Synchro/Resolver-to-Linear DC Converter

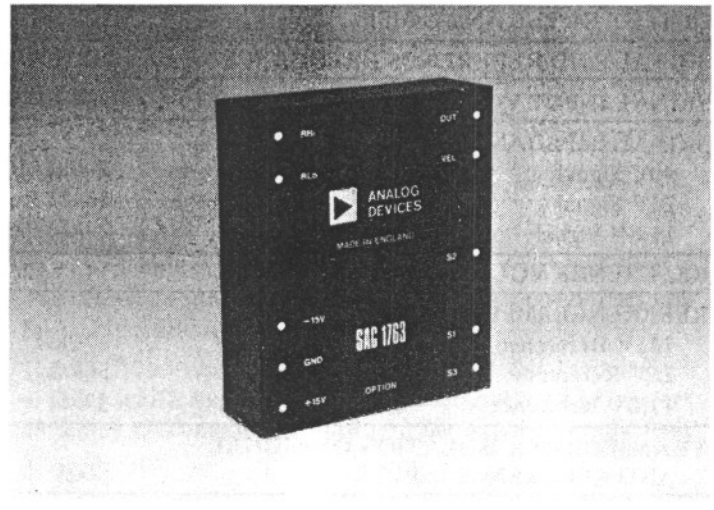
SAC1763

FEATURES

- High Dynamic Performance (27,000°/sec)
- High Accuracy (±11 Arc-Minutes)
- Internal Converter Tracking Loop Provides High Noise Immunity
- Low Output Ripple (Less than 5mV p-p)
- DC Output Proportional to Input Rate
- 50Hz to 2.6kHz Reference Frequency Operation
- Self Contained—No External Transformers or Adjustments Needed

APPLICATIONS

- Measurement and Recording of Synchro or Resolver Information on Chart Recorders, X-Y Plotters, FM Recorders, Etc.
- Servo Control and Positioning



GENERAL DESCRIPTION

The SAC1763 is a Synchro/Resolver-to-Linear dc Converter. It takes input angular information in synchro or resolver form voltages and gives an output voltage which is linearly proportional to the input angle. The output voltage of ±10V at ±5mA represents an input angular change of ±180 degrees of the synchro or resolver format signals applied to the converter input.

Options are available for all the standard line to line voltages and frequencies for either synchro or resolver inputs. Theses options together with commercial or extended temperature ranges are determined by a code following the type number (see ordering information).

An important feature of the SAC1763 series converters is that no external transformer modules are required. The transformer isolation is carried out by micro transformers which are inside the converter module *even for the 60Hz versions.*

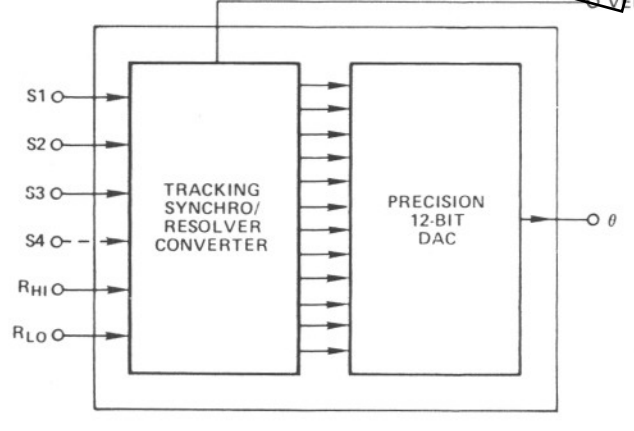
When converters are used in control loops, it is often useful to have a voltage which is proportional to angular velocity. This voltage is available and has been brought out on all SAC1763 converters. The availability of the velocity voltage eliminates the need for a tachometer for stabilization.

MODELS AVAILABLE

Options of the SAC1763 are available to cover all the standard synchro and resolver voltages and frequencies. In addition, options exist for standard operating temperature (0 to +70°C) and extended operating temperature (-55°C to +105°C) (see ordering information).

THEORY OF OPERATION

The SAC1763 is based upon the well proven 12-bit tracking Synchro/Resolver Converter type SDC1700. This is followed by a 12-bit precision DAC (Digital-to-Analog Converter).



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SPECIFICATIONS (max at 25°C unless otherwise stated)[1]

Model	SAC1763
ACCURACY[2]	±11 arc-minutes
RESOLUTION	1 part in 4096
ANALOG OUTPUT	±10V Representing ±180° 5mA is Available
OUTPUT DRIFT	0.175 arc-minutes per °C
OUTPUT RIPPLE AND NOISE	<5mV p-p
SIGNAL AND REFERENCE FREQUENCY[1]	60Hz, 400Hz and 2.6kHz
SIGNAL INPUT VOLTAGE (LINE TO LINE)	90V, 26V or 11.8V rms
SIGNAL IMPEDANCE	
90V Signal	200kΩ Resistive
26V Signal	58kΩ Resistive
11.8V Signal	27kΩ Resistive
REFERENCE VOLTAGE	115V, 26V or 11.8V rms
REFERENCE IMPEDANCE	
115V Reference	270kΩ
26V Reference	56kΩ
11.8V Reference	27kΩ
TRANSFORMER ISOLATION ON SIGNAL AND REFERENCE INPUTS	500V dc
MAX INPUT RATES FOR FULL ACCURACY	
60Hz Options	5revs/sec
400Hz Options	36revs/sec
2.6kHz Options	75revs/sec
MAX ACCELERATION ON INPUT FOR ADDITIONAL ERROR LESS THAN 6 ARC-MINUTES	
60Hz Options	166°/sec²
400Hz Options	9668°/sec²
2.6kHz Options	45,528°/sec²
STEP RESPONSE (179° Step) (For less than 6 arc-minutes error)	
60Hz	1.5sec
400Hz	125ms
2.6kHz	50ms
VELOCITY VOLTAGE OUTPUT (See also Specifications on the next page)	±10V nominal for ∓max input rate of the option
POWER SUPPLY REQUIREMENTS	+15V at 150mA -15V at 45mA
POWER DISSIPATION	2.93 watts
OPERATING TEMPERATURE RANGE	
Standard	0 to +70°C
Extended	-55°C to +105°C
STORAGE TEMPERATURE	-55°C to +125°C
DIMENSIONS	3.12" X 2.625" X 0.8" (79.4mm X 66.7mm X 20.3mm)
WEIGHT	7 ozs. (200 grams)

NOTES

[1] The converters can be used over the following reference frequency ranges with no loss of accuracy. They will, however, retain the dynamic characteristics (input rate and acceleration) quoted for the particular option.

60Hz options can be used over 50Hz to 800Hz
400Hz options can be used over 400Hz to 2000Hz
2.6kHz options can be used over 2kHz to 3.5kHz

[2] Accuracy is specfied for the following conditions:

(a) ±10% signal and reference amplitude variation.
(b) ±10% signal and reference harmonic distortion.
(c) ±5% power supply variation.

Specifications subject to change without notice.

CONNECTING THE CONVERTER

The electrical connections to the converter are straighforward. The power lines, which must not be reversed, are ±15V. They must be connected to the "+15V" and "–15V" pins with the common connection to the ground pin "GND".

It is suggested that 0.1μF and 6.8μF capacitors be placed in parallel from +15V to GND, from –15V to GND.

In the case of a Synchro, the signals are connected to "S1", "S2" and "S3" according to the following convention:

$$E_{S1-S3} = E_{RLO-RHI} \sin \omega t \sin \theta$$
$$E_{S3-S2} = E_{RLO-RHI} \sin \omega t \sin (\theta + 120^\circ)$$
$$E_{S2-S1} = E_{RLO-RHI} \sin \omega t \sin (\theta + 240^\circ)$$

For a resolver, the signals are connected to "S1", "S2", "S3" and "S4" according to the following convention:

$$E_{S1-S3} = E_{RLO-RHI} \sin \omega t \sin \theta$$
$$E_{S2-S4} = E_{RHI-RLO} \sin \omega t \cos \theta$$

The system reference voltage is connected to pins "R_{HI}" and "R_{LO}" in accordance with the above convention.

The analog output voltage representing the digital angle is between the pin "OUT" and "GND", ±10V corresponding to ±180 degrees. Up to 5mA may be taken from the "OUT" pin. The relationship between the output voltage and the input angle is shown in the diagram below.

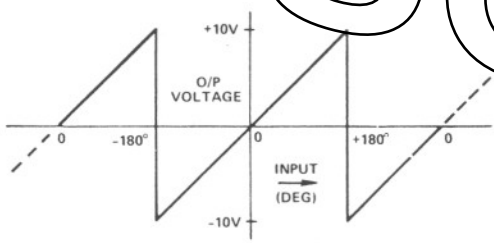


Diagram Showing Relationship Between Input and Output

Sometimes, it is required that the input/output relationship of the converter is the other way round. This can be achieved in the case of synchro options by interchanging connections "S1" and "S3". This is shown in the diagram below.

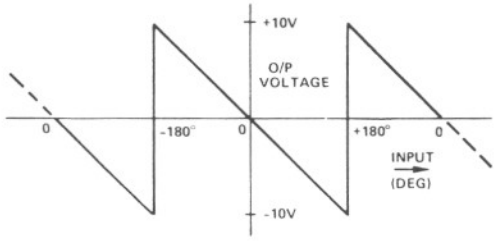


Diagram Showing Relationship Between Input and Output When "S1" and "S3" are Interchanged

VELOCITY PIN

The analog voltage proportional to the rate of change of angle is provided between the pins VEL and GND. The variation is ±10.0V nominal for the maximum velocity of the option.

This pin provides a dc voltage output which is proportional to the angular velocity of the input. The voltage goes negative for an increasing digital angle and goes positive for a decreasing digital angle.

The characteristics of the velocity pin output are given in the following table.

Scaling of Output Voltage for One Fifth max Velocity	2 Volts (Nominal)
Output Voltage Temp. Coeff.	0.05%/°C of Output
Output Voltage Drift (All Models)	0 to +70°C ±50μV/°C –55°C to +105°C ±100μV/°C
Linearity	0 to 100°/sec 60Hz Options 1.5% 0 to 800°/sec 400Hz Options 2% 0 to 1600°/sec 2.6kHz Options 2%
Noise (0 to 20Hz)	60Hz Options: 0 to 200°/sec 2mV rms 400Hz Options: 0 to 1600°/sec 2mV rms 2.6kHz Options: 0 to 3300°/sec 2mV rms
Impedance (Output)	1Ω
max Current Available	1mA

The velocity voltage can be used in closed loop servo systems for stabilization instead of a tachometer.

The SAC1763 velocity outputs do not have the disadvantages of being inefficient at low speeds and do not need gearing required by tachometers. In addition, the output is available at no extra cost.

For other velocity output scaling and linearity consult the factory.

RESISTIVE SCALING OF INPUTS

A feature of this converter is that the signal and reference inputs can be resistively scaled to accommodate any range of input signal and reference voltages.

This means that a standard converter can be used with a personality card in systems where a wide range of input and reference voltages are encountered.

To calculate the values of the external scaling resistors in the case of a Synchro Converter, add 1.11kΩ per extra volt of signal in series with "S1", "S2" and "S3", and 2.2kΩ per extra volt of reference in series with "R_{HI}".

In the case of a Resolver-to-Digital Converter, add 2.22kΩ in series with "S1" and "S2" per extra volt of signal and 2.2kΩ per extra volt of reference in series with "R_{HI}".

For example, assume that we have an 11.8V line to line, 26V reference Synchro Converter, and we wish to use it with a 60V line to line signal with a 115V reference.

In each signal input line, the extra voltage capability required is:

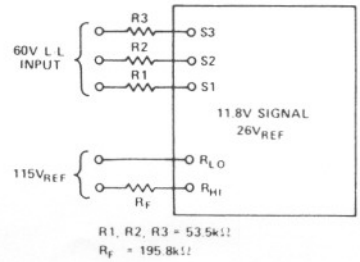
$$60 - 11.8 = 48.2V$$

Therefore each one of the three resistors needs to have a value of:

$$48.2 \times 1.11 = 53.5k\Omega$$

Similarly the single resistor needed in series with "R_{HI}" can be calculated as being 195.8kΩ.

The inputs of the converter can therefore be scaled as in the diagram below.



NOTE
IN THE CASE OF THE SIGNAL RESISTORS THE RATIO ERRORS BETWEEN THE RESISTANCES IS MORE IMPORTANT THAN THE ABSOLUTE RESISTANCE VALUES.

IN GENERAL A 1% RATIO ERROR WILL GIVE RISE TO AN EXTRA INACCURACY OF 17 ARC-MINUTES WHILE A RATIO ERROR OF 0.1% WILL GIVE RISE TO AN EXTRA INACCURACY OF 1.7 ARC-MINUTES.

THE ABSOLUTE VALUE OF R_F IS NOT CRITICAL.

USING THE CONVERTERS WITH OTHER THAN THE SPECIFIED REFERENCE FREQUENCY

The converters can be used with different reference frequencies, other than those for which they are basically specified, with no resulting loss of accuracy (see below). However, they will retain the dynamic characteristics given in the specification.

Basic Option	Frequency Range for no Loss in Accuracy
60Hz	50Hz → 800Hz
400Hz	400Hz → 2000Hz
2.6kHz	2kHz → 3.5kHz

TRANSFER FUNCTION

The transfer functions for the three reference frequency options of the converters are shown below.

60Hz Options

$$\frac{\theta_0}{\theta_1} = \frac{1.9 \times 10^5 \, (1 + 5.6 \times 10^{-2} s)}{s^3 + 1.03 \times 10^2 s^2 + 1.08 \times 10^4 s + 1.9 \times 10^5}$$

400Hz Options

$$\frac{\theta_0}{\theta_1} = \frac{8.8 \times 10^7 \, (1 + 6.8 \times 10^{-3} s)}{s^3 + 8.04 \times 10^2 s^2 + 6.1 \times 10^5 s + 8.8 \times 10^7}$$

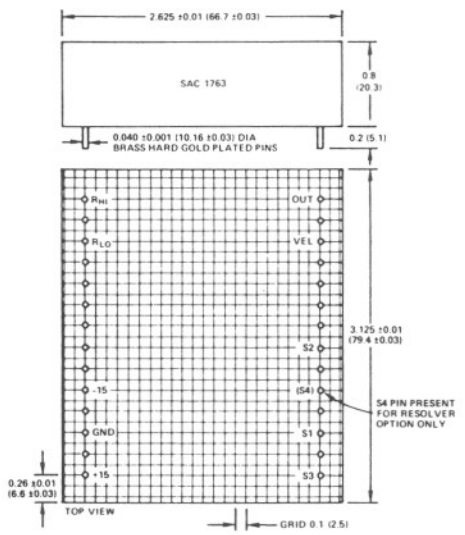
2.6kHz Options

$$\frac{\theta_0}{\theta_1} = \frac{10^9 \, (1 + 3.3 \times 10^{-3} s)}{s^3 + 1.7 \times 10^2 s^2 + 3.303 \times 10^6 s + 10^9}$$

OUTLINE DIMENSIONS AND PIN CONNECTION DIAGRAM

Dimensions shown in inches and (mm).

MATING SOCKET: CAMBION 450-3388-01-03



APPLICATIONS OF THE SAC1763

The SAC1763 may be used to record synchro or resolver information, from for example gyrocompasses or other navigational aids, on to equipment such as X-Y recorders, chart recorders or FM tape recorders, see below.

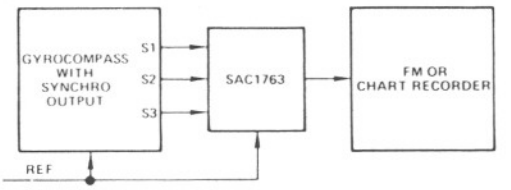


Diagram Showing Gyrocompass Information Being Recorded Using SAC1763

The applications of the SAC1763 are not only in measurement of synchro or resolver information but also in controlling angular movement. The diagram below shows the SAC1763 being used inside an angular control loop where the input is a dc voltage. The availability of the velocity voltage eliminates the need for an electromechanical tachometer for stabilization purposes.

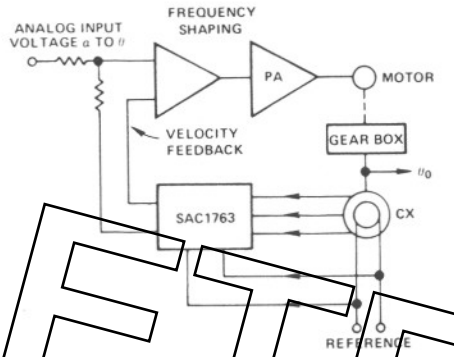


Diagram Showing the SAC1763 Used in a Servo System Where the Input is a dc Voltage

ORDERING INFORMATION

The full part number for all the standard converter options defining reference and signal voltage and frequency, operating temperature range and whether Synchro or Resolver format is given below. It should also be remembered that the signal and reference inputs can be resistively scaled (see section "Resistive Scaling of Inputs") and that in certain cases reference frequencies other than those specified can be used. (See section "Using the Converters with other than the Specified Reference Frequency".)

Part Number	Operating Temp. Range	L to L Voltage/Format	Ref. Voltage	Ref. Freq.
SAC1763511	0 to +70°C	11.8V Synchro	26 Volts	400Hz
SAC1763611	-55°C to +105°C	11.8V Synchro	26 Volts	400Hz
SAC1763512	0 to +70°C	90.0V Synchro	115 Volts	400Hz
SAC1763612	-55°C to +105°C	90.0V Synchro	115 Volts	400Hz
SAC1763522	0 to +70°C	90.0V Synchro	115 Volts	60Hz
SAC1763622	-55°C to +105°C	90.0V Synchro	115 Volts	60Hz
SAC1763513	0 to +70°C	11.8V Resolver	11.8 Volts	400Hz
SAC1763613	-55°C to +105°C	11.8V Resolver	11.8 Volts	400Hz
SAC1763514	0 to +70°C	26.0V Resolver	26 Volts	400Hz
SAC1763614	-55°C to +105°C	26.0V Resolver	26 Volts	400Hz
SAC1763518	0 to +70°C	11.8V Resolver	26 Volts	400Hz
SAC1763618	-55°C to +105°C	11.8V Resolver	26 Volts	400Hz
SAC1763543	0 to +70°C	11.8V Resolver	11.8 Volts	2.6kHz
SAC1763643	-55°C to +105°C	11.8V Resolver	11.8 Volts	2.6kHz
SAC1763544	0 to +70°C	26.0V Resolver	26 Volts	2.6kHz
SAC1763644	-55°C to +105°C	26.0V Resolver	26 Volts	2.6kHz
SAC1763548	0 to +70°C	11.8V Resolver	26 Volts	2.6kHz
SAC1763648	-55°C to +105°C	11.8V Resolver	26 Volts	2.6kHz