Using the KAD/ABM/103

TEC/NOT/086

This paper discusses the following topics:

57.1 ARINC-429 overview

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.

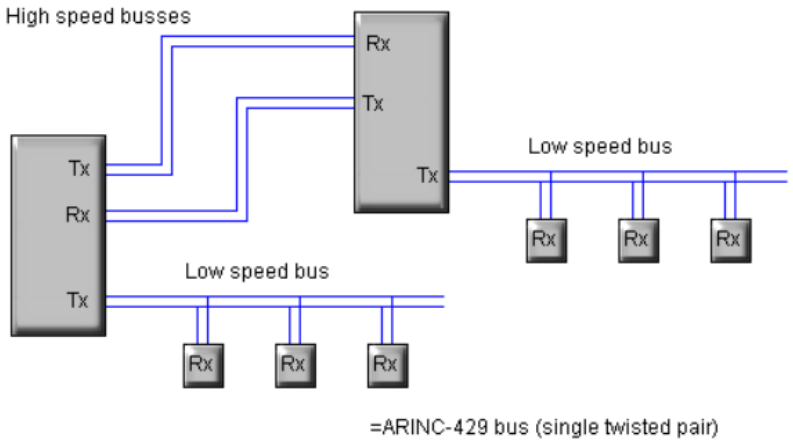


Figure 57-1: An example of ARINC-429 architecture

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.

57.1.1 Physical layer

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

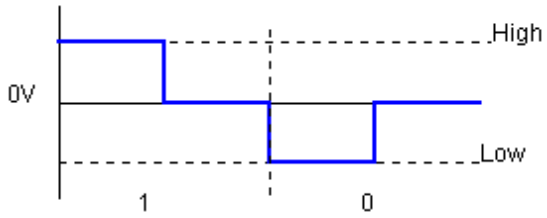


Figure 57-2: ARINC-429's bipolar, RZ code

For a Tx, the high (low) voltage must be +10V ±10% (-10V ±10%). A receiver must be specified to a minimum level of ±5V. The Tx output impedance is 75Ω (±5Ω) 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.

57.1.2 Word definition

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

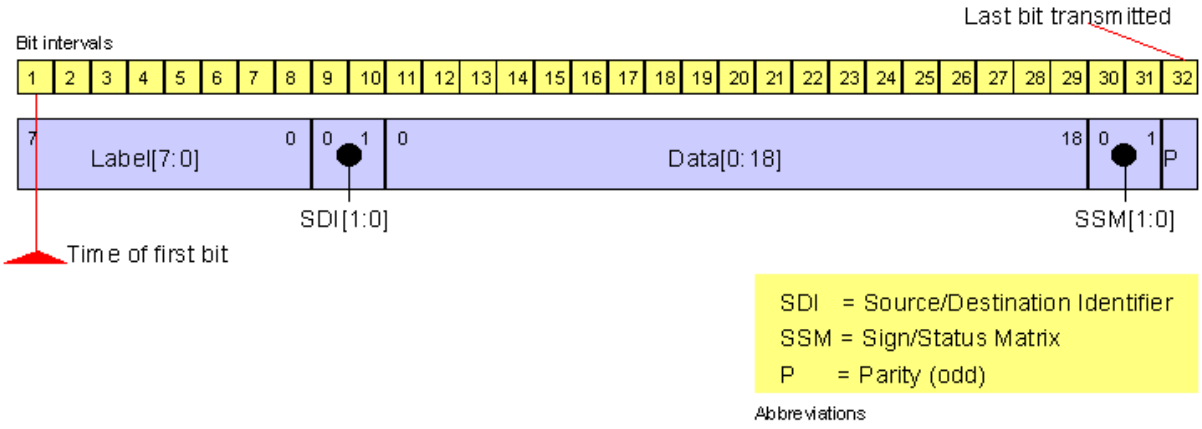


Figure 57-3: Generic word definition for ARINC-429

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.

57.2 Module overview

The KAD/ABM/103 is a 24-channel ARINC-429 bus monitor which can parse and/or packetize each channel at the same time. It can coherently parse traffic and tags for up to 8191 messages and it can transmit aperiodically packetized ARINC-429 messages including tags as iNET-X parser-aligned, IENA D Type, or IENA N Type payload structures per channel or per instrument.

The sections below show screen shots and descriptions of settings in DAS Studio 3 software. DAS Studio 3 is used to create a configuration, which contains the various elements which make up your data acquisition system. You then use this configuration file to manage and program these elements. To see how hardware is represented in the DAS Studio 3 graphical user interface, see Figure 1 in the *DAS Studio 3 User Manual*.

57.3 ARINC-429 bus monitor modules history

The following table below describes the different ARINC-429 bus monitor modules.

Table 57-1: ARINC-429 module history

Module	Description
KAD/ARI/001/B	Legacy - ARINC-429 bus monitor parser/snarfer - 8ch
KAD/ABM/101	Replacement of the KAD/ARI/001
KAD/ABM/102/B	ARINC-429 bus monitor parser/packetizer - 8ch (The KAD/ABM/102 only supports packetizer)
KAD/ABM/103	ARINC-429 bus monitor parser/packetizer - 24ch

NOTE: Packetizer cannot be used over PCM. An aperiodic sink is required for the packetizer operation such as the KAD/BCU/140 or KAM/MEM/113.

57.4 Parser operation

57.4.1 How parsing works

Like other Curtiss-Wright bus monitors, the KAD/ABM/103 uses a triple buffer for parsing. The following figure illustrates the triple buffering of data words (green) and message tags (white) used for each bus in the KAD/ABM/103's parser.

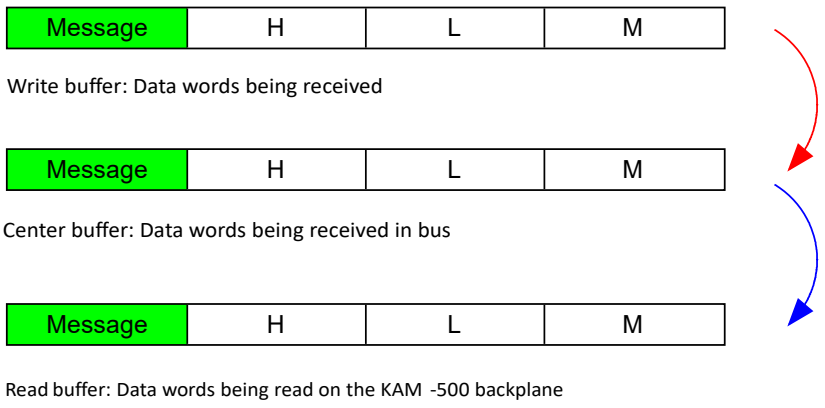


Figure 57-4: Triple buffering of traffic and associated message tags

Message corresponds to MessageDataStyle as described in the module data sheet.

The time tags H, L, M correspond to High time, Low time and Micro time, which is the time midway through the first transmitted bit. It has a 1-µsec resolution.

The way triple buffering works is as follows:

Time message tags are added to each message received and stored in separate buffers for each of the four busses. As soon as a message is received with no errors, the contents of the write 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.

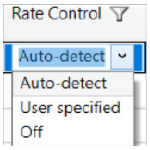
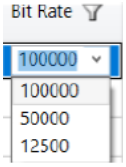
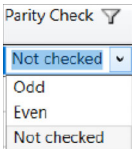
As soon as the last parameter of interest has been read from the buffer being read by the backplane, the contents of the center buffer (if new) are transferred to the read buffer. If no new data word has been received, the stale flag is set. A center and read buffer exist for every message ID (parser slot). Skipped and stale bits can be found in the Message Info register to indicate whether messages have been lost or repeated (undersampling or oversampling situations).

A Message Count register is also available as additional information and can be added from DAS Studio's ARINC-429 Builder application as explained in section "57.4.3 Defining parsing rules" on page 4. For further information regarding this register refer to the *KAD/ABM/103* data sheet.

57.4.2 Module Settings tab

NOTE: To view the screen shots shown in this section in DAS Studio 3, ensure the KAD/ABM/103 module is in context and the Settings tab is selected.

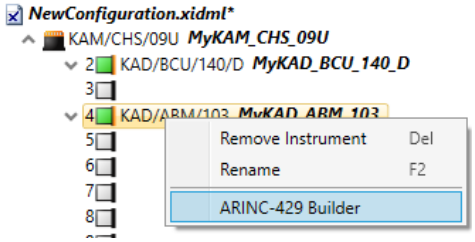
Before using the module, you need to define Rate Control and Parity Check.

Setting	Description
Rate Control 	Auto-detect: module detects bus speed automatically. User specified: restricts reception to specific bus rate. Because DAS Studio automatically calculates the packetizer rate according to the ARINC-429 bit rate when verifying the XidML file, this should be set if using a lower ARINC-429 bit rate than 100 kbps and packetizer in order to make the backplane scheduling easier. Off: no messages are parsed or packetized from channel.
Bit Rate 	Input bus bit rate. (Auto-detected bit rate sets to maximum to reserve backplane capacity for maximum rate. Note: 50 kbps is a non-standard ARINC-429 rate.
Parity Check 	Parity settings configures whether parity bit is present in incoming data. It can be set to Not checked, Even Parity, or Odd Parity. Not checked means the parity bit in the ARINC-429 message parser/packetizer is not checked. Odd Parity/Even Parity means the parity bit in the ARINC-429 message is checked against the bits received. If there's a parity error, the REPORT word reports it and the error code is set accordingly in the packetizer packet.

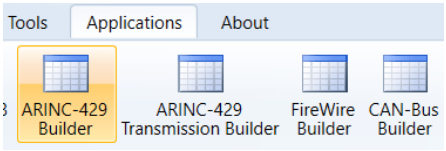
57.4.3 Defining parsing rules

After you have all channel settings configured, refer to the following to define rules to identify messages.

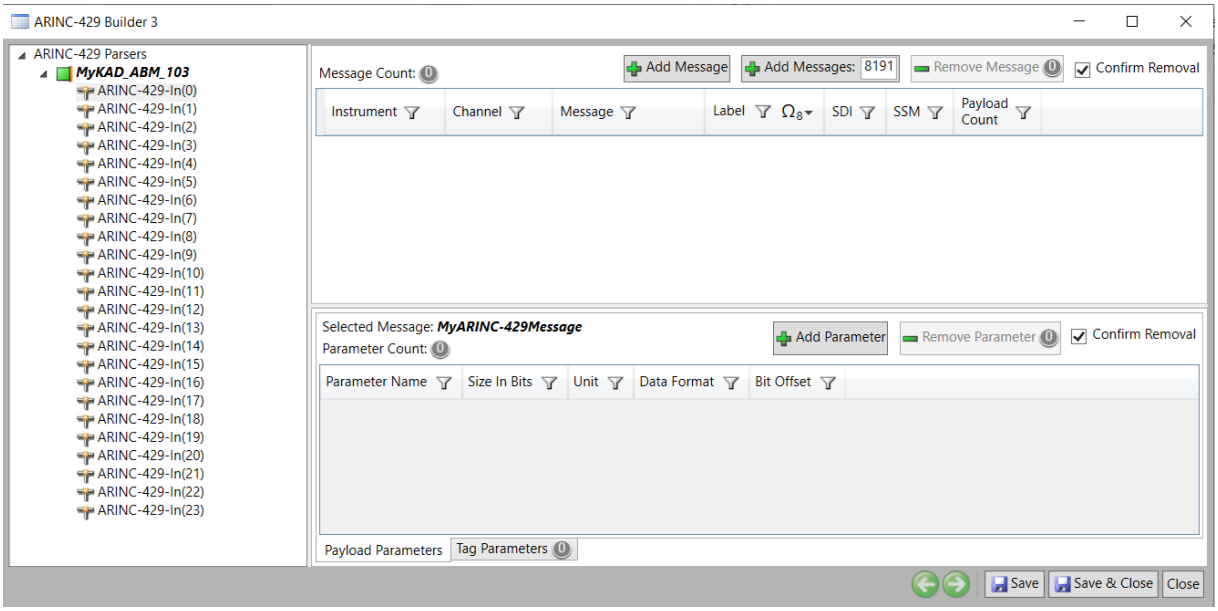
1. Do one of the following.
   - In the Navigator, right-click the KAD/ABM/103 module and then click **ARINC-429 Builder**.



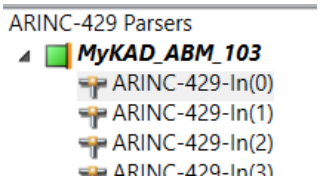
- On the **Applications** menu click **ARINC-429 Builder**.



The **ARINC-429 Builder** application opens.



2. In the Navigator (left pane of Builder application), select the channel on the KAD/ABM/103 that you want to parse data off.

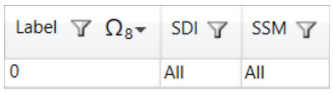


3. Click **Add Message** to add a single message. To add multiple messages (up to 8191), click **Add Messages** (typing the number of packages in the field).

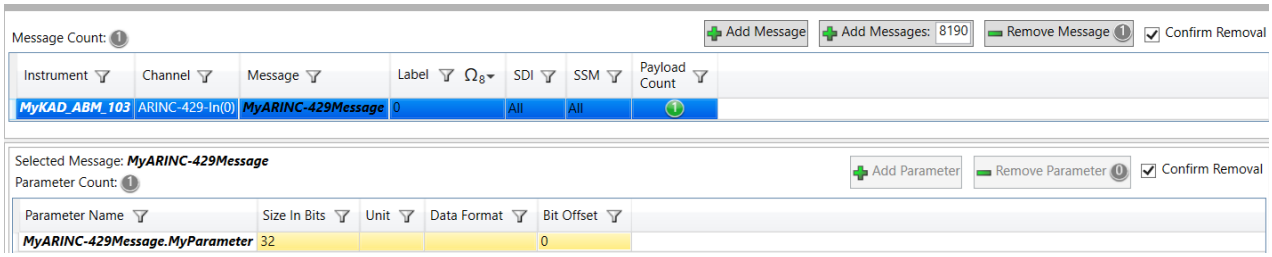
Now you must define the rules to identify or parse the desired message.

4. Define **Label**.

   The default is **Octal** as indicated by Ω_8. Values can be from **0** to **255** in decimal.

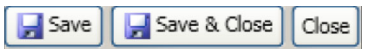


5. Define **SDI** and **SSM**.
   These can be either **All**, **00**, **01**, **10** or **01**. **All** being the wildcard.
6. Click **Add Message** to add the message.
   When the message is added, ARINC-429 Builder automatically creates a 32-bit parameter.

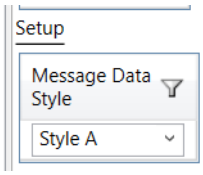


Although the parameter has 32 bits, it has a different layout than the 32-bit ARINC-429 message defined in “57.1 ARINC-429 overview” on page 1. This is because the message is parsed using the label; the parameter itself doesn’t contain the label.

7. Click **Save & Close** to save your changes and close **ARINC-429 Builder**.



8. With the KAD/ABM/103 selected, click the **Settings** tab.
9. To program the Message Data Style, click the **Message Data Style** drop-down menu and choose **Style A** or **Style B**.



Style A = MessageDataStyleA and is defined as:

R[31:0]

R[31:30] SSM - Sign/Status Matrix.

R[29:11] Data - Data Word.

R[10:9] SDI - Source Destination Identifier.

R(8) Empty - This parser slot has not been written to yet.

R(7) Stale - This parser slot has been read before.

R(6) Skipped - This parser slot has been overwritten without being read.

R[5:1] Bus - The bus the message was received on.

R(0) Parity - The parity bit received.

Style B = MessageDataStyleB (see “57.8 MessageStyleB” on page 8) and is defined as:

R[31:0]

R(31) Parity - The parity bit received.

R[30:29] SSM - Sign/Status Matrix.

R[28:20] Data[18:10] - Bits 18 to 10 of the Data Word.

R[19:17] Bus - The bus the message was received on (3 least significant bits only).

R(16) Reserved

R[15:6] Data[9:0] - Bits 9 to 0 of the Data Word.

R[5:4] SDI - Source Destination Identifier.

R(3) Empty - This parser slot has not been written to yet.

R(2) Stale - This parser slot has been read before.

R(1) Skipped - This parser slot has been overwritten without being read.

R(0) Reserved

Messages are saved to the configuration file and parameters become available to be placed to any sinks in the chassis such as a PCM stream or placed packet.

NOTE: Tags such at the Message Time, Message count can be enabled on the Tag Parameters tab of the ARINC-429 Builder as shown below. The tags are described in the KAD/ABM/103 data sheet.

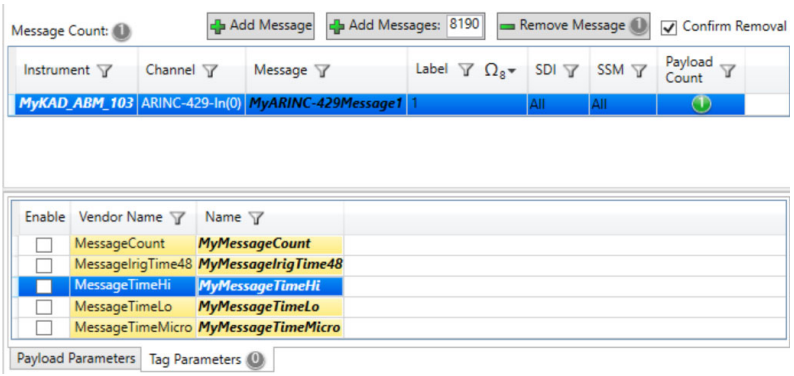


Figure 57-5: Tag Parameters tab

57.5 Packetizer operation

Independently of the parser, a packetizer stream is generated for each channel or per instrument. All received ARINC-429 messages are encapsulated in an iNET-X parser-aligned or IENA Type N/D payload structure. A block header attached to each sequence stores the channel index, length, and the time each message is received. These parser-aligned packets may be transmitted aperiodically to optimize network bandwidth utilization and memory usage when recording ARINC-429 traffic.

There are many settings available to configure or tune packetizer behavior.

NOTE: To view the screen shots shown in this section in DAS Studio 3, ensure the KAD/ABM/103 module is in context and the Settings tab is selected.

The available packetizer settings are shown in the following figure and described in the table that follows.

Packetizer

Source Name	Packetizer Format	Stream Id	IENA Type	IENA Key	Packetization Enabled	Packet Size	Packet Timeout	Utilization	Packetization Sink
ARINC-429-In(0)	iNET-X	FFFFFFFF	N/A	0	☐	511	50	1.00	All
ARINC-429-In(1)	iNET-X	FFFFFFFF	N/A	0	☐	511	50	1.00	All
ARINC-429-In(2)	iNET-X	FFFFFFFF	N/A	0	☐	511	50	1.00	All
ARINC-429-In(3)	iNET-X	FFFFFFFF	N/A	0	☐	511	50	1.00	All

Figure 57-6: Packetizer settings

Setting	Description
Source Name	Channel to packetize
Packetizer Format	iNET-X, IENA or IENA-iNET-X hybrid. Note: IENA-iNET-X hybrid is a non-standard format.
Stream ID	iNET-X stream identifier for selected channel if a packet is generated via the assertion of Packetization Enabled. This is a conditional setting and is only active when the Packetizer Format is set to iNET-X.
IENA Type	IENA Type D or Type N packet payload.
IENA Key	IENA Key for selected channel if a packet is generated via the assertion of Packetization Enabled.
Packetization Enabled	Enables the transmission of a packetizer packet containing the contents of this channel if a packetizer transmitter or memory module is present in the chassis. DAS Studio automatically creates a packetizer packet after verification/programming.
Packet Size	The number of words in the packet buffer, ranges from 200 words to 511 words. The default value is 511 words; reducing this value results in smaller and therefore generally more frequent packets.

Setting	Description
Packet Timeout	The timeout in milliseconds before a packet is generated if insufficient messages have been received to reach the Packet Size. Packets generated due to Packet Timeout are tagged in the iNET-X header. The Packet Timeout ranges from 10 ms to 999 ms (default value is 50 ms). Reducing this value results in more frequent and generally smaller packets. Increasing the value results in less frequent, but generally bigger packets.
Utilization	The default of 1.0 should be used as it provides sufficient packets to carry all messages even when the bus is 100% active. Reducing Utilization schedules less packets for this bus, releasing backplane capacity for reading other modules. It should only be used when incoming message rates on the bus are known to be less than the maximum possible rate.
Packetization Sink	Selects which modules the packetizer package is sent to for transmission or storage. The choices are **Controller only**, **All slots** or **Slot** in which a sink module that supports packetizer logging such as KAM/MEM/113 is placed. For example, on a system consisting of KAD/BCU/140 controller on J2, KAD/ABM/103 on J3, and KAM/MEM/113 on J4, setting up **Slot 4** creates packetizer packets on the KAM/MEM/113 only and setting up **All** creates packets on both KAD/BCU/140 and KAM/MEM/113.

For further information regarding iNET-X parser aligned packets used by the packetizer, refer to *TEC/NOT/067 - IENA and iNET-X packet payload formats*.

57.6 Enabling packetizer

To turn on packetizer operation on any channel, define a unique stream ID for that channel and then select the **Packetization Enabled** check box for that channel as shown in the following figure. The packetizer is enabled the next time the module is programmed.

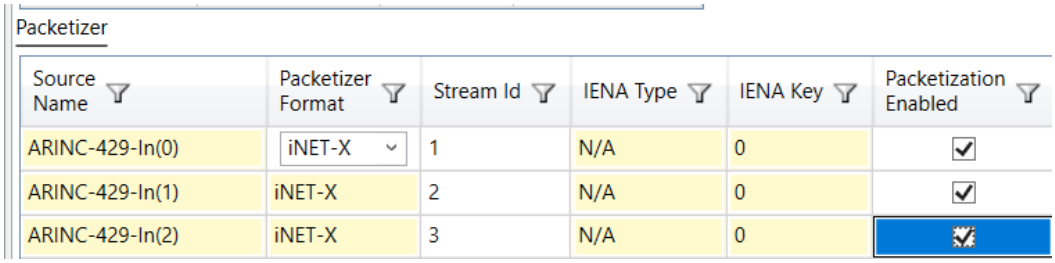
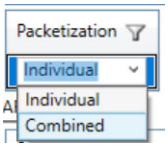


Figure 57-7: Packetization Enabled setting

NOTE: When Combined Packetization is selected, messages from all busses are placed in a single stream of packets, with a single stream ID. The bus ID field identifies on which bus a message was received.



57.7 Packet format

Refer to the “Getting the most from the KAD/ABM/103” section of the KAD/ABM/103 data sheet.

57.8 MessageStyleB

MessageStyleB was specifically designed for 12 bits of PCM. From this 32-bit parameter in PCM, you can reduce bandwidth by reducing it to the most necessary information such as Parity, SSM, Data and SDI.

When MessageStyleB is selected in the KAD/ABM/103 module Settings tab and you add parameter(s) using ARINC-429 Builder, DAS Studio 3 automatically and transparently creates 24-bit discrete parameters. These parameters are then available to be placed in the PCM as shown in the following figure.

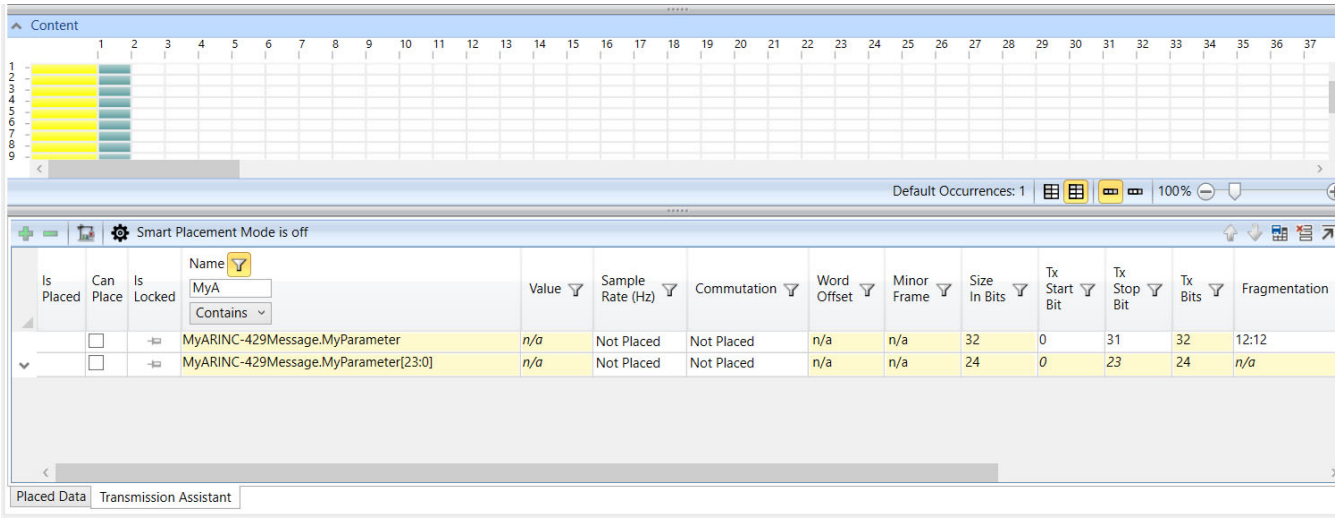


Figure 57-8: MyARINC-429Message.MyParameter[23:0] 24-bit discrete parameter

The previous figure shows the **MyARINC-429Message.MyParameter[23:0]** 24-bit discrete parameter. The following figure shows the bits that are used (gray bits are masked out).

	Parity	SSM		Data									Bus			R
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

	Data										SDI		Empty	Stale	SKipped	R
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

R = Reserved

Figure 57-9: MyARINC-429Message.MyParameter[23:0] used bits

57.9 Related documentation

To better understand this paper, read the following documents.

Table 57-2: Data sheets

Document	Description
KAD/ABM/103	ARINC-429 bus monitor parser/packetizer - 24ch

Table 57-3: Technical notes

Document	Description
TEC/NOT/006	ARINC-429
TEC/NOT/052	Using the KAD/ARI/001
TEC/NOT/063	Grounding and shielding of the Acra KAM-500
TEC/NOT/067	IENA and iNET-X packet payload formats

Table 57-4: User manuals

Document	Description
DOC/MAN/030	DAS Studio 3 User Manual