KAM/TCG/102

Combined GPS and IRIG input

FEATURES

- Synchronizes with IRIG-B or GPS
- Interfaces with onboard L1 GPS receiver or to an external National Marine Electronics Association (NMEA) stream
- Accepts and generates analog and digital IRIG-B
- 1µs time resolution
- Outputs one Pulse Per Second (PPS) or ten-PPS pulses
- Less than three parts per million drift when acting as a generator
- Time is maintained by an external battery during power-down
- GPS navigation information available
- Secondary time source input

APPLICATIONS

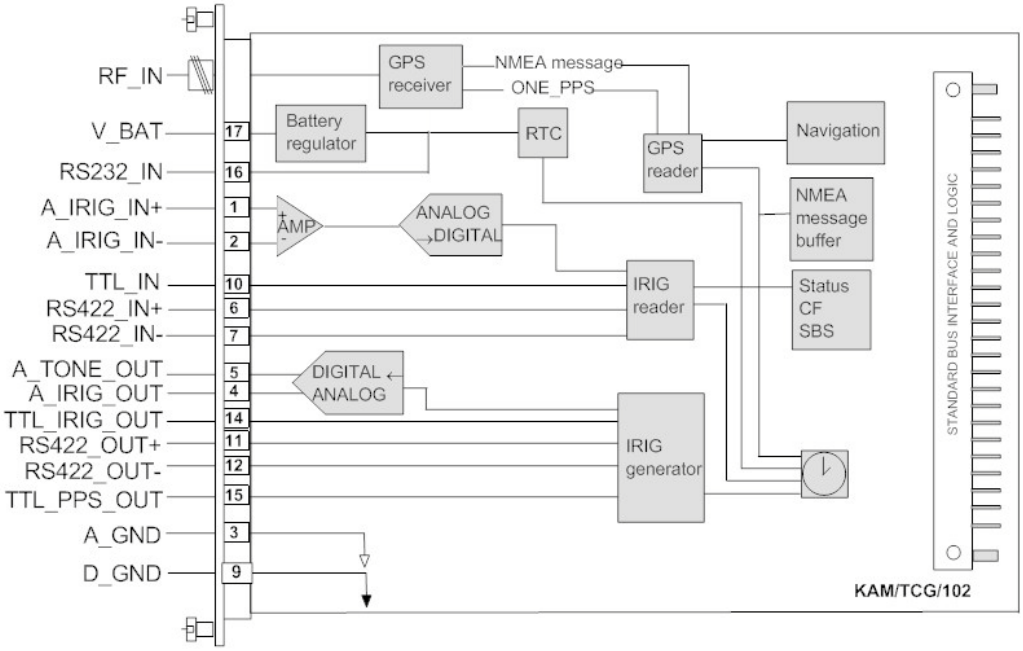
- System synchronization
- Parameter time tagging
- Global positioning

DESCRIPTION

The KAM/TCG/102 can accept time from an IRIG-B time source, from its onboard GPS receiver (external antenna required), or from an external GPS receiver outputting NMEA messages and a one-PPS signal. The received time is written to an internal timer and to a real-time clock that maintains time during power-down (when an external battery is connected). The time can be used for synchronization of a distributed Acra KAM-500 data acquisition system. The module generates IRIG-B outputs to allow external devices to synchronize with the Acra KAM-500.

The module comprises a GPS reader and an IRIG reader which decode incoming signals. The IRIG reader extracts Control Functions (CF) and Straight Binary Seconds (SBS) as well as time. The GPS reader parses NMEA messages as they are generated by the GPS receiver. Extracted navigation data such as position, altitude, velocity, and heading are available as individual parameters. Key NMEA messages are buffered, and can be sourced from this module.

The timer block is a 4 x 16-bit Binary Coded Decimal (BCD) counter with microsecond resolution. For example, at 1µs before midnight on January 1, the timer reads 0001 23:59 59.99 9999.



Inputs and outputs on the KAM/TCG/102

Ordering Information

Part Number	Description
KAM/TCG/102/D	Combined GPS and IRIG input

By default, the standard mating connector CON/KAD/003/CP, and an ACD/BAC/004/B backshell, are included with each module in the shipment. Its part number will be added to the Confirmation of Order unless an alternative option is specified (see the *Cables* data sheet). Additional items must be ordered separately; refer to Related Products for options.

Revision History

Revision	Differences	Status
KAM/TCG/102/D	Leap seconds adjustment read from settings	Recommended for new programs
KAM/TCG/102/C	Improved GPS acquisition time; internal PLL locks faster and makes finer timing adjustments; GPS leap seconds step-back corrected	Not recommended for new programs
KAM/TCG/102/B	Addition of a secondary time source input	Not recommended for new programs
KAM/TCG/102	First release	Not recommended for new programs

Supporting Software

Software	Details
DAS Studio 3	User interface for setup and management of data acquisition, network switches, recorders and ground stations in an integrated environment
KSM-500	This module is supported by the KSM-500 suite of software tools

Related Products

Module	Details
RFE/AEG/001	Airborne active GPS antenna, with TNC female connector
ACC/GPS/001/05M	GPS antenna interface cable (5m long) terminated with Threaded Neill-Concelman (TNC) male (shield isolated)
ASM/TCG/102	GPS antenna interface cable (1.82m long) terminated with Threaded Neill-Concelman (TNC) male (shield isolated)

Related Documentation

Document	Details
DOC/DBK/001	Acra KAM-500 Databook
DOC/HBK/002	Environmental Qualification Handbook
DOC/MAN/018	KSM-500 Databook
DOC/MAN/030	DAS Studio 3 User Manual
TEC/NOT/003	IRIG-B
TEC/NOT/016	Power dissipation
TEC/NOT/049	Power estimation

Specifications

All values provided in the following specification tables are valid within the operating temperature range specified under “Environmental ratings” in the “General specifications” table.

General specifications

Parameter	Min.	Typ.	Max.	Units	Condition/details
Slots	–	–	1	–	Can be placed in any user-slot in any combination.
Mass					
	–	70	–	g	
	–	2.47	–	oz	Design metric is grams.
Height above chassis					For recommended clearance requirements see the *CON/KAD/003/CP* data sheet.
bare connector	–	–	11	mm	
bare connector	–	–	0.43	inch	Design metric is millimeters.
Access rate	–	–	2	Msps	Maximum combined access rate for read and write.
Power consumption					
+5V	–	–	230	mA	
±7V	–	–	0	mA	
+12V	–	–	63	mA	When driving the recommended antenna RFE/AEG/001.
+12V	–	–	32	mA	With no antenna connected.
-12V	–	–	28	mA	
total power	–	–	2.24	W	Particular combinations of chassis and Acra KAM-500 modules may have power or current limitations. For details, see *TEC/NOT/016 - Power dissipation, TEC/NOT/049 - Power estimation*, and the relevant chassis data sheet.
Environmental ratings					See *Environmental Qualification Handbook*.
operating temperature	-40	–	85	°C	Chassis base/side plate temperature.
storage temperature	-55	–	105	°C	

Active antenna inputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	1	–	
Bias voltage	5.15	–	5.35	V	
Bias current	–	–	50	mA	
Signal strength	-138	–	–	dBm	
Antenna gain	10	26	50	dB	See “GPS antenna” on page 13.

Onboard GPS receiver

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	1	–	
Time accuracy	–	–	1	µs	Relative to GPS time. See “GPS time” on page 13.
Position accuracy					See “Navigation data accuracy” on page 14.
2D fix	2.5	–	22	m	Circular Error Probable (CEP).
3D fix	2.5	–	22	m	Spherical Error Probable (SEP).
Satellite acquisition time					See “Acquisition” on page 13.
reacquisition	3.5	5	–	s	
warm power up	–	40	–	s	
cold power up	–	60	–	s	Test carried out with a minimum of four satellites in use.

Onboard GPS receiver (continued)

Parameter	Min.	Typ.	Max.	Units	Condition/details
GPS update rate	–	1	1	Hz	
Time format	–	–	–	–	Coordinated Universal Time (UTC).
Navigation datum	–	–	–	–	World Geodetic System-84 (WGS-84). See “Datum” on page 14.
Restrictions					Coordinating Committee for Multilateral Export Controls (COCOM) restrictions apply.
velocity	–	–	1,854	kph	
velocity	–	–	1,000	knots	
altitude	–	–	18,000	m	
altitude	–	–	60,000	ft	

Analog IRIG time inputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	1	–	
Sampling rate					
A_IRIG_IN	–	–	2	Msps	Operating as analog IRIG-B input, the following time codes are supported: IRIG-B 120, 121, 122, 123.
Input voltage					
voltage range	0.1	–	10	V_{p-p}	
overvoltage protection	-7	–	12	V	Voltages outside of this range can damage input.
Time error					
offset	–	–	4	µs	
Input resistance					
between inputs (off)	–	1.1	–	MΩ	Module powered off.
between inputs (on)	52	–	–	kΩ	Module powered on.
each input to GND (off)	–	75	–	kΩ	Module powered off.
each input to GND (on)	390	–	–	kΩ	Module powered on.

BTTL inputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	1	–	
Signalling rate					
TTL_IN	–	–	1	bps	Operating as ONE_PPS input.
TTL_IN	–	–	100	bps	Operating as IRIG-B input, the following time codes are supported: IRIG-B 000, 001, 002, 003.
Input voltage					
operating range	0	–	5.25	V	
logic 0	0	–	0.7	V	
logic 1	2	–	5.25	V	
overvoltage protection	-0.3	–	6	V	Voltage in excess of these values can damage input.
Signalling currents					
logic 0	–	-0.2	-0.5	mA	
logic 1	–	2	5	mA	
Input resistance					
each input to GND	–	27	–	MΩ	Module powered on.
each input to GND	–	53	–	kΩ	Module powered off.
Time error					
offset	–	–	2	µs	Over full operating temperature range. When configured as primary (TTL_IRIG) input range.

RS-232 inputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	1	–	
Baud rate					
RS232_IN	4,800	–	115,200	bps	The following baud rates are supported: 4800, 9600, 19200, 115200.
Input voltage					
operating range	-25	–	25	V	Do not exceed operating range.
logic 0	–	–	0.6	V	V_{IN+} - V_{IN-}.
logic 1	2.4	–	–	V	V_{IN+} - V_{IN-}.
overvoltage protection	-25	–	25	V	Voltage in excess of these values can damage input.
ESD protection	-15	–	15	kV	Human Body Model.
Input resistance					
each input to GND	–	4.8	–	MΩ	Module powered on.
each input to GND	–	4.7	–	kΩ	Module powered off.

RS-422 inputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	2	–	
Signalling rate					
RS422_IN	–	–	100	bps	Operating as IRIG-B input, the following time codes are supported: IRIG-B 000, 001, 002, 003.
RS422_IN	4,800	–	115,200	bps	Operating as NMEA data input, the following baud rates are supported: 4800, 9600, 19200, 115200.
Input voltage					
operating range	-7	–	12	V	Do not exceed operating range.
logic 0	–	–	-0.7	V	V_{IN+} - V_{IN-}.
logic 1	0.7	–	–	V	V_{IN+} - V_{IN-}.
overvoltage protection	-7	–	12	V	Voltage in excess of these values can damage input.
ESD protection	–	–	15	kV	Human Body Model.
Input resistance					
between inputs (on)	–	117	–	MΩ	Module powered on.
between inputs (off)	–	117	–	kΩ	Module powered off.
between inputs (term, on)	–	121	–	Ω	Module powered on and inputs terminated.
between inputs (term, off)	–	121	–	Ω	Module powered off and inputs terminated.
each input to GND (on)	–	4.2	–	MΩ	Module powered on.
each input to GND (off)	–	59	–	kΩ	Module powered off.

Battery inputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Inputs	–	–	1	–	
Input voltage					
operating range	4.5	–	12	V	The Acra KAM-500 must be powered on (or the power should be cycled) when the battery is connected for the first time. Otherwise, 10mA is drawn from the battery, shortening its life span.
overvoltage	-12	–	12	V	Voltage in excess of these values can damage input.
Input current					
operating range	–	–	100	µA	
Input resistance					
battery input	45	–	–	kΩ	

Analog IRIG time outputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Outputs	–	–	1	–	
Signaling rate					
A_IRIG_OUT	–	–	1	kHz	Operating as analog IRIG-B 123 output with a 1kHz carrier frequency.
Output voltage					
mark amplitude	4	–	20	V_{p-p}	Range: 4, 8, 12, 16, 20.
mark to space ratio	–	3	–	–	Space amplitude = mark amplitude/3.
short circuit current	3	10	–	mA	
short circuit duration	∞	–	–	s	To GND.
Output resistance	–	0.2	–	Ω	Load impedance must not be less than 3.3kΩ.

Tone outputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Outputs	–	–	1	–	
Signalling rate					
TONE_OUT	500	–	2,000	Hz	500Hz, 1,000Hz, 1,500Hz, and 2,000Hz are the permitted values.
Output voltage					
operating range	4	–	20	V_{p-p}	
short circuit current	3	10	–	mA	
short circuit duration	∞	–	–	s	To GND.
Output resistance	–	0.2	–	Ω	Load impedance must not be less than 3.3kΩ.

BTTL outputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Outputs	–	–	2	–	
Signaling rate					
TTL_IRIG_OUT	–	–	100	bps	Operating as IRIG-B 003 digital output.
TTL_PPS_OUT	1	–	10	Hz	Operating as a selectable one or 10-PPS output.
Output voltage					
logic 0	–	–	0.2	V	Sinking 0.1mA through 100Ω output resistance.
logic 1	4.8	–	–	V	Sourcing 0.1mA through 100Ω output resistance.
short circuit current	–	–	50	mA	
short circuit duration	∞	–	–	s	To GND.
Output resistance	–	200	–	Ω	

RS-422 outputs

Parameter	Min.	Typ.	Max.	Units	Condition/details
Outputs	–	–	1	–	
Signaling rate					
RS422_OUT	100	–	–	bps	When providing IRIG-B.
RS422_OUT	–	–	1	Mbps	When providing X-SYNC.
Output voltage					
operating voltage	-7	–	12	V	Absolute voltage of the operating signal must stay within this range.
logic 0	–	–	-2	V	V_{0+} - V_{0-} ; R_{LOAD} = 100Ω.
logic 1	2	–	–	V	V_{0+} - V_{0-} ; R_{LOAD} = 100Ω.
overvoltage protection	-7	–	12	V	
short circuit current	–	–	250	mA	
short circuit duration	∞	–	–	s	Only one output may be shorted at a time.
ESD protection	-15	–	15	kV	Human Body Model.
Output resistance	–	25	–	Ω	

Setting up the KAM/TCG/102

All module setup can be defined in XML using XidML® schemas (see http://www.xidml.org).

Instrument settings

Setup data	Choice	Default	Notes
Manufacturer	-	-	-
Name	ACRA CONTROL	ACRA CONTROL	Name of manufacturer.
PartReference	KAM/TCG/102/D	KAM/TCG/102/D	The instrument part reference.
SerialNumber	AB1234	AB1234	Unique name for each module.
Settings	-	-	-
Time Server	Master FreeRunning	Master	When Master, time is seeded from the KAM/TCG/102 into other slave modules. When slave, time is seeded from a master module into the KAM/TCG/102. When FreeRunning, no time seeding takes place.
Primary Input	IRIG-B GPS	IRIG-B	Specifies which input takes priority.
Allow Secondary	True False	True	-
Settings *IRIG-B-In*	-	-	Settings for the IRIG-B input.
Current Year	2011 to 2030	2012	Indicates the current year.
IRIG Source	Analog RS-422 TTL	Analog	-
Channels	-	-	-
GPS-In *GPS-In Input*	-	-	Time and navigation parameters are taken from the KAM/TCG/102's onboard GPS receiver.
Settings	-	-	-
GPS Source	OnBoardGPS RS-422 RS-232	OnBoardGPS	-
Maximum Dilution Of Precision	1 to 15	5	Specifies the maximum Dilution of Precision (DOP) allowed. DOP is an expression of the quality of the GPS solution; the lower the value, the more accurate it is.

Setup data	Choice	Default	Notes
Baud Rate	4800 9600 19200 38400 57600 115200	19200	Specifies the number of symbols received per second.
Settings *On Board GPS*	-	-	These settings are only applied to the onboard GPS receiver.
Dynamic	Stationary Pedestrian Automotive Sea Airborne with <1g Acceleration Airborne with <2g Acceleration Airborne with <4g Acceleration	Airborne with <2g Acceleration	Dynamic profile of the onboard GPS receiver.
Leap Seconds	0 to 255	15	The number of seconds difference between UTC and GPS time; is only applied to onboard GPS receiver.
PPS-Out *TTL Output*	-	-	One or ten-PPS output.
Settings	-	-	-
PPS Rate	1 10	1	-
RS-422-Out *RS-422 Output*	-	-	Outputs IRIG-B or X-SYNC.
Settings	-	-	-
Mode	IRIG-B X-SYNC	IRIG-B	Switches between outputting digital IRIG-B or X-SYNC out to synchronize the data acquisition system.
TTL-Out *TTL Output*	-	-	Outputs an IRIG-B stream.
Analog-Tone-Out *Analog Output*	-	-	Outputs a sine wave tone.
Settings	-	-	-
Frequency	500 1000 1500 2000	1000	Specifies the frequency of the analog tone output in Hz.
Amplitude	2 to 10	4	Specifies the peak amplitude of the signal in volts peak (Vp).
Analog-IRIG-BOut *Analog Output*	-	-	Outputs an analog IRIG-B stream (1KHz amplitude modulated sine wave).
Settings	-	-	-
Amplitude	4 to 10	4	-
RS-422-In *RS-422 Input*	-	-	-
Settings	-	-	-
TTL-In *TTL Input*	-	-	-
Analog-IRIG-BIn *Analog Input*	-	-	-
Settings	-	-	-
RS-232-In *RS-232 Input*	-	-	-

Parameter definitions

Name/description	Base unit	Data format	Bits	Register definition
Global Parameters				
StatusIn IRIG-B and timer status register.	BitVector	BitVector	16	**R[15:0]** R(15) IRIG-BLock - When 1, the IRIG-B decoder is locked to a valid IRIG-B stream. R(14) StraightBinarySeconds(16) - Bit 16 (MSB) of the Straight Binary Seconds decoded from the IRIG-B stream (see StraightBinarySeconds for bits 15 to 0). R[13:3] Reserved R(2) SourcePrimary - When 1, the internal clock is locked to the primary time source. R(1) TimerLock - When 1, the timer's Phase Locked Loop (PLL) is in lock with the input TIME ONE_PPS source. R(0) BatteryFail - When 1, power-on test fails (battery voltage is not present or real-time clock is not running).
ControlFunction Control Function (CF) bits received from the IRIG-B input.	BitVector	BitVector	32	**R[31:0]** R[31:5] ControlFunction R[4:0] Reserved
StraightBinarySeconds Sixteen LSB's of the seventeen SBS received in the IRIG-B stream.	Second	OffsetBinary	16	R[15:0]
IrigTime48 48-bit wide IRIG time word.	BitVector	BitVector	48	R[47:0]
TimeHi Hours and minutes at the start of the acquisition cycle.	BitVector	BitVector	16	**R[47:32]** R[15:13] Reserved - Reserved for future use. R[12:7] Hours - BCD Hours 0 to 23. R[6:0] Minutes - BCD Minutes 0 to 59.
TimeLo Seconds and centiseconds at the start of the acquisition cycle.	BitVector	BitVector	16	**R[31:16]** R(15) Reserved - Reserved for future use. R[14:8] Seconds - Seconds 0 to 59. R[7:0] Centiseconds - Centiseconds 0 to 99.
TimeMicro Microseconds at the start of the acquisition cycle.	Second	BCD	16	**R[15:0]** R[15:0] Microseconds - Microseconds 0 to 9999.
DayOfYear The day of the year from 1 to 366 at the start of the acquisition cycle.	BitVector	BitVector	16	**R[15:0]** R[15:10] Reserved R[9:0] DayOfYear
GPS-In Parameters				
Latitude Latitude received in the NMEA stream.	BitVector	BitVector	48	R[47:0]
LatitudeHi Degrees and minutes of latitude.	Unitless	BCD	16	**R[47:32]** R[15:8] Degrees - Degrees of latitude 0 to 89. R[7:0] Minutes - Minutes of latitude 0 to 59.
LatitudeLo Decimal minutes of latitude.	Unitless	BCD	16	**R[31:16]** R[31:16] DecimalMinutes - Decimal places of minutes of latitude 0.0000 to 0.9999.
LatitudeMicroMinutes Fifth decimal place of minutes of latitude.	BitVector	BitVector	16	**R[15:0]** R[15:4] Reserved R[3:0] DecimalMinutes - Fifth decimal place of minutes of latitude 0.00009 to 0.00009.
Longitude Longitude received in the NMEA stream.	BitVector	BitVector	48	R[47:0]

Name/description	Base unit	Data format	Bits	Register definition
LongitudeHi Degrees of longitude.	BitVector	BitVector	16	**R[47:32]** R[47:44] Reserved R[43:32] Degrees - Degrees of longitude 0 to 179.
LongitudeLo Minutes and decimal minutes of longitude.	Unitless	BCD	16	**R[31:16]** R[31:24] Minutes - Minutes of longitude 0 to 59. R[23:16] DecimalMinutes - Decimal places of minutes of longitude 0.00 to 0.99.
LongitudeMicroMinutes Decimal minutes of longitude.	BitVector	BitVector	16	**R[15:0]** R[27:12] Reserved R[11:0] DecimalMinutes - Last three decimal places of minutes of longitude 0.00000 to 0.00999.
Altitude Altitude expressed as height above mean sea level.	BitVector	BitVector	32	R[31:0]
AltitudeHi Tens of thousands of meters.	BitVector	BitVector	16	**R[31:16]** R(31) AltitudeIsNegative - When 1, the altitude is below mean sea level. R[30:20] Reserved R[19:16] Altitude - Tens of thousands of meters 0 to 9.
AltitudeLo Thousands of meters.	Meter	BCD	16	**R[15:0]** R[15:0] Altitude - Meters 0 to 9999.
VelocityInKph Velocity in kilometers per hour.	MetersPerSecond	BCD	16	**R[15:0]** R[15:0] VelocityInKph - KM 0 to 9999.
VelocityInKn Velocity in nautical miles per hour.	Unitless	BCD	16	**R[15:0]** R[15:0] VelocityInKn - KN 0 to 9999.
Heading True course over ground.	BitVector	BitVector	32	R[31:0]
HeadingHi Degrees of true course over ground.	Unitless	BCD	16	**R[31:16]** R[31:26] Reserved R[25:16] Degrees - Degrees 0 to 359.
HeadingLo Decimal degrees of true course over ground.	Unitless	BCD	16	**R[15:0]** R[7:0] Reserved R[7:0] DecimalDegrees - Decimal degrees of true course over ground.
DilutionOfPrecision Dilution Of Precision. See “Dilution Of Precision (DOP)” section.	BitVector	BitVector	16	**R[15:0]** R[15:12] Reserved R[11:8] PDOP - Positional DOP; if DOP > 15 then 15 is returned. R[7:4] HDOP - Horizontal DOP; if DOP > 15 then 15 is returned. R[3:0] VDOP - Vertical DOP; if DOP > 15 then 15 is returned.

Name/description	Base unit	Data format	Bits	Register definition
StatusGPS GPS status register.	BitVector	BitVector	16	**R[15:0]** R(15) GPSLock - When 1, the GPS decoder is locked to a valid NMEA stream. R(14) FixError - When 1, indicates that the fix flag was not set R(15)=0. R(13) CheckSumError - When 1, indicates that a check-sum error was detected R(15)=0. R(12) ToFewSatellites - When 1, indicates that less than the minimum configured number of satellites are used, which can affect the quality of the received data. R(11) DOPTooHigh - When 1, indicates that one of the DOP figures is outside a specified range. R(10) NorthSouth - When 0, the latitude read is in the northern hemisphere; when 1, the latitude read is in the southern hemisphere. R(9) East/West - When 0, the longitude read is east of the Greenwich Meridian; when 1, the longitude read is west of the Greenwich Meridian. R(8) Reserved R[7:4] SattellitesInView - Number of satellites in view. R[3:0] SatellitesInUse - Number of satellites used to calculate GPS solution.

NOTE: It is recommended that names are less than 20 characters, have no white space or contain any of the following five characters "/><\.

Getting the most from the KAM/TCG/102

The KAM/TCG/102 is a combined GPS and IRIG-B input module. It can accept inputs from a number of sources.

SMA torque setting

The recommended torque setting for the SMA screws is 0.68Nm (0.50 foot pound-force).

PPS pulse input

The 1-PPS input cannot be used with an analog IRIG-B input; it is only used for an NMEA GPS input.

Time seeding

On power-up of the Acra KAM-500, the KAM/TCG/102's timer is seeded with time from the real-time clock (provided an external battery is connected and the real-time clock is running). Otherwise, the module resets and begins counting from 0001 00:00 00.00 0000. The timer then synchronizes with the selected time source (GPS or IRIG). If there is no input to the time reader, the timer continues counting while powered up.

Primary and secondary inputs

The KAM/TCG/102 accepts time from either an IRIG-B stream or a GPS receiver via NMEA messages.

It is possible to use one time source as the primary input and optionally enable the other time source as the secondary input. If the primary time source becomes unavailable (missing or has errors), then after 10 seconds the KAM/TCG/102 switches to the secondary source. Later, if the primary source becomes available again then the KAM/TCG/102 switches back to the primary time source after 10 seconds.

This allows for synchronization with a secondary IRIG source when an aircraft is in the hangar where GPS is not available; then for GPS to be used when the aircraft is on the runway or in flight, without reprogramming the Acra KAM-500.

If the primary source is GPS then the secondary source must be IRIG and vice versa. For instance, you cannot use an external GPS receiver as the primary time input and use the onboard GPS receiver as the secondary time input. Also, because the digital pins are used for more than one function, there must be no pin clash between the primary and secondary input pins.

The following table shows available combinations of primary and secondary time inputs:

		IRIG		
		Analog	TTL_IN	RS422_IN
GPS	On Board	Y	Y	Y
	RS422_IN TTL_PPS	Y	N	N
	RS232_IN TTL_PPS	Y	N	Y

Clock synchronization

The KAM/TCG/102's timer uses a digital Phase Locked Loop (PLL) to synchronize its own clock to an external time source. Frequency and phase error are corrected every second. If the error is greater than 500µs, the PLL jumps to the correct time immediately. After that it tracks the external time source. When the PLL is locked to the external time source, R(3) of the IRIG_STATUS register is set to one. This marks an improvement in operation since the release of KAM/TCG/102/B.

The timer in a KAD/BCU/101 can be seeded with time from the KAM/TCG/102 at the start of the acquisition cycle, but over the course of the acquisition cycle, it can drift by up to 4µs per second. This can be eliminated by physically connecting the KAM/TCG/102's X-SYNC OUT signal to the KAD/BCU/101 X-SYNC signal.

Using the module as an IRIG analog/digital converter while in a PTP-synchronized chassis

The KAM/TCG/102 cannot be used to perform analog-IRIG to digital-IRIG conversion (respectively digital-IRIG to analog-IRIG conversion) while the module is in a chassis synchronized by PTP even if the module Time Server is set to FreeRunning. In these configurations, the use of the generated time code stream causes a feedback loop on the input decoder.

GPS antenna

The recommended antenna (RFE/AEG/001) has an antenna gain of 26dB with an antenna noise figure of 2.5dB. We recommend a minimum antenna gain of 10dB to compensate for losses in the cable connecting the antenna to the KAM/TCG/102. We recommend a maximum antenna noise figure of 1.5 dB for an antenna with a gain of 50dB.

The GPS receiver calculates the carrier-to-noise ratio for the antenna at power-up. It is therefore important that the GPS antenna is connected to the module before it is powered up.

GPS receiver

The KAM/TCG/102 uses a civilian-band (L1) GPS receiver. The United States Department of Defence (DoD) can turn on Selective Availability (SA) at any time without warning. This degrades the accuracy of the GPS data.

The KAM/TCG/102 can extract time and navigation information from an NMEA data stream. It is fitted with an onboard GPS receiver but can be interfaced to an external L1 or L2 GPS receiver via the 19-way connector.

The NMEA messages, GGA, GSV, ZDA, GSA, and GLL, are the minimum required for KAM/TCG/102 time synchronization. The VTG message is required to get velocity and true heading. If it is not provided then registers VELOCITY_KPH, VELOCITY_KN, HEADING are forced to an illegal state of all 1s.

NOTE: GPS is a broad subject and beyond the scope of this data sheet. There are many online guides and GPS dictionaries such as those found at the following links:

www.gps.oma.be/gb/dic_gb_ok_css.htm

www.colorado.edu/geography/gcraft/notes/gps/gps_f.html

GPS time

The KAM/TCG/102 derives time from data received from a constellation of satellites. These satellites are in continuous moving orbit which affects the behavior of the KAM/TCG/102 as described in “Acquisition” on page 13 and “Reacquisition” on page 13.

The KAM/TCG/102 measures GPS time; the accuracy of the time is not absolute but relative to the GPS time. If an external GPS receiver is used, the KAM/TCG/102 locks to within ±1µs without considering the external GPS receiver accuracy.

Acquisition

Along with time and navigation data, GPS satellites transmit GPS ephemeris data and GPS almanac data.

Ephemeris data tells the GPS receiver where each GPS satellite is at any time throughout the day. Each satellite transmits ephemeris data showing the orbital information for that satellite and for every other satellite in the system.

Almanac data is constantly transmitted by each satellite. It contains information about the status of the satellite, current date and time.

Cold power up

When the GPS receiver is powered up for the first time or has no backup battery connected, the GPS receiver has no knowledge of its last position or approximate time, and has no ephemeris or almanac data. The GPS receiver starts to search for signals blindly. This is normal behavior. Cold power up for GPS receivers can take several minutes.

Warm power-up

If the GPS receiver was connected to a backup battery before powering down, the GPS receiver knows its last position, approximate time and almanac. The ephemeris data is cleared. Because the almanac data is retained it can acquire satellites and get a position fix faster than in cold start mode.

Reacquisition

If the GPS receiver was off for less than two hours with battery backup, the almanac and ephemeris data are used to acquire satellites. Because the ephemeris data is retained it can acquire satellites and get a position fix faster than in other modes.

Navigational data

The KAM/TCG/102 may be used to record navigation information. The information provided by the KAM/TCG/102 is referenced to a specific datum.

Datum

The onboard GPS receiver uses WGS-84, which is a geographic model obtained by referencing the earth's sea level surface area and applying theoretical mathematical calculations. The chart datum is usually defined in the legend of the chart.

Navigation data accuracy

Unlike GPS time the position information is subject to a number of inaccuracies, due to the inherent behavior of the GPS system.

GPS status register

GPS lock is set to one when the KAM/TCG/102 receives a valid NMEA stream and accompanying PPS signal from either the onboard GPS receiver or an external GPS receiver connected to the KAM/TCG/102. It is cleared only on arrival of a PPS signal if the NMEA stream is not valid (for example the fix flag not set), or after two seconds without a PPS signal.

Any error in the GPS stream is indicated by the fix error bit which is set as soon as an error is received and can lead to the clearing of the GPS lock bit by up to two seconds, if the GPS receiver stops outputting a PPS pulse.

Dilution Of Precision (DOP)

DOP is a function expressing the mathematical uncertainty in a position fix, based on the relative positions of the satellites used to obtain that position fix. In standard GPS applications there are three types of DOP information available.

PDOP: Position (3 coordinates)

HDOP: Horizontal (2 horizontal coordinates)

VDOP: Vertical (height only)

DOP has a best case value of 1; higher numbers indicating a greater uncertainty in the precision of the position fix. A low DOP value (2) is considered good, a high number (>7) is considered poor.

Circular Error Probable (CEP)

CEP is the radius of a circle within which there is a 50% probability of the antenna being located.

Spherical Error Probable (SEP)

SEP is the three-dimensional analog of CEP, it is the radius of a sphere within which there is a 50% probability of being located.

Grounding the IRIG source

It is important to ground (GND) the source of the IRIG-B stream. If the time source is a single-ended analog signal, the GND must be connected to the negative IRIG-B input A_IRIG_IN- (see Figure 5 on page 16).

X-SYNC operation

The KAM/TCG/102 can output an X-SYNC stream on pins 11 and 12 (for synchronization of backplane controller modules) instead of IRIG time on RS422_OUT. This allows the KAM/TCG/102 to be used to synchronize the acquisition cycle to the start of a second. When X-SYNC is in use, some restrictions must be placed on the acquisition cycle frequency; that is, only the following frequencies are supported: 0.5, 1, 2, 4, 5, 8 10, 16, 20, 25, 32, 40, 50, 64, 80, 100Hz.

Possible configurations

The following diagrams illustrate the different configurations possible with the KAM/TCG/102. In each case the time input source is illustrated in the top half of the diagram, while the available outputs are shown in the bottom half.

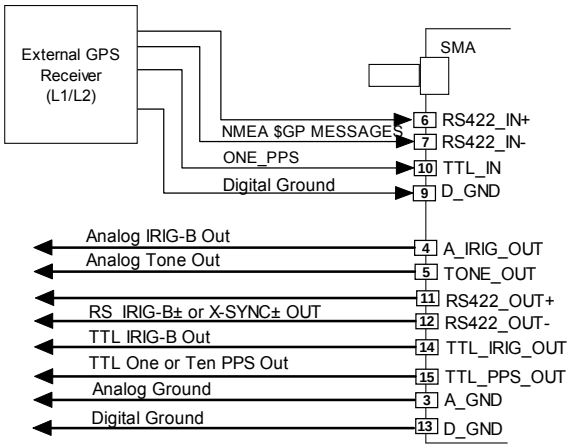


Figure 2: Connected to external GPS receiver using RS-422 and TTL

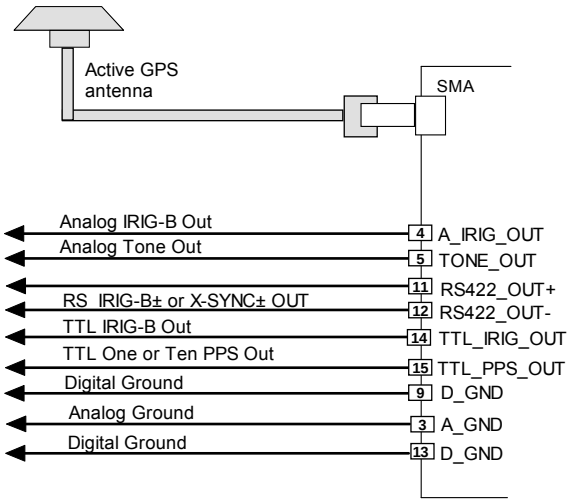


Figure 3: Connected to active GPS antenna

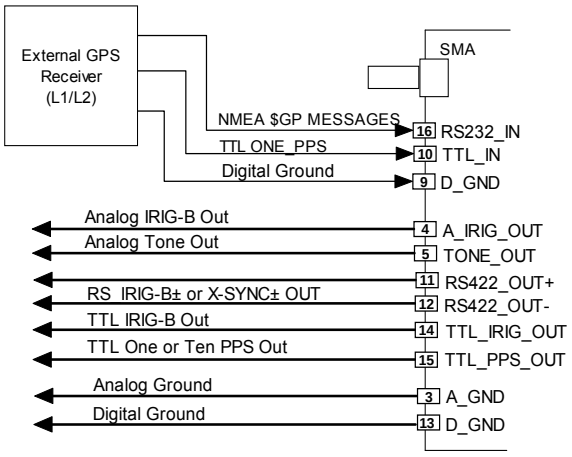


Figure 4: Connected to external GPS receiver using RS-232 and TTL

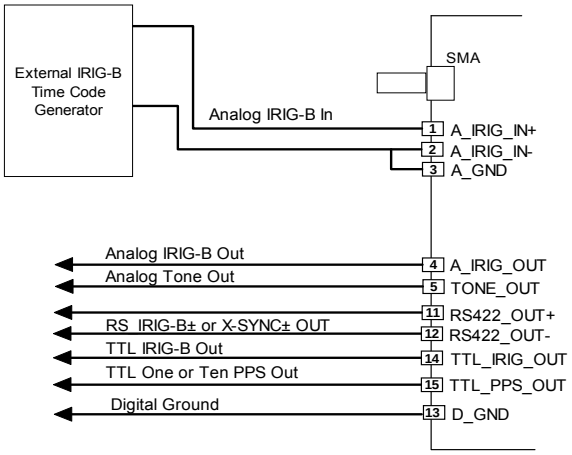


Figure 5: Receiving analog IRIG Time

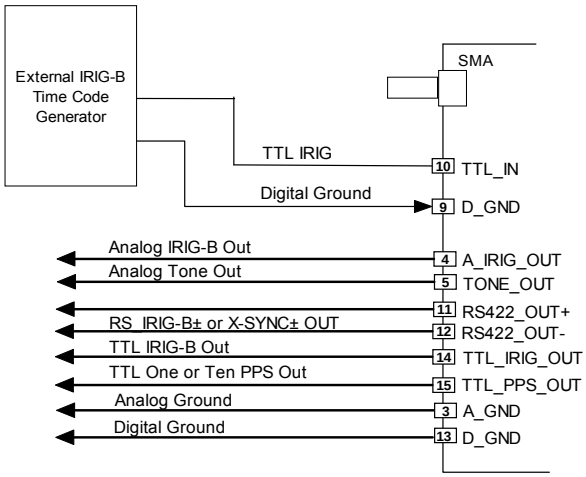


Figure 6: Connected to external IRIG source using TTL

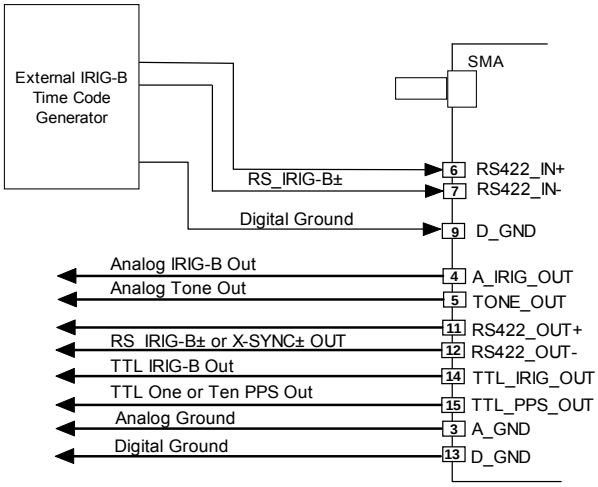


Figure 7: Connected to external IRIG Time source using RS422

This page is intentionally blank

Connector pinout of the KAM/TCG/102

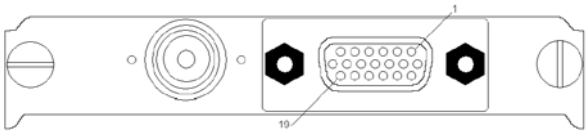


Figure 8: 19-way DD-type connector plus SMA connector

19-way Double-Density (DD) type connector

Pin	Name	See specifications table	Comment
1	A_IRIG_IN+	Analog IRIG time inputs	Analog IRIG-B time in (AM/PWM); 1kHz carrier
2	A_IRIG_IN-	Analog IRIG time inputs	Analog IRIG-B time in (AM/PWM); 1kHz carrier
3	A_GND	Analog ground	
4	A_IRIG_OUT	Analog IRIG time outputs	Analog IRIG-B time out (AM/PWM); 1kHz carrier
5	TONE_OUT	Tone outputs	1kHz sine wave, $\pm 4V_{p-p}$
6	RS422_IN+	RS-422 inputs	Either IRIG-B time (PWM) or NMEA data
7	RS422_IN-	RS-422 inputs	Either IRIG-B time (PWM) or NMEA data
8	RS_IRIG_TERM	Termination pin for RS-422	Connect to RS422_IN+ if needed
9	D_GND	Digital ground	
10	TTL_IN	BTTL inputs	Either IRIG-B or ONE_PPS in from external GPS source
11	RS422_OUT+	RS-422 outputs	Either IRIG-B or X-SYNC out
12	RS422_OUT-	RS-422 outputs	Either IRIG-B or X-SYNC out
13	D_GND	Digital ground	
14	TTL_IRIG_OUT	BTTL outputs	IRIG-B time out (PWM)
15	TTL_PPS_OUT	BTTL outputs	One or ten pulses per second
16	RS232_IN	RS-232 inputs	NMEA-183 stream in from external GPS receiver
17	V_BAT	Battery inputs	Positive battery input
18	D_GND	Digital ground	Ground return for battery
19	CHASSIS	Chassis	Chassis connection

Connector pinout of the GPS interface (CON/SMA/001[1])

Pin	Name	See specifications table	Comment
Center	RF_IN	Active antenna inputs	Excitation output to active antenna and RF input to module
Outer shell	RF_GND	Active antenna inputs	RF ground reference; isolated from chassis

1. For details of cables that connect to this interface, see the *Cables* data sheet.