering that a minimum switching frequency requirement applies based on the operating frequency.
- **Multiple Motors:** When a single filter is used for multiple motors, size the filter so that its amp rating is equal to or greater than the sum of the nominal currents of all motors.

Product Code:

Enclosure
E0 = No Enclosure
E0P = No Enclosure Panelmount
E0M = No Enclosure Modular
E1 = Standard Enclosure
E1E = Type 3R Enhanced

Frequency:
Min. Switching (kHz) = F
/ Operating (Hz) = f
(see table below)

Motor Horsepower
5 to 1600 HP

ATA-AP1S_82 - HP - vvv - Ff - En - O

Options

Sinewave Filter

Voltage (VAC)
400, 440, 480, 600, 690

15 = 1kHz / 50Hz
16 = 1kHz / 60Hz
212 = 2kHz / 120Hz
320 = 3kHz / 200Hz
325 = 3kHz / 250Hz
430 = 4kHz / 300Hz
435 = 4kHz / 350Hz
540 = 5kHz / 400Hz

Add-on Option:

Motor Horsepower
5 to 1600 HP

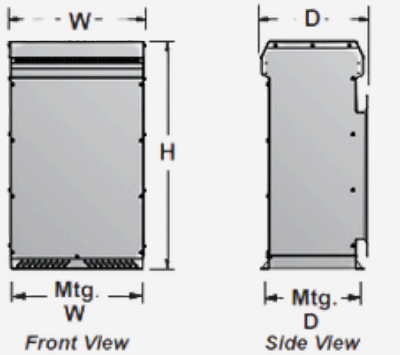
Operating Frequency
05 = 50Hz
12 = 120Hz
20 = 200Hz
25 = 250Hz
30 = 300Hz
35 = 350Hz
40 = 400Hz
*Leave blank for 60Hz

CMCHK - HP - vvv - ff

Common-Mode Choke Option

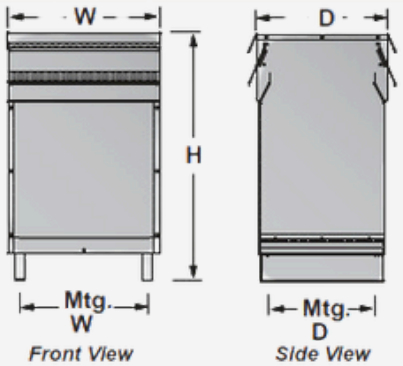
Voltage (VAC)
400, 440, 480, 600, 690

'SU' Style Enclosure



Front View *Side View*

'MT', 'LT' Style Enclosure



Front View *Side View*

Dimensions

Case Style	H (Height) inches [mm]	W (Width) inches [mm]	D (Depth) inches [mm]	Mtg. Center W inches [mm]	Mtg. Center D inches [mm]
SU1	23.50 [597]	11.25 [286]	11.25 [286]	9.00 [229]	9.50 [241]
SU2	30.00 [762]	13.25 [336]	12.75 [324]	11.00 [279]	11.25 [286]
SU3	34.00 [864]	20.25 [514]	16.00 [406]	18.00 [457]	14.25 [362]
SU4	40.00 [1016]	22.00 [559]	22.00 [559]	20.00 [508]	20.00 [508]
MT3	45.00 [1143]	26.00 [661]	21.00 [534]	21.50 [546]	19.00 [483]
MT4	51.50 [1308]	32.00 [813]	25.50 [648]	23.50 [597]	23.50 [597]
LT1	59.00 [1499]	39.50 [1003]	30.00 [762]	24.00 [610]	32.00 [813]
LT2	66.00 [1677]	44.00 [1118]	34.00 [864]	26.00 [660]	36.00 [915]
LT3	75.00 [1905]	48.50 [1232]	39.00 [991]	27.50 [699]	41.00 [1041]
LT4	78.00 [1981]	58.50 [1486]	50.50 [1283]	32.00 [813]	52.00 [1321]

Expect More. Contact Us.

To learn how ALENNTRONICS TEKNO ASIA can assist you in addressing your power quality challenges, reach out to us at our head office:

PT.ALENNTRONICS TEKNO ASIA
JAKARTA, INDONESIA

Email : sales@alenntronics-pa.com
Website : https://alenntronics-pa.com
LinkedIn : https://www.linkedin.com/company/pt-alenntronics-tekno-asia