

Using the KAD/ARI/001

TEC/NOT/052

The KAD/ARI/001 is an ARINC-429 bus monitor combining the capabilities of an all-pass/selected-pass monitor, a coherent message parser and an error-detection function on a single module. This paper explains how to set up the KAD/ARI/001 for monitoring ARINC-429 traffic and is divided into the following sections:

- “27.1 Introducing ARINC-429” on page 1
- “27.2 Features of the KAD/ARI/001 in relation to ARINC-429 bus monitoring” on page 3
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27.1 Introducing ARINC-429

ARINC-429 is the standard for the predominant avionics data bus used on most high-end commercial and transport aircraft.

Connected to the busses is a transmitter (source), a receiver (sink), or a transmitter and receiver (see the following figure). All data is transmitted over a single, twisted pair in one direction only.

NOTE: The first revision of the ARINC-429 mark 33 Digital Information Transfer System (DITS) was generated on 11 April 1978. The current specification is ARINC-429-10.

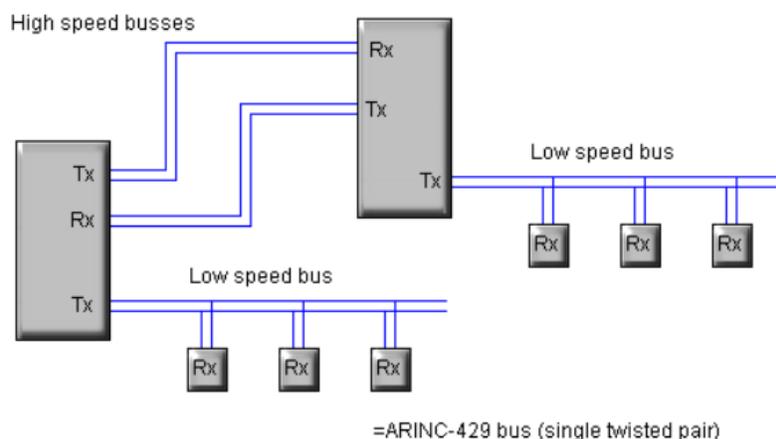


Figure 27-1: An example of ARINC-429 architecture

A transmitter (Tx) may transmit to up to 20 Receivers (Rx). If an Rx is required to acknowledge reception of data, another ARINC-429 Tx is required in the opposite direction.

Data is sent in single words identified by one of 255 Labels and a two-bit source/destination identifier.

27.1.1 Physical layer

Data is transmitted in a bipolar Return-to-Zero (RZ) format. This is a trilevel code (see the following figure).

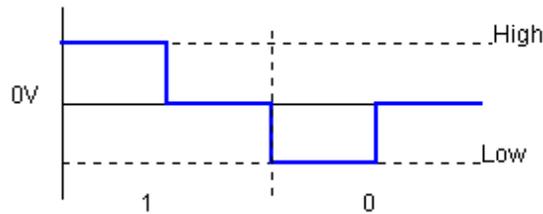


Figure 27-2: ARINC-429's bipolar, RZ code

For a Tx, the high (low) voltage must be $+10V \pm 10\%$ ($-10V \pm 10\%$). A receiver must be specified to a minimum level of $\pm 5V$. The Tx output impedance is $75\Omega (\pm 5\Omega)$ and a suitable 75Ω cable should be used.

Typically, there are two bit-rates: the high speed bus is 100 kbps and the low speed bus is between 12 and 14.5 kbps. Only one data rate is allowed per bus.

ARINC-429 also specifies the data rate tolerances and rise and fall times.

27.1.2 Word definition

The following figure illustrates the generic format of an ARINC-429 word.

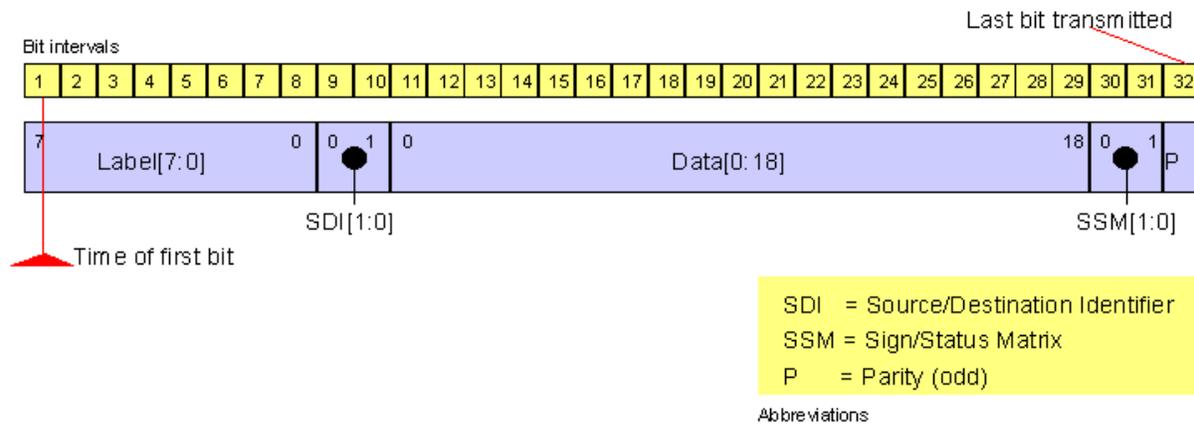


Figure 27-3: Generic word definition for ARINC-429

As shown in the previous figure, the eight-bit Label identifies the parameter being transmitted.

The main purpose of the Source/Destination Identifier (SDI) bits are to direct data words to a particular Rx. The SDI bits are not used with certain types of data.

The Sign/Status Matrix (SSM) bits are used to indicate plus or minus, north, south, east or west and so on for certain types of data, the word type for AIM (Acknowledge, ISO alphabet No. 5 and Maintenance) data and the status of the Tx. For binary data, bit 29 (Data18) is used to indicate sign.

There are five types of data words:

- Binary
- BCD subset of ISO Alphabet No. 5
- Discrete
- Maintenance
- AIM

Also, file transfer is supported.

27.2 Features of the KAD/ARI/001 in relation to ARINC-429 bus monitoring

27.2.1 Physical layer

The KAD/ARI/001 monitors up to eight ARINC-429 busses. The following figure displays the Rx circuit internal to the KAD/ARI/001.

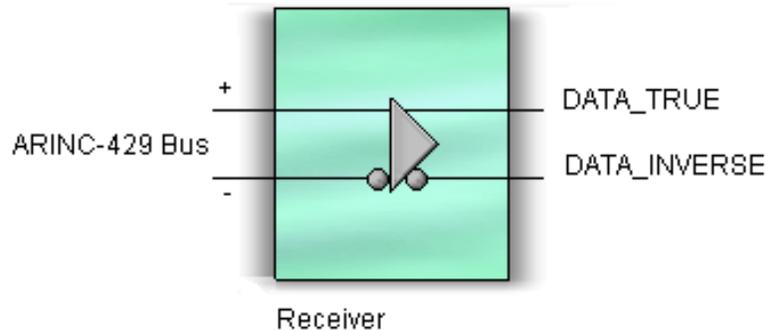


Figure 27-4: One of eight receivers on the KAD/ARI/001

For exact threshold levels for high and low signals, see the *KAD/ARI/001* data sheet. The Rx components are third-party products certified for ARINC-429 operation. Any combination of busses can be programmed to monitor high (100 kbps) or low speed (13.25 ±10%) operation.

As per the ARINC-429 specification, the shields for each bus must be connected to the GND pin of the KAD/ARI/001.

27.2.2 Bit detection circuitry

Each of the eight busses has a separate independent bit detection circuit. The true/complement output of the Rx is sampled at 20 times the selected bit-rate. The output of the bit detection circuitry is 1,0, Hi-Z or bad.

The bit detector outputs a bad indication if one of the three masks is not met after a 1 or a 0 has been received. In other words, every bit period, a 1, a 0, a Hi-Z or a bad is clocked into the serial-to-parallel register of the word detection circuitry.

27.2.3 Word detection circuitry

Each bus has a separate word detection circuit. A word is considered found when two Hi-Z bits follow at least eight good 1s or 0s.

This circuit checks that there is precisely the correct number of good bits and that the parity is correct. The Label[7:0], SDI[1:0] and SSM[1:0], along with three bits indicating the bus, are used to address a trigger list. The trigger list assigns one of 1,024 identifiers (IDs) to each word along with flags for invalid Label, SSM and SDI. For details of the time tag words, refer to the *KAD/ARI/001* data sheet.

As the data transfer is word based (not messages or frames), there is no protocol tracking on the KAD/ARI/001. A received word either has errors or it does not.

27.2.4 Error reporting, word counting and time tagging

The errors detected by the bit detection and word detection circuitry are combined in a four-bit code. This code can be part of the report parameter from the KAD/ARI/001, along with three bits indicating the bus on which the fault was recorded (for details of bit definition, see the *KAD/ARI/001* data sheet).

All errors are also reported/logged along with the time that it occurred and the traffic following.

When a valid word is received, a word counter increments for each bus. This is a 16-bit binary counter that resets at FFFF hex. This parameter can be read for each of the eight busses from the KAD/ARI/001. For details of the time tag words, refer to the *KAD/ARI/001* data sheet.

27.2.5 Parsing

The following figure illustrates the triple buffering of words and tags used for each bus in the KAD/ARI/001 parser.

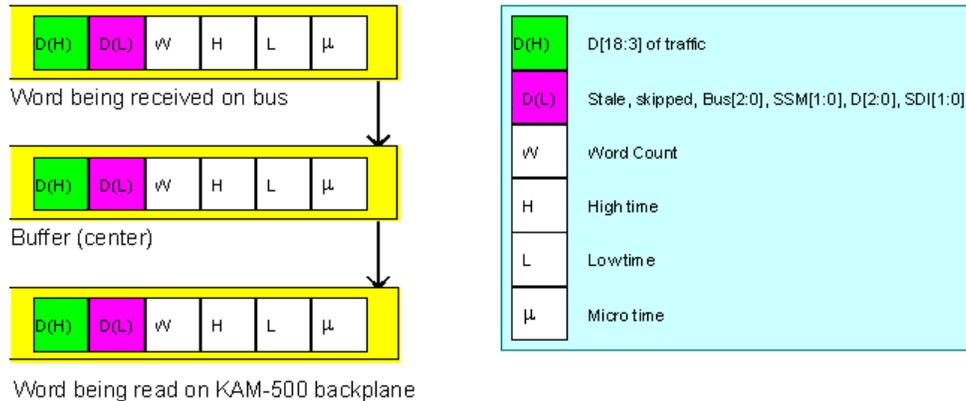


Figure 27-5: Triple buffering of traffic and associated tags

Time tags and a word count are added to each word received and stored in separate buffers for each of the eight busses. As soon as a word is received with no errors, the complete buffer is transferred to the center buffer. If the data in the center buffer has not been transferred to a read buffer, a skipped flag is set.

As soon as the last parameter of interest has been read from the buffer being read by the backplane, the contents of the center buffer (if new) are transferred to the read buffer. If no new word has been received, the stale flag is set. A center and read buffer exist for every ID (1,024).

27.2.6 General features of the KAD/ARI/001

- Eight valid word counters, one for each bus.
- A 48-bit BCD timer that counts to hours of the day with 1 μ s resolution. This timer is used to tag data to 1 μ s resolution and is typically seeded from an IRIG-B module—for example KAM/TCG/102—in the same chassis.
- Valid words are defined and assigned IDs using all the bits of the Label, SDI and SSM. Multiple words can be mapped to any ID.
- Parsing of traffic from up to 1,024 IDs. Added to each parsed message is the word count and time when the word arrived. The parser provides stale and skipped indication for each word.
- Parsing even during 100% utilization of all busses, at high speed.

27.3 Using kSetup to configure the KAD/ARI/001

The KAD/ARI/001 has eight busses and can coherently parse traffic and tags for up to 4,095 words per bus. You must use kSetup software to configure the KAD/ARI/001 according to your requirements. kSetup is included in the KSM-500 suite of tools.

27.3.1 Default parameters

To view parameters for the KAD/CBM/102, select the module in the Task Explorer pane of kSetup. The Parameters tab (see the following figure) displays a list of fixed module parameters. For more information on using kSetup, contact Curtiss-Wright support (acra-support@curtiss-wright.com).

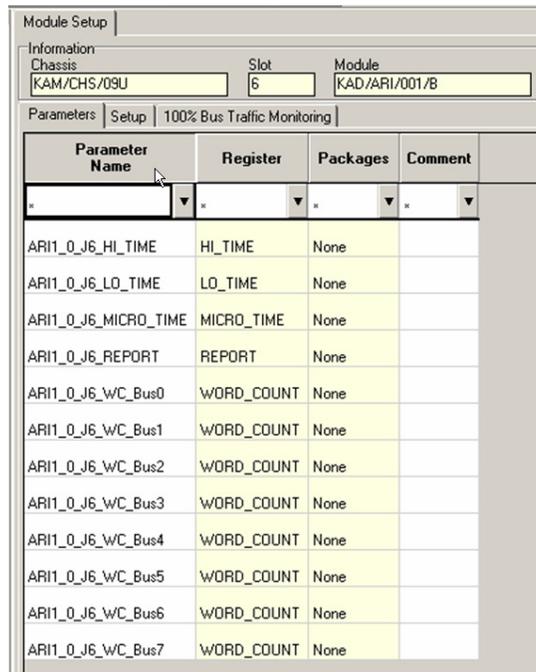


Figure 27-6: Parameter settings

To edit parameters for the KAD/ARI/001, select the module in the Task Explorer pane of kSetup. On the Parameters tab, complete the fields described in the following table.

Table 27-1: Parameter settings

Field name	Description
Parameter Name	Name of the parameter.
Register	Output register that stores values relating to the word count, parser or snarfer; for more information on register definitions, see the <i>KAD/ARI/001</i> data sheet.
Packages	The package of data in the PCM after the parameter is placed; by clicking on package after placing the parameter in the PCM, the transmission details of that parameter is displayed.
Comment	User-defined text relating to the parameter.

27.3.2 Configuring busses

On the Setup tab (see the following figure), you can define settings for Time Server and Parity as well as defining settings for any of the eight busses.

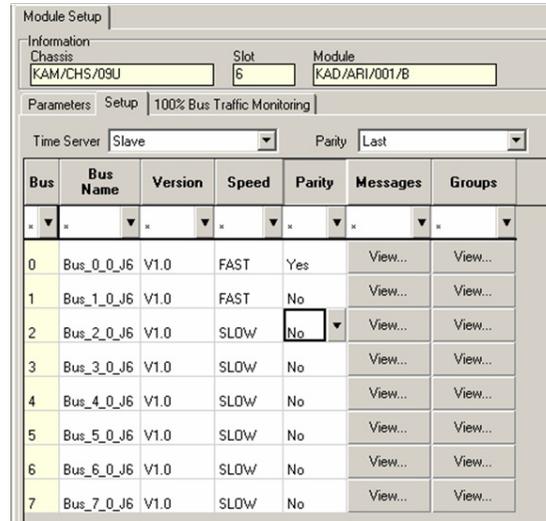


Figure 27-7: Bus settings

27.3.2.1 Defining Time Server settings

In the Time Server field (see the following figure), the following settings are available:

- Slave - configures the KAD/ARI/001 to be seeded with system time; all time tags reported by the KAD/ARI/001 are based on the system time.
- Excluded - configures the KAD/ARI/001 so that it is not time seeded; time increments from 0 the instant the system is powered up.

27.3.2.2 Defining bus settings

To define bus settings, complete the fields described in the following table.

Table 27-2: Bus settings

Field name	Description
Bus	Number of the bus; read-only.
Bus Name	Name of the bus; package corresponding in the XidDML file is changed accordingly.
Version	Version of the bus.
Speed	FAST refers to 100 KBit/s. SLOW refers to 12.5 KBit/s.
Parity	Parity check; if YES is selected, the module checks the parity bit coming from the ARINC-429 message.
Messages	Click View to load the message definition; for more information, see “27.3.3 Defining messages” on page 8.
Groups	Not used.

27.3.2.3 Defining parity status

The parity status (see Parity field in the following figure) affects the bit setting on the module register. Figure 27-9 on page 7 and Figure 27-10 on page 7 illustrate the formats of Parity First and Parity Last.

For information on bit settings, see the *KAD/ARI/001* data sheet.

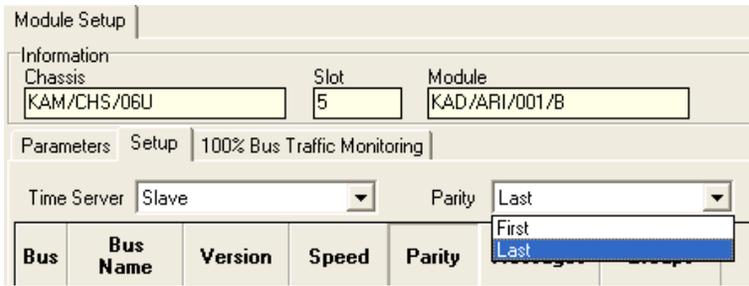


Figure 27-8: Parity settings

NOTE: Parity first is typically used when you want to transmit the ARINC parameter to a 12-bit fixed PCM.

	Parity	SSM			Data																SDI			
ARINC Bit	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data Bit	0	1	0	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	0
Data (bin)	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0
Data (hex)	1	3			4				3				C				3				C		0	

	Parity	SSM			Data Bits 18 to 10								Bus			R
Data Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data (bin)	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
Data (hex)	F			0				F				0			0	

Data_Hi (Parity First)

	Data Bits 9-0								SDI		MT	S	Sk	R		
Data Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data (bin)	0	0	0	1	1	1	1	0	0	0	0	0	0	X	0	0
Data (hex)	F				0				F		0/4					

Data Low (Parity First)

Figure 27-9: Parity First (bit level)

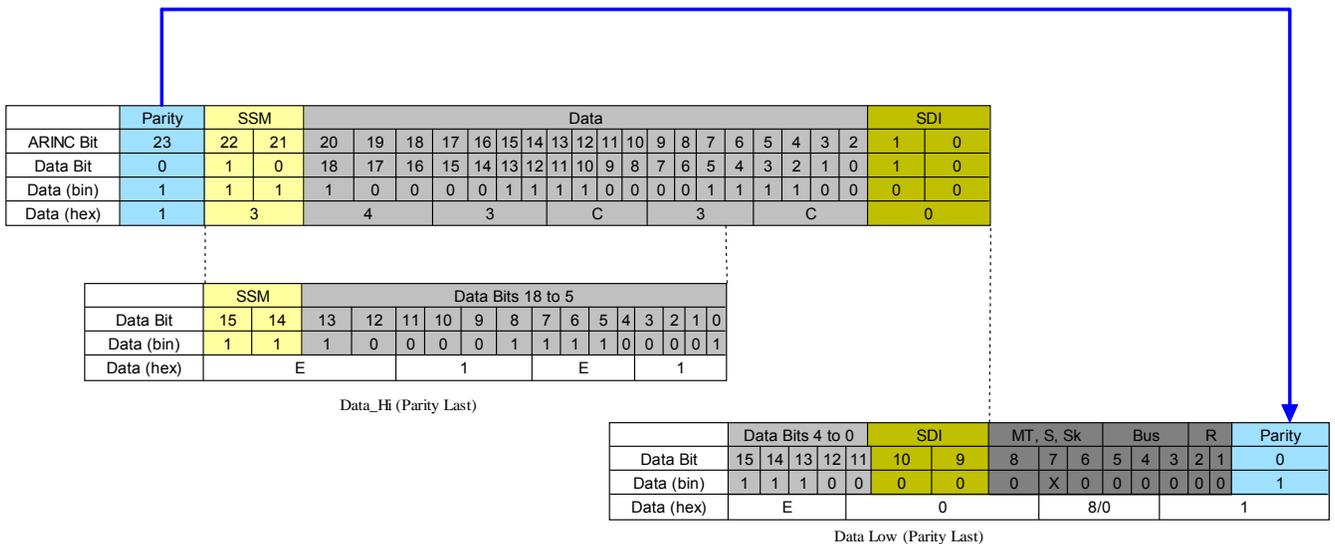


Figure 27-10: Parity Last (bit level)

27.3.3 Defining messages

You can specify the data characteristics of messages (see the following figure) to be monitored by each bus of the module. To view or edit the data characteristics of a message, click View to the right of a bus on the Setup tab.

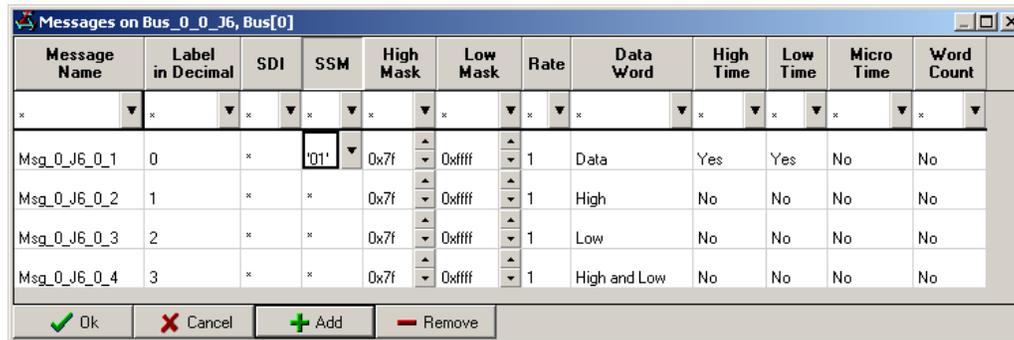


Figure 27-11: Message settings

The settings for messages are described in the following table.

Table 27-3: Message settings

Field name	Description
Message Name	When adding a message, the monitoring parameters are automatically created; the parameters are named <bus>:<message>\${type}; type depends on the DataWord choice.
Label in Decimal	Message matching this label is to be captured; to view the label in a different format such as hexadecimal or octal, right-click the label value.
SDI	Message matching this value is to be captured; wild cards allowed.
SSM	Message matching this value is to be captured; wild cards allowed.
High Mask	23-bit payload as a 23-bit word: SSM[1:0]Data[18:0]SDI[1:0]; Figure 27-12 on page 9 shows the result of selecting Mask values to adjust the payload.
Low Mask	Payload setting; see High Mask.
Rate	Not used.
Data Word	Selecting a data word changes the ARINC monitoring registers: High - just the DATA_HI word is captured; creates a parameter called <Bus>:<Message>\$dh. Low - just the DATA_LO word is captured; creates a parameter called <Bus>:<Message>\$dl. High & Low - both DATA_LO and DATA_HI are captured as two 16-bit words; as Ethernet modules only support parameter transmission up to 16 bits, this mode should be used if DATA_HI or DATA_LO is not sufficient. All - DATA_LO and DATA_HI are captured as a single 32-bit word; creates a parameter called <Bus>:<Message>.
High Time	If set to YES, the appropriate time tag word to the corresponding message is captured as a parameter called <bus>:<message>\$th.
Low Time	If set to YES, the appropriate time tag word to the corresponding message is captured as a parameter called <bus>:<message>\$tl.
Micro Time	If set to YES, the appropriate time tag word to the corresponding message is captured as a parameter called <bus>:<message>\$tu.
Word Count	If set to YES, the Word Count word is captured as a parameter called <bus>:<message>\$wc.

NOTE: The default setting for an SDI or an SSM field is a wild card, that is, *. If the * wild card is set for SDI, data words are directed to the Rx with all the following IDs 00, 01, 10 and 11. For SSM, the sign and status for all data corresponding to 00, 01, 10, 11 is active.

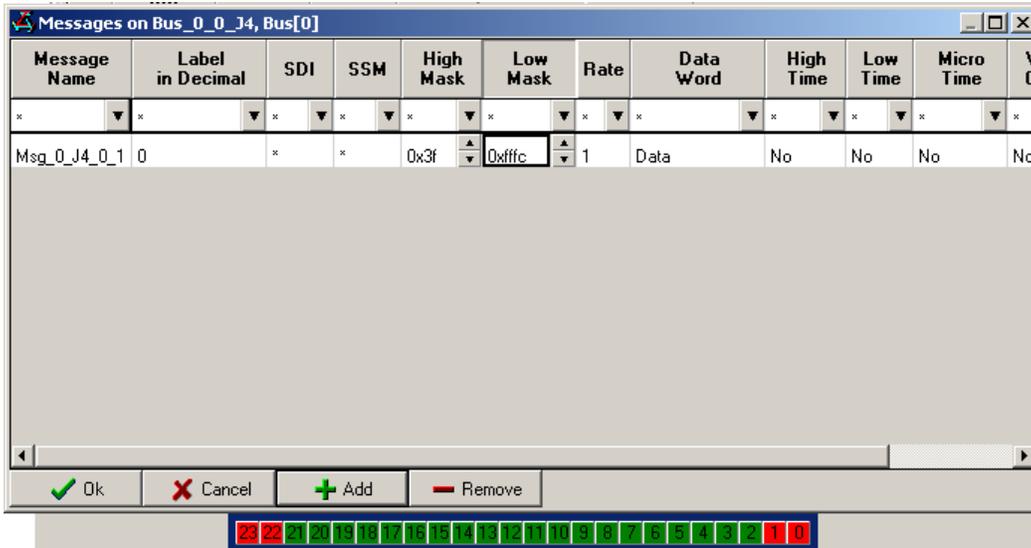


Figure 27-12: Using High Mask and Low Mask to set payload

NOTE: The payload adjustment shown in the previous figure can only be used under PCM.

27.3.4 Defining bus traffic settings

To define bus traffic monitoring settings on the 100% Bus Traffic Monitoring tab, complete the fields described in the following table.

Table 27-4: Bus settings

Field name	Description
Parameter Name	Name of the parameter; if #Words is greater than 1, the parameter name is appended with a number.
Active	If set to YES, snarfer data is made available.
#Words	You can read the snarfer multiple times in an acquisition cycle; by increasing the number of instances of the snarfer word, you can place data irregularly in the PCM frame, which allows you to save some PCM bandwidth.
Mode	If set to snarfer (see the following figure), 32-bit word mode; if set to snarfer16, 2x16-bit consecutive word mode.
Comment	User-defined comment relating to the parameter.

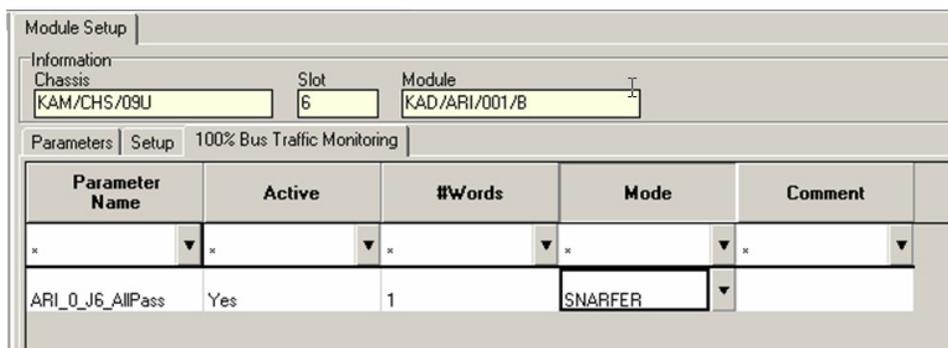


Figure 27-13: 100% Bus Traffic Monitoring Settings tab for the KAD/ARI/001

NOTE: For further information on the snarfer, contact Curtiss-Wright support (acra-support@curtiss-wright.com).

27.4 Troubleshooting

The common issues are

- The bus +/- is physically inverted.
- The wrong bus is being parsed.
- The bus speed is wrongly set.
- The message is defined in KSM-500 in decimal but it's defined by the avionics in octal.

27.5 References

An Overview of ARINC-429

AIM USA Inc.

4547 Gateway Circle

Dayton

Ohio 45440

Standards

ARINC-429-10