Caller ID (CID) Algorithm User's Guide

SPIRIT CORP
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Preface

Read This First

About This Manual

The following abbreviations are used in this document:

AS	Alerting Signal
CallerID, CID	Caller Identification Delivery (service)
CAS	Customer premises equipment Alerting Signal
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CPE	Customer premises equipment. Also known as TE (Terminal Equipment)
DT-AS	Dual Tone-Alerting Signal.
DTMF	Dual Tone Multi-Frequency
FSK	Frequency-Shift Keying
LE	Local Exchange
MDMF	Multiple data message format. Also known as “Call Setup”
PBX	Private Branch Exchange
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
SDMF	Single data message format. Is used in old telephone networks
TAS TE	Alerting Signal
TE	Terminal Equipment
TE-ACK	TE Acknowledgement Signal
VMWI	Visual Message Waiting Indication
XDAIS	TMS320 DSP Algorithm Standard

Related Documentation From Texas Instruments

Using the TMS320 DSP Algorithm Standard in a Static DSP System (SPRA577)

TMS320 DSP Algorithm Standard Rules and Guidelines (SPRU352)

TMS320 DSP Algorithm Standard API Reference (SPRU360)

Technical Overview of eXpressDSP-Compliant Algorithms for DSP Software Producers (SPRA579)

The TMS320 DSP Algorithm Standard (SPRA581)

Achieving Zero Overhead with the TMS320 DSP Algorithm Standard IALG Interface (SPRA716)

Related Documentation

Public Switched Telephone Network (PSTN); Calling Line Identification Presentation (CLIP) supplementary service; Service description, ETS 300 648, March 1997, DE/NA-010023

Public Switched Telephone Network (PSTN); Calling Line Identification Restriction (CLIR) supplementary service; Service description, ETS 300 649, March 1997, DE/NA-010024

Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 1: On hook data transmission, ETS 300 659-1, DE/SPS-03034-1

Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 2: Off-hook data transmission, ETS 300 659-2, September 1997, DE/SPS-03034-2

Public Switched Telephone Network (PSTN); Protocol over the local loop for display and related services

Terminal Equipment requirements; Part 1: Off-line data transmission, ETS 300 778-1, September 1997, DE/ATA-005062-1

Public Switched Telephone Network (PSTN); Protocol over the local loop for display and related services; Terminal Equipment requirements; Part 2: On-line data transmission, ETS 300 778-2, September 1997, DE/ATA-005062-2

CCITT Recommendation V.23 (1988): “600/1 200-baud modem standardized for use in the general switched telephone network”.

Calling Line Identification Service, British Telecommunication plc, SIN227, Issue 03.

Calling Line Identification Service, TE Equipment Requirement, British Telecommunication plc, SIN242, Issue 02, Nov., 1996.

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For additional CST technical support, see the TI CST Home Page (www.ti.com/telephonyclientside) or the TI Semiconductor KnowledgeBase Home Page (www.ti.com/sc/knowledgebase).

If you have any problems with the Client Side Telephony software, please, read first the list of Frequently Asked Questions at http://www.spiritDSP.com/CST.

You can also visit this web site to obtain the latest updates of CST software & documentation.

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Figures

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Notes, Cautions, and Warnings

Chapter 1

Introduction to Caller ID (CID) Algorithms

This chapter briefly describes Caller ID (CID) algorithms and their limitations when used with the TMS320C5400 platform.

For the benefit of users who are not familiar with the TMS320 DSP Algorithm Standard (XDAIS), brief descriptions of typical XDAIS terms are provided.

Topic **Page**

1.1 Introduction

This document describes implementation of Caller ID software developed by SPIRIT™ Corp for TMS320C5400 platform and is intended for integration into various embedded devices and telephony equipment such as:

- Embedded modems
- Payphones
- Fax and answering machines
- Data and voice relays
- PBX Systems

Both Terminal Equipment and Local Exchange sides are supported in full versions of Caller ID packages.

Note: Caller ID and CST support

Caller ID packages can be delivered with different set of options supported.

In TMS320C54CST device, only CID types 1 and 2 on CPE side are supported inside of ROM.

The SPIRIT Caller ID can be used for signal reception in Telcordia (Bellcore) Calling Identity Delivery, Calling Identity on Call Waiting (CIDCW) systems, British Telecom Calling Line Identification Service (CLIP), ETSI PSTN display service at Local Exchange and similar evolving services.

The SPIRIT Caller ID software is a fully TMS320 DSP Algorithm Standard (XDAIS) compatible, reentrant code. The Caller ID interface complies with the TMS320 DSP Algorithm Standard and can be used in multitasking environments.

The TMS320 DSP Algorithm Standard (XDAIS) provides the user with object interface simulating object-oriented principles and asserts a set of programming rules intended to facilitate integration of objects into a framework.

The following documents provide further information regarding the TMS320 DSP Algorithm Standard (XDAIS):

- *Using the TMS320 DSP Algorithm Standard in a Static DSP System* (SPRA577)
- *TMS320 DSP Algorithm Standard Rules and Guidelines* (SPRU352)
- *TMS320 DSP Algorithm Standard API Reference* (SPRU360)

- *Technical Overview of eXpressDSP-Compliant Algorithms for DSP Software Producers* (SPRA579)
- *The TMS320 DSP Algorithm Standard* (SPRA581)
- *Achieving Zero Overhead with the TMS320 DSP Algorithm Standard IALG Interface* (SPRA716)

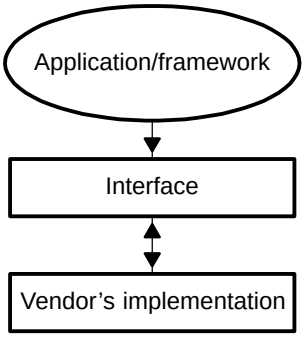
1.2 XDAOS Basics

This section instructs the user on how to develop applications/frameworks using the algorithms developed by vendors. It explains how to call modules through a fully eXpress DSP-compliant interface.

Figure 1-1 illustrates the three main layers required in an XDAIS system:

- Application/Framework layer
- Interface layer
- Vendor implementation. Refer to appendix A for a detailed illustration of the interface layer.

Figure 1-1. XDAIS System Layers



1.2.1 Application/Framework

Users should develop an application in accordance with their own design specifications. However, instance creation, deletion and memory management requires using a framework. It is recommended that the customer use the XDAIS framework provided by SPIRIT Corp. in ROM.

The framework in its most basic form is defined as a combination of a memory management service, input/output device drivers, and a scheduler. For a framework to support/handle XDAIS algorithms, it must provide the framework functions that XDAIS algorithm interfaces expect to be present. XDAIS framework functions, also known as the ALG Interface, are prefixed with "ALG_". Below is a list of framework functions that are required:

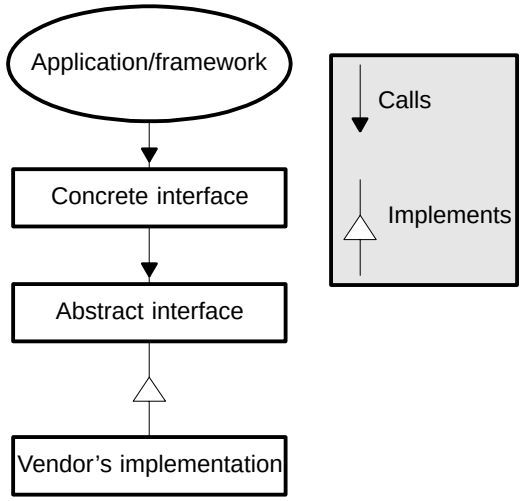
- `ALG_create` - for memory allocation/algorithm instance creation
- `ALG_delete` - for memory de-allocation/algorithm instance deletion
- `ALG_activate` - for algorithm instance activation

- ALG_deactivate - for algorithm instance de-activation
- ALG_init - for algorithm instance initialization
- ALG_exit - for algorithm instance exit operations
- ALG_control - for algorithm instance control operations

1.2.2 Interface

Figure 1-2 is a block diagram of the different XDAIS layers and how they interact with each other.

Figure 1-2. XDAIS Layers Interaction Diagram



1.2.2.1 Concrete Interface

A concrete interface is an interface between the algorithm module and the application/framework. This interface provides a generic (non-vendor specific) interface to the application. For example, the framework can call the function MODULE_apply() instead of MODULE_VENDOR_apply(). The following files make up this interface:

- Header file MODULE.h - Contains any required definitions/global variables for the interface.
- Source File MODULE.c - Contains the source code for the interface functions.

1.2.2.2 Abstract Interface

This interface, also known as the IALG Interface, defines the algorithm implementation. This interface is defined by the algorithm vendor but must comply with the XDAIS rules and guidelines. The following files make up this interface:

- Header file `iMODULE.h` - Contains table of implemented functions, also known as the IALG function table, and definition of the parameter structures and module objects.
- Source File `iMODULE.c` - Contains the default parameter structure for the algorithm.

1.2.2.3 Vendor Implementation

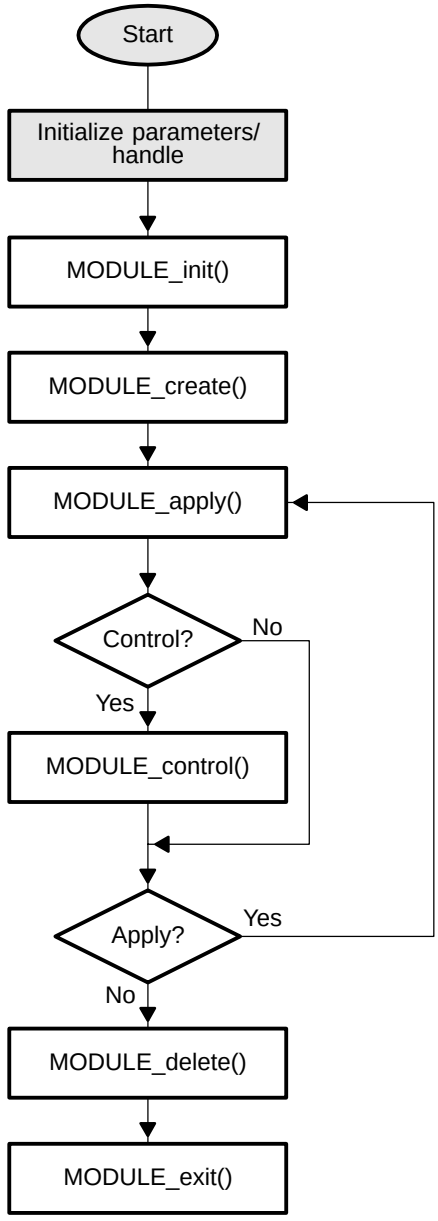
Vendor implementation refers to the set of functions implemented by the algorithm vendor to match the interface. These include the core processing functions required by the algorithm and some control-type functions required. A table is built with pointers to all of these functions, and this table is known as the function table. The function table allows the framework to invoke any of the algorithm functions through a single handle. The algorithm instance object definition is also done here. This instance object is a structure containing the function table (table of implemented functions) and pointers to instance buffers required by the algorithm.

1.2.3 Application Development

Figure 1-3 illustrates the steps used to develop an application. This flowchart illustrates the creation, use, and deletion of an algorithm. The handle to the instance object (and function table) is obtained through creation of an instance of the algorithm. It is a pointer to the instance object. Per XDAIS guidelines, software API allows direct access to the instance data buffers, but algorithms provided by SPIRIT prohibit access.

Detailed flow charts for each particular algorithm is provided by the vendor.

Figure 1-3. Module Instance Lifetime



The steps below describe the steps illustrated in Figure 1-3.

Step 1: Perform all non-XDAIS initializations and definitions. This may include creation of input and output data buffers by the framework, as well as device driver initialization.

Step 2: Define and initialize required parameters, status structures, and handle declarations.

Step 3: Invoke the `MODULE_init()` function to initialize the algorithm module. This function returns nothing. For most algorithms, this function does nothing.

Step 4: Invoke the `MODULE_create()` function, with the vendor's implementation ID for the algorithm, to create an instance of the algorithm. The `MODULE_create()` function returns a handle to the created instance. You may create as many instances as the framework can support.

Step 5: Invoke the `MODULE_apply()` function to process some data when the framework signals that processing is required. Using this function is not obligatory and vendor can supply the user with his own set of functions to obtain necessary processing.

Step 6: If required, the `MODULE_control()` function may be invoked to read or modify the algorithm status information. This function also is optional. Vendor can provide other methods for status reporting and control.

Step 7: When all processing is done, the `MODULE_delete()` function is invoked to delete the instance from the framework. All instance memory is freed up for the framework here.

Step 8: Invoke the `MODULE_exit()` function to remove the module from the framework. For most algorithms, this function does nothing.

The integration flow of specific algorithms can be quite different from the sequence described above due to several reasons:

- Specific algorithms can work with data frames of various lengths and formats. Applications can require more robust and effective methods for error handling and reporting.

- Instead of using the `MODULE_apply()` function, SPIRIT Corp. algorithms use extended interface for data processing, thereby encapsulating data buffering within XDAIS object. This provides the user with a more reliable method of data exchange.

1.3 Limitations

This implementation supports all mandatory procedures defined in ETS 300 648, ETS 300 649, ETS 300 659-1, ETS 300 659-2, ETS 300 778-1, ETS 300 778-2, CCITT Recommendation V.23. However, limitations for using optional features are listed below.

Recommendation	Limitation
ETS 300 659-1	Annex G. Qualification parameter encoding is not supported.
ETS 300 778-1	Annexes D.5, D.7. Mutual exclusion of parameters is not verified.
CCITT Recommendation V.23	600 bps bit rate is not supported.

Chapter 2

Caller ID Integration

This chapter provides descriptions, digarms, examples and explanations of the various states of CID integration.

Topic **Page**

2.1 Overview

The basic concept of SPIRIT's implementation of CallerID is that at any moment, the CID object can be configured for detection or transmission of a particular CallerID signal and can be switched to any one of states listed below:

- ❏ DT-AS (CAS) signal detector
- ❏ FSK carrier (mark bit) detector
- ❏ FSK message (including data-link layer) detector
- ❏ TE-ACK signal generator
- ❏ DT-AS signal generator
- ❏ TE-ACK detector
- ❏ SAS signal generator
- ❏ FSK message generator
- ❏ DTMF-based message decoder
- ❏ DTMF-based message generator

The state of a CID object can be changed at any moment by calling `CID_setState()`. Selecting state `CID_WAIT` allows for delay insertion between detection stages. The CID object automatically leaves the selected state upon any of the following events:

- ❏ A timeout has expired.
- ❏ Signal generation was completed.
- ❏ An incoming signal was detected (includes incorrect detection).

Table 2-1 briefly describes the CallerID signal states.

Table 2-1. Brief Description of Caller ID States

Enumeration	Action
(a) Common states	
CID_DONOTHING	does nothing
CID_WAIT	waits for timeout expiration

Table 2-1. Brief Description of Caller ID States (Continued)

Enumeration	Action
(b) TE (CPE) side	
CID_DTAS	receives DTAS signal
CID_TEACK	generates TEACK signal
CID_FSKDET	receives FSK carrier (find mark bit)
CID_FSK	receives FSK message (including data-link layer)
CID_DTMFDET	receives DTMF-based message and converts it into generic data-link layer
(c) LE side	
CID_DTASGEN	generates DT-AS signal
CID_TEACKDET	receives TE-ACK signal from TE
CID_DTASTEACK	generates DT-AS signal and receives TE-ACK signal from TE simultaneously
CID_SAS	generates SAS signal
CID_FSKGEN	generates V.23 of Bell 202 FSK modulated message
CID_DTMFGEN	generates DTMF-based message

Decoded FSK and DTMF messages are automatically converted into common data-link layer format, allowing them to be processed without modification to host software[1].

Complete implementation of CallerID protocol is represented by consecutive switching of CID object states.

Figure 2-1 illustrates typical CallerID sequencing during CallerID detection on Call Waiting.

Figure 2-2 illustrates typical CallerID sequencing during on-hook state. Some timeouts and parameters of signals can be selected by local network operators.

Network operators in some countries use different signaling protocols for CallerID. The most common options are listed in chapter Chapter 3.

[1] Also SPIRIT Corp. supplies algorithms for R1.5 (Russian) CallerID detection in this manner.

2.2 Integration Flow

In order to integrate CallerID into a framework the user should:

Step 1: Create a `CID_Params` structure and initialize it with the required parameters.

Step 2: Call `CID_create()` to create the instance of CallerID.

Step 3: Select the required mode of CID object by using `CID_setState()`.

Step 4: Receive or transmit samples according to the selected mode.

Step 5: Check current object state by using `CID_getState()`. Repeat Step 4 and Step 5 until the object cannot be switched to `CID_DONOTING` state.

Step 6: Perform additional actions associated with error code returned by `CID_getLastError()`.

Step 7: Repeat Step 3 through Step 6.

Step 8: Call `CID_delete` to delete the instance of CallerID.

Figure 2-1. Typical CallerID Flowchart During Off Hook (on call waiting)

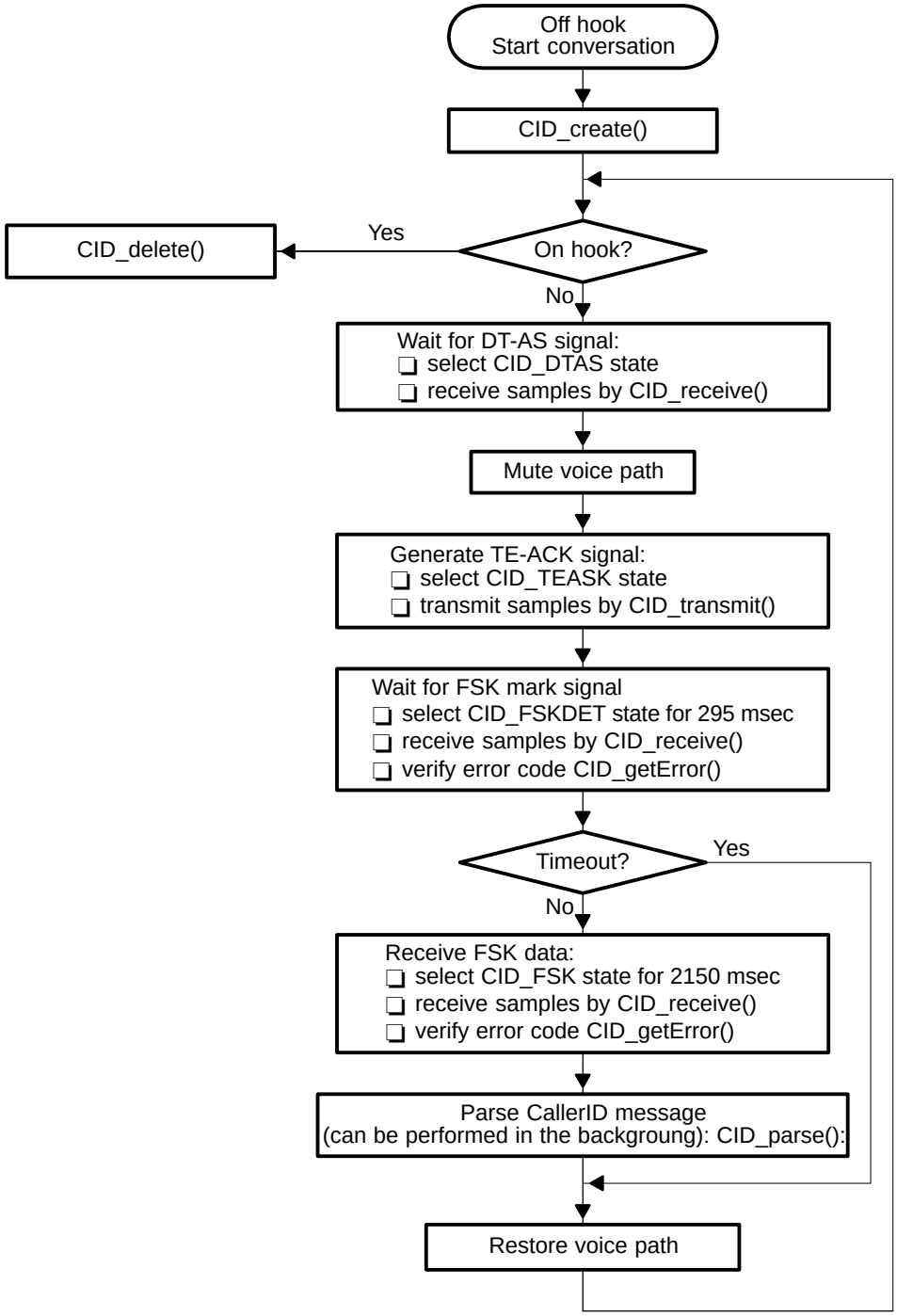
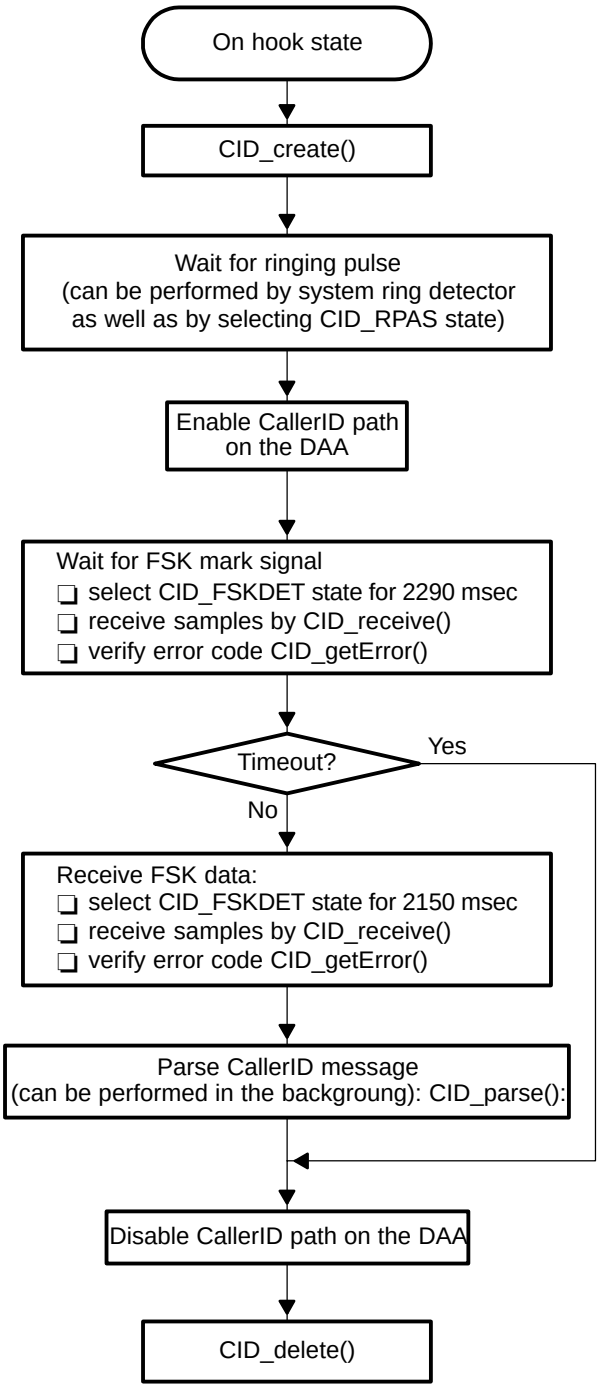


Figure 2-2. Typical CallerID Flowchart During On Hook



2.3 International Support

Network operators have the option to use several types of Caller ID. They are classified in the following categories:

- ❑ Caller ID associated with ringing.
- ❑ Caller ID prior to ringing.
- ❑ Caller ID on Call Waiting.

The categories differ by execution sequence and timeouts. Typical sequences are listed in Table 2-2. Strict complicity of real parameters with this list is not mandatory and can be subject to changes according to specific settings of the actual operator.

Table 2-2. Caller ID Network-Specific Protocols Summary

Type	Alert Signal	State	Reference
Caller ID associated with ringing (Type I)	First ring pattern	On hook	Table 2-3, Figure 2-2
Caller ID prior to ringing	DT-AS	On hook	Table 2-4
Caller ID prior to ringing	Ringing Pulse	On hook	Table 2-5
Caller ID prior to ringing	Line reversal followed by a DT-AS	On hook	Table 2-6
Caller ID on Call Waiting (Type II)	DT-AS	Off hook	Table 2-7, Figure 2-1

Operations of CallerID on the CPE side (terminal equipment) and on LE side (network end) are substantially different. Section 2.3.1 contains typical sequences for CPE side and section 2.3.2 contains summarized LE operations.

2.3.1 CPE Side Operation

Table 2-3. Caller ID Associated With Ringing (Type I) - CPE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Wait for the first ring pattern	N/A	N/A
Turn on CallerID path	N/A	N/A
Wait for FSK modulation†	CID_FSKDET	2290
Receive the message	CID_FSK	2150
Parse and indicate the message	CID_Parse()	N/A
Turn off CallerID path	N/A	N/A

† Starts after the end of ring.

Table 2-4. Caller ID Prior to Ringing Alerted by DT-AS - CPE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Turn on CallerID path	N/A	N/A
Wait for DT-AS signal	CID_DTAS	infinite (0)
Wait for FSK modulation	CID_FSKDET	790
Receive the message	CID_FSK	2150
Parse and indicate the message	CID_Parse()	N/A

Table 2-5. Caller ID Prior to Ringing Alerted by Ringing Pulse - CPE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Wait for the first ringing pulse	N/A	N/A
Turn on CallerID path	N/A	N/A
Wait for FSK modulation†	CID_FSKDET	1090
Receive the message	CID_FSK	2150
Parse and indicate the message	CID_Parse()	N/A

† Starts on trailing edge of ringing pulse.

Table 2-6. Caller ID Prior to Ringing Alerted by Line Reversal + DT-AS - CPE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Wait for line reversal	N/A	N/A
Apply AC/DC load and DC wetting pulse (optionally)	N/A	N/A
Turn on CallerID path	N/A	N/A
Wait for DT-AS signal†	CID_DTAS	655
Wait for FSK modulation	CID_FSKDET	1090
Receive the message	CID_FSK	2150
Parse and indicate the message	CID_Parse()	N/A
Wait	CID_WAIT	100
Remove AC/DC load (optionally) and turn off CallerID path	N/A	N/A

† Starts on line reversal detection.

Table 2-7. Caller ID on Call Waiting. CPE side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Wait for DT-AS signal†	CID_DTAS	infinite (0)
Block speech path	N/A	N/A
Send TE-ACK acknowledgement	CID_TEACK	300
Wait for FSK modulation	CID_FSKDET	295
Receive the message	CID_FSK	2150
Parse and indicate the message	CID_Parse()	N/A
Wait	CID_WAIT	40…120
Restore speech path	N/A	

† Good talk-off performance of DT-AS detector offers waiting during the whole off-hook state.

Notes: CPE Side Operations

- ❑ All timeouts include appropriated detection delays.
- ❑ Timeouts for FSK modulation include maximum channel seizure duration 315 bits for SIN227 standard. In some countries, these timeouts can be reduced.
- ❑ In case of any error, Caller ID path should be turned off if it was enabled previously.
- ❑ Although ringing pulse duration should be in 200…300 msec range, in some networks it may extend to 450 msec and be accompanied by a polarity reversal. Also, any frequency in range of 15 to 75 Hz should be accepted.
- ❑ Some exchanges (for example, complying with SIN227 standard) require AC or DC load switching in addition to enabling Caller ID path in on-hook state. The detailed operation is described in appropriate recommendations (see Calling Line Identification Service, British Telecommunication plc, SIN227, Issue 03 and Calling Line Identification Service, TE Equipment Requirement, British Telecommunication plc, SIN242, Issue 02, Nov., 1996).

2.3.2 Local Exchange Side Operation

Table 2-8 through Table 2-12 characterize optimal methods for using Caller-ID software on LE side. Some implementations require more complicated state machines to accomplish more robust operations, but using the CID object will provide basic processing.

Timeouts listed below are subject to change according the specific country standards and indicate typical values for most European countries.

Table 2-8. Caller ID Associated With Ringing (Type I) - LE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Encode the message	CID_Parse()	N/A
Send the first ring pattern	N/A	N/A
Wait†	CID_WAIT	800
Send FSK modulation	CID_FSKGEN	2290

† After the end of ring.

Table 2-9. Caller ID Prior to Ringing Alerted by DT-AS - LE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Encode the message	CID_Parse()	N/A
Send DT-AS signal	CID_DTASGEN	150
Wait	CID_WAIT	300
Send FSK modulation	CID_FSKGEN	2290

Table 2-10. Caller ID Prior to Ringing Alerted by Ringing Pulse - LE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Encode the message	CID_Parse()	N/A
Send ringing pulse	N/A	N/A
Wait	CID_WAIT	650
Send FSK modulation	CID_FSKGEN	2290

Table 2-11. Caller ID Prior to Ringing Alerted by Line Reversal + DT-AS - LE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Encode the message	CID_Parse()	N/A
Change polarity	N/A	N/A
Wait	CID_WAIT	200
Send DT-AS signal	CID_DTASGEN	150
Wait	CID_WAIT	300
Send FSK modulation	CID_FSKGEN	2290

Table 2-12. Caller ID on Call Waiting - LE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Encode the message	CID_Parse()	N/A
Block speech path	N/A	N/A
Wait	CID_WAIT	100
Send DT-AS signal and receive TE-ACK†	CID_DTASTEACK	185
Wait	CID_WAIT	70
Send FSK modulation	CID_FSKGEN	2290
Wait	CID_WAIT	40
Restore speech path	N/A	N/A

† When no TE-ACK signal is received, restore speech path in <150 msec.

2.3.3 DTMF-Based CallerID Reception and Transmission

Various network operators use DTMF-based signaling protocol to provide subscribers with information about the calling party. SPIRIT's implementation of CallerID contains complete DTMF message decoders and message generators that acquire data in common data-link format and converts them into DTMF digits internally.

Table 2-13. DTMF-Based Caller ID operation - CPE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Wait for DIT state: ❑ wait for line reversal ❑ detect the voltage has reached at least 30 V	N/A	N/A
Turn on CallerID path	N/A	N/A
Receive DTMF-message	CID_DTMFDET	4000
Parse and indicate the message	CID_Parse()	N/A
Wait	CID_WAIT	40…120
Turn on CallerID path	N/A	N/A

Table 2-14. DTMF-Based Caller ID Operation - LE Side

Action	Associated CID Object State or Method	Duration (Timeout), msec
Encode the message	CID_Parse()	N/A
Reverse polarity	N/A	N/A
Wait	CID_WAIT	100
Send DTMF-message	CID_DTMFGEN	4000
Wait	CID_WAIT	50

2.4 Specific Issues

2.4.1 Link-Time Configurable Options

SPIRIT Corp.'s implementation of CallerID allows the user a choice of software options that operate both at run-time and link-time by using parameters only. Whenever parts of functionality are not utilized, Link-time configurability removes program memory overhead.

For example, in typical cases, the SAS generation can be skipped. The user has the option of selecting the `&CID_STD` parameter on CID object creation. CallerID parts relevant to processing will be linked. Unused library sections will not be linked.

Table 3-3 lists the sets of available link-time options.

Note: CID object delivery and CID libraries

When a CID object is delivered as a part of a ROM-based system and package contains no CID library itself, only a part of the functionality can be linked in ROM. In this case, any attempt to use missing options will cause a linker error. If you need to extend the given set of options, request the full version of object library from SPIRIT Corp.

In TMS320C54CST device, only `CID_STD` option (CallerID types 1 and 2 on CPE side) is supported inside of ROM.

2.4.2 Detection Delays

Each kind of detector stage introduces a specific delay. These types of delays are summarized in Table 2-15. Additionally, real delay depends on the size of buffer passed to the detector. A delay cannot be less than `buffer_size/8` [msec].

Table 2-15. Caller ID Detection Delays

State	Delay, msec
`CID_DONOTHING`	N/A
`CID_SAS`	N/A
`CID_DTAS`	25 … mDTAS.mDuration+25, see Table 3-2 and Table 3-5
`CID_TEACK`	N/A
`CID_FSKDET`	25
`CID_FSK`	4, At first, detector waits for modulation during `mBITSYNC.mMarkTimeout*0.833` msec (see Table 3-2 and Table 3-8). Later, detector leaves its state when no FSK pulse is arrived during 1.25 msec (1.5 bits periods)
`CID_DTASGEN`	N/A
`CID_TEACKDET`	13
`CID_DTASTEACK`	13
`CID_FSKGEN`	N/A
`CID_WAIT`	0

2.5 Integration by Using the `CIDWRAPPER` Class

SPIRIT Corp. supplies a complete CID API including a simple wrapper class `CIDWRAPPER`. This class contains a state machine for consecutive executions of CID object states and allows easy implementation of any Caller ID standard.

API functions of this class are described in section 3.5.

2.6 Example of a Call Sequence

The example below demonstrates a typical call sequence for CallerID on Call Waiting (Type II). A similar example is available in `Src\FlexExamples\StandaloneXDAS\CallerID\main.c`.

```
XDAS_Int16 len, samples[100];
static const CID_Sequence seq []=
{
   {CID_DTAS, 0, 0},       // infinite waiting for Dual-Tone Alert Signal from LE
   {CID_TEACK, 100, 1},    // generate TE Acknowlegment Signal
   {CID_FSKDET, 300, 1},   // wait for FSK carrier (300 msec)
   {CID_FSK,  2150, 1},    // receive Data-Link Message
   {CID_DONOTHING, 0, 0}
};
CIDWRAPPER        cidWrapper;
CIDWRAPPER_State  wrpState;
CID_Handle        handle;
   // create CID object
   CIDWRAPPER_create (&cidWrapper, handle, seq);
   while ( !(wrpState=CIDWRAPPER_getState (&cidWrapper)).mIsCompleted )
{
       if (wrpState.mIsTransmitter)
   {
       CIDWRAPPER_transmit (&cidWrapper, samples, 100);
       writeNext (samples, 100);
   }
   else
   {
       len = readNext(samples,100);
       CIDWRAPPER_receive(&cidWrapper, samples, len);
   }
}
       if (wrpState.mLastError)
{
       switch (seq[wrpState.mSequenceIndex].mState)
   {
       case CID_FSKDET: printf (”FSK mark signal is not found\n”);break;
       case CID_FSK:           printf (”FSK message is not found\n”); break;
   }
}
```

Chapter 3

CallerID (CID) API Descriptions

This chapter provides the user with a clear understanding of CallerID (CID) algorithms and their implementation with the TMS320 DSP Algorithm Standard interface (XDAIS).

Topic **Page**

3.1 Standard Interface Structures

This section describes Standard parameter structures for Caller ID.

Table 3-1 lists the standard Interface Structures for CallerID API.

Table 3-1. CallerID Standard Interface Structures

Parameters	Located in Table...
Instance Creation	Table 3-2
Link-Time Configurable Options	Table 3-3
SAS Signal	Table 3-4
DT-AS Detector	Table 3-5
TE-ACK Signal	Table 3-6
FSK Carrier Detector	Table 3-7
Bit Synchronizer	Table 3-8
DT-AS Generator	Table 3-9
TE-ACK Detector	Table 3-10
FSK Generator	Table 3-11
DTMF Decoder	Table 3-12
DTMF Encoder	Table 3-13
Russian Caller ID	Table 3-14

3.1.1 Instance Creation Parameters

Description This structure defines the creation parameters for the algorithm. A default parameter structure is defined in "iCID.c".

Client has to specify basic Caller ID parameters in ICID_Params on creation of the CID detector (see CID_create() function, section 3.2.3).

Structure Definition

Table 3-2. Instance Creation Parameters

```
typedef struct ICID_Params {
```

Parameter type	Parameter Name	Description	Affected States (see Table 3-17) or Functions
const CID_Options*	options	Link-time configurable options (see Table 3-3)	all
CID_DataLinkMessage*	pMessage	Pointer to the parsed message. Make sure that mpMessage is not out of scope during the lifetime of CID_Handle (see Table 3-18)	CID_FSKG, CID_FSKGEN, CID_parse()
XDAS_Int16	maxLevel	Maximum level of input signal.	
CID_SASGenSignal	sasGen	SAS signal parameters (see Table 3-4)	CID_SAS
CID_DTASDetSignal	dtasDet	DT-AS signal parameters (see Table 3-5)	CID_DTAS
CID_TEACKGenSignal	teackGen	TE-ACK signal parameters (see Table 3-6)	CID_TEACK
CID_FSKDetSignal	fskDet	FSK carrier detector parameters (see Table 3-7)	CID_FSKDET
CID_BitSyncSignal	bitSync	Bit synchronizer parameters (see Table 3-8)	CID_FSK
CID_DTASGenSignal	dtasGen	DT-AS signal generator parameters (see Table 3-9)	CID_DTASGEN, CID_DTASTEACK
CID_TEACKDetSignal	teackDet	TE-ACK signal detector parameters (see Table 3-10)	CID_TEACKDET, CID_DTASTEACK
CID_FSKGenSignal	fskGen	FSK generator parameters (see Table 3-11)	CID_FSKGEN
CID_DTMFDetSignal	dtmfDet	DTMF-message decoder parameters (see Table 3-12)	CID_DTMFDET
CID_DTMFGenSignal	dtmfGen	DTMF-message encoder parameters (see Table 3-13)	CID_DTMFGEN
CID_R15Signal	r15	Russian Caller ID detector parameters (see Table 3-14)	CID_R15

```
} ICID_Params
```

Type ICID_Params is defined in "iCID.h". The following types are used:

3.1.2 Link-Time Configurable Options

Table 3-3. Link-Time Configurable Options

Option	Supported States (see Table 3-17)	Functionality
&ICID_STD	CID_DTAS CID_TEASK CID_FSK CID_FSKDET CID_WAITK	Limited. Support both CallerID of types 1 and 2 on CPE side.
&ICID_STDDTMF	CID_DTAS CID_TEASK CID_FSK CID_FSDET CID_DTMFDET CID_WAIT	Limited. Support both CallerID of types 1 and 2 on CPE side and DTMF-based subscriber decoder.
&ICID_LE	CID_DTASGEN CID_TEASKDET CID_DTASTEASK CID_FSKGEN CID_SAS CID_DTMFGEN CID_WAIT	Limited. Support both CallerID of types 1, 2 and DTMF-based message generator on local exchange side.
&ICID_FULL	all listed in	Full

3.1.3 SAS Signal Parameters

Table 3-4. SAS Signal Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	duration	200	>0	duration (in msec)
XDAS_Int16	toneLevel	0x4000 (-6 dB)	0…0x7FFF	tone level (Q15.0 format). 0x7FFF corresponds to the full-scale sine-wave.

```
}
CID_SASGenSignal;
```

3.1.4 DT-AS Detector Parameters

Table 3-5. DT-AS Detector Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	duration	50	50…100	minimum acceptable duration (in msec)
XDAS_Int16	twist	0x32F5 (8 dB)	0x2000… 0x7FFF	max tones twist (Q15.0 format)
XDAS_Int16	toneLevel	1036 (-30 dB)	0…0x7FFF	Detector sensitivity. This parameter controls minimum signal level per tone to be accepted by detector. (Q15.0 format - 0x7FFF corresponds to the full-scale sine-wave)
XDAS_Int16	spuriousLevel	0x2000 (-12 dB)	0x1000… 0x4000	Acceptable relative spurious level. (Q15.0 format). Greater values enhance tone recognition, but make worse talk-off performance.

```
}
CID_DTASDetSignal;
```

3.1.5 TE-ACK Signal Parameters

Table 3-6. TE-ACK Signal Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	duration	80	65…90	Duration of TE-ACK signal, msec
XDAS_Int8	dtmfSymbol	’D’	’A’,’B’,’C’,’D’	DTMF symbol to be generated. Network operator option.
XDAS_Int16	toneLevel	00x4000 (-6 dB)	0…0x4000	Generated signal level per tone (Q15.0 format) - 0x7FFF corresponds to the full-scale sine-wave

```
}
CID_TEACKGenSignal;
```

3.1.6 FSK Carrier Detector Parameters

Table 3-7. FSK Carrier Detector Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	toneLevel	583 (-35dB)	100…0x7FFF	Detector sensitivity. This parameter controls minimum signal level per tone to be accepted by detector. (Q15.0 format - 0x7FFF corresponds to the full-scale sine-wave)
XDAS_Int16	spuriousLevel	10362 (-10 dBc)	0x2000… 0x4000	Acceptable relative spurious level. (Q15.0 format). Greater values enhance tone recognition but make worse talk-off performance.

```
}
CID_FSKDetSignal;
```

3.1.7 Bit Synchronizer Parameters

Table 3-8. Bit Synchronizer Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	clockRate	08000	8000	Clock rate (samples per second). Must be equal to 8000.
XDAS_Int16	bitRate	01200	1100…1300	Bit rate (bits per second)
XDAS_Int16	markTimeout	0190	80…300	Maximum mark bit duration (in bit counts)

```
}
CID_BitSyncSignal;
```

3.1.8 DT-AS Generator Parameters

Table 3-9. DT-AS Generator Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	duration	90	50…110	Duration (in msec) of DT-AS signal to be generated
XDAS_Int16	twist	0x3FFF (0 dB)	0x2000… 0x7FFF (-6 …+6dB)	Tone twist (Q14.1 format)
XDAS_Int16	toneLevel	0x4000 (-6 dB)	0…0x7FFF	Generated signal level per tone (Q15.0 format) - 0x7FFF corresponds to the full-scale sine-wave

```
}
CID_DTASGenSignal;
```

3.1.9 TE-ACK Detector Parameters

Table 3-10. TE-ACK Detector Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	duration	50	50…80	Minimum acceptable duration (in msec)
XDAS_Int8	dtmfSymbol	’D’	’A’, ’B’, ’C’ ,’D’, 0	DTMF symbol to be detected. When any of the listed symbols can be accepted, 0 should be passed
XDAS_Int16	twist	0x32F5 (8 dB)	0x2000… 0x7FFF	Max tone twist (Q15.0 format)

Table 3–10. TE-ACK Detector Parameters (Continued)

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	toneLevel	1036 (–30 dB)	0…0x7FFF	Detector sensitivity. This parameter controls minimum signal level per tone to be accepted by detector. (Q15.0 format – 0x7FFF corresponds to the full-scale sine-wave)
XDAS_Int16	spuriousLevel	10362 (–10 dB)	0x1000… 0x4000	Acceptable relative spurious level. (Q15.0 format). Greater values enhance tone recognition but make worse talk-off performance.

```
}
CID_TEACKDetSignal;
```

3.1.10 FSK Generator Parameters

Table 3–11. FSK Generator Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	modulationType	01	0, 1	Used modulation: 0 – Bell 202 1 – V.23
XDAS_Int16	preambleMark	080	55…205	Preamble mark bit duration (in bit counts)
XDAS_Int16	channelSeizure	0120	96…315	Channel seizure duration (in bit counts)
XDAS_Int16	signalLevel	6925 (–13.5 dB)	0…0x7FFF	Level of FSK signal (Q15.0 format) – 0x7FFF corresponds to the full-scale sine-wave

```
}
CID_FSKGenSignal
```

3.1.11 DTMF Decoder Parameters

Table 3-12. DTMF Decoder Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	duration	25	25…80	Minimum acceptable duration (in msec)
XDAS_Int16	twist	0x32F5 (8 dB)	0x2000… 0x7FFF	Maximum acceptable tones twist (Q15.0 format)
XDAS_Int16	toneLevel	1036 (-30 dB)	0…0x7FFF	Detector sensitivity. This parameter controls minimum signal level per tone to be accepted by detector. (Q15.0 format - 0x7FFF corresponds to the full-scale sine-wave)

```
}
CID_DTMFDetSignal;
```

3.1.12 DTMF Encoder Parameters

Table 3-13. DTMF Encoder Parameters

```
typedef struct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	signalLevel	0x4000 (-6 dB)	0…0x7FFF	Level of a signal to be generated (Q15.0 format - 0x7FFF corresponds to the full-scale sine-wave).

```
}
CID_DTMFGenSignal;
```

3.1.13 Russian Caller ID Parameters

Table 3-14. Instance Creation Parameters

```
typedefstruct
{
```

Parameter Type	Parameter Name	Typical Value	Acceptable Limits	Description
XDAS_Int16	genDuration	160	0…0x7FFF	Minimum acceptable duration (in msec)
XDAS_Int16	genAmplitude	0x7fff (0 dB)	0-9	Level of a signal to be generated (Q15.0 format - 0x7FFF corresponds to the full-scale sine-wave).
XDAS_Int16	inquiriesCount	3	250-275	Quantity of inquiries. If this field is equal to zero, the inquiry is not dispatched.
XDAS_Int16	startDelay	260		Delay before sending of inquiry after call.
XDAS_Int16	pauseBetween	50		Pause between inquiries.
XDAS_Int16	detectDuration	1000		Signal analysis duration (in msec).
XDAS_Int16	toneLevel	1036 (-30 dB)	0…0x7FFF	Detector sensitivity. This parameter controls minimum signal level per tone to be accepted by detector. (Q15.0 format - 0x7FFF corresponds to the full-scale sine-wave)
XDAS_Int16	spuriousLevel	10362 (-10 dB)	0x1000… 0x4000	Acceptable relative spurious level. (Q15.0 format). Greater values enhance tone recognition but make worse talk-off performance.

```
}
CID_R15Signal;
```

3.2 Standard Interface Functions

Table 3-15 summarizes the standard Interface functions of CallerID API. These functions are required when using the CID algorithm CID.

CID_apply() and CID_control() are optional, but neither are supported by Spirit Corp.

Table 3-15. CallerID Standard Interface Functions

Functions	Description	See Page...
`CID_init`	Calls the framework initialization function (Algorithm initialization)	3-11
`CID_exit`	Calls the framework exit function (Algorithm deletion)	3-11
`CID_create`	Calls the framework creation function (Instance creation)	3-12
`CID_delete`	Calls the framework deletion function (Instance deletion)	3-12

3.2.1 Algorithm Initialization

CID_init *Calls ALG_init() to initialize a CID algorithm*

Function Prototype `void CID_init()`

Arguments none

Description This function calls the framework initialization function, `ALG_init()`, to initialize the `CID` algorithm. For SPIRIT's CallerID, this function does nothing. It can be skipped and removed from the target code according to *The TMS320 DSP Algorithm Standard (SPRA581)*.

Return Value none

3.2.2 Algorithm Deletion

CID_exit *Calls ALG_exit() to remove a CID algorithm*

Function Prototype `void CID_exit()`

Arguments none

Description This function calls the framework exit function, `ALG_exit()`, to remove the `CID` algorithm.For SPIRIT Corp.'s implementation of CallerID, this function does nothing. It can be skipped and removed from the target code according to The TMS320 DSP Algorithm Standard (SPRA581).

Return Value none

3.2.3 Instance Creation

CID_create *Function called to create a new CID decoder object*

Function Prototype

```
CID_Handle CID_create (const ICID_Fxns *fxns, const ICID_Params *prms);
```

Description

In order to create a new CID decoder object, `CID_create` function should be called. This function calls the framework create function, `ALG_create()`, to create the instance object and perform memory allocation tasks. Global structure `CID_SPCORP_ICID` contains `CID` virtual table supplied by SPIRIT Corp.

Arguments

`ICID_Fxns *`	Pointer to vendor's functions (Implementation ID). Use reference to `CID_SPCORP_ICID` virtual table supplied by SPIRIT Corp.
`ICID_Params *`	Pointer to Parameter Structure (see section 3.1.1). Use `NULL` pointer to load default parameters.

Return Value

`CID_Handle` defined in file "`CID.h`". This is a pointer to the created instance object.

Restrictions

none

3.2.4 Instance Deletion

CID_delete *Function called to delete an instance object*

Function Prototype

```
void CID_delete (CID_Handle handle)
```

Arguments

`CID_Handle`	Instance's handle obtained from `CID_create()`

Description

This function calls the framework delete function, `ALG_delete()`, to delete the instance object and perform memory de-allocation tasks.

Return Value

none

3.3 Vendor-Specific Interface Structures

In the following sections, parameter structures and functions in the SPIRIT's algorithm implementation and interface (extended IALG methods) are described.

Table 3-16 summarizes the list of tables containing SPIRIT's API interface structures.

Table 3-16. CallerID Vendor-Specific Interface Structures

Parameters	Located in Table...
Bitmasks in `CID_Message.validFields`	Table 3-21
Caller ID Error Codes	Table 3-22
Caller ID States	Table 3-17
Data-link Layer	Table 3-18
Message Types	Table 3-20
Presentation Layer	Table 3-19

3.3.1 Caller ID States

CID object can be configured either as transmitter of alert signal or as receiver. Actual state of CallerID object can be retrieved by `CID_getState()` (page 3-22) and established by `CID_setState()` (page 3-21).

Table 3-17. Caller ID States

`typedef enum`

`{`

Enumeration	Mode	State
(a) Common states		
`CID_DONOTHING`	n/a	does nothing
`CID_WAIT`	receiver	does nothing and waits for timeout expiration
(b) TE (CPE) side		
`CID_DTAS`	receiver	receives DTAS signal
`CID_TEACK`	transmitter	generates TEACK signal
`CID_FSKDET`	receiver	receives FSK carrier
`CID_FSK`	receiver	receives FSK message (including data-link layer)
`CID_R15`	receiver	receives Russian CallerID decoder
`CID_DTMFDET`	receiver	receives DTMF-based message and converts it into generic data-link layer
(c) LE side		
`CID_DTASGEN`	transmitter	generates DT-AS signal
`CID_TEACKDET`	receiver	receives TE-ACK signal from TE
`CID_DTASTEACK`	transmitter and receiver	generates DT-AS signal and receives TE-ACK signal from TE simultaneously
`CID_SAS`	transmitter	generates SAS signal
`CID_FSKGEN`	transmitter	generates V.23 of Bell 202 FSK modulated message
`CID_DTMFGEN`	transmitter	generates DTMF-based message

`}`

`CID_State0;`

3.3.2 Data-Link Level Message

Data-link level message structure `CID_DataLinkMessage` contains unformatted bytes that were received during `CID_FSK, CID_DTMFDET` CID object states, and bytes to be transmitted during `CID_FSKGEN, CID_DTMFGEN` states (DTMF-based detector/transmitter automatically converts DTMF-digits into appropriate fields of data-link level message).

Table 3-18. Data-Link Layer Structure

```
typedef struct
{
```

Parameter Type	Parameter Name	Description
XDAS_UInt8	type	Message type 0x04 - SDMF, 0x80 - MDMF (Call Setup), 0x82 - Message Waiting Indicator, 0x86 - Advise of Charge
XDAS_UInt8	length	number of valid bytes in the unformatted message
XDAS_UInt8	presentation[253]	unformatted message
XDAS_UInt8	checksum	checksum
XDAS_UInt16	lastError	last error: 0x00 - no error, 0x10 – checksum error 0x11 - frame length error (unrecoverable) 0x12 – unrecognized message type (unrecoverable)

```
}
CID_DataLinkMessage
```

Data-link layer can be converted into presentation layer and back by using function `CID_parse()`, see section 3.4.6.

3.3.3 Presentation Level Message

Presentation level structure `CID_Message` holds all possible parameters that can be received during the Caller ID transaction. Bit masks in the `validFields` define the set of currently available fields. In any case, all unused fields are set to 0. Fields of this structure are corresponded to clause 7 of Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 1: On hook data transmission, ETS 300 659-1, DE/SPS-03034-1.

Function `CID_parse()` (see 3.4.6) converts both SDMF and MDMF message into the presentation layer. Also, this function provides reverse conversion for using on LE-side equipment.

Table 3-19. Presentation Layer Structure

```
typedef struct
{
```

Parameter Type	Parameter Name	Description
`CID_Messagetype`	`type`	Message type (see Table 3-20)
`XDAS_Int8 [9]`	`date`	Date and time of a call
`XDAS_Int8 [21]`	`callingLineIndentity`	Identifies the origin of a call
`XDAS_Int8 [21]`	`calledLineIndentity`	Identifies the called party
`XDAS_Int8 [51]`	`callingPartyName`	Identifies the name of the party at the origin of a call
`XDAS_Int8 [21]`	`firstLineIndentity`	In case of forwarded call, it identifies the first called party
`XDAS_Int8 [21]`	`redirectedNumber`	In case of forwarded call only
`XDAS_Int8 [21]`	`complementaryCallingLineIndentity`	
`XDAS_int8`	`reasonForAbsence`	The purpose of the Reason for Absence of Calling Line Identity parameter is to describe the reason for absence of Calling Line Identity. Can assume one of 2 values: ('O'): Unavailable (probably out of range) ('P'): Private (CLIR involved) call

Table 3-19. Presentation Layer Structure (Continued)

Parameter Type	Parameter Name	Description
XDAS_int8	reasonForAbsenceOfParty	Describes the reason for absence of the Calling Party Name. Can assume one of 2 values: ('O'): Unavailable ('P'): Private (CLIR involved) call Values in the range 80_{16}-FF_{16} are reserved for network operators.
XDAS_int08	callType	Specifies the type of a call. 01_{16} Voice Call 02_{16} CLI Ring Back in case of free call 03_{16} Calling Name Delivery $7F_{16}$ Set Clock 81_{16} Message Waiting Call Values in the range 82_{16}-FF_{16} are reserved for network operators.
XDAS_int8	visualInicator	The purpose of this parameter is to switch on/off a visual indicator (presence of waiting messages).
XDAS_int16	networkMessageSystemStatus	Specifies the number of waiting messages in the network message system. Zero value means no messages, value of 1 means 1 or unspecified numer of messages in the queue, other values indicate the number of waiting messages.
XDAS_int8	typeOfForwardedCall	Identifies the type of forwarded call: 01_{16}: Call forwarded on busy 02_{16}: Call forwarded on no reply 03_{16}: Unconditional forwarded call 04_{16}: Deflected call (after alerting) 05_{16}: Deflected call (immediate) 06_{16}: Call forwarded on inability to reach mobile subscriber Values in the range $E0_{16}$-FF_{16} are reserved for network operators.

Table 3-19. Presentation Layer Structure (Continued)

Parameter Type	Parameter Name	Description
XDAS_int8	typeOfCallingUser	00_{16}: Origination unknown or unavailable
		03_{16}: Virtual Private Network
		04_{16}: Mobile phone
		05_{16}: Mobile phone + Virtual Private Network
		$0A_{16}$: Ordinary calling subscriber
		$0B_{16}$: Calling subscriber with priority
		$0C_{16}$: Data Call
		$0D_{16}$: Test call
		$0F_{16}$: Payphone
XDAS_Int8 [10]	extension	
XDAS_UInt16	lastError	last error:
		0x00 - no error,
		0x10 - checksum error
		0x11 - frame length error (unrecoverable)
		0x12 - unrecognized message type (unrecoverable)
XDAS_Int16	validFields	Bit mask for available fields (see Table 3-21)

}

CID_Message

Enumeration constants CID_MessageType define currently available message format.

Table 3-20. Message Types

```
typedef struct
{
```

Enumeration Constant	Value	Description
CID_NONE	0	No available messages
CID_SDMF	0x040	Message is in the SDMF format
CID_MDMF	0x800	Message is in the MDMF format
CID_MESSAGEWAITING	0x82	Message is in the VMWI format
CID_ADVISE	0x86	Message contains information about actual balance of payment

```
}
CID_MessageType
```

Bitmasks in `CID_Message.validFields` allow defining the set of valid fields in the currently available Caller ID message. To validate variable `xxx` from presentation level `CID_Message`, you have to perform `AND` operation on `CID_Message.validFields` with bit mask `CID_xxx`.

Table 3-21. Bit Masks in `CID_Message.validFields`

Enumeration	Description
CID_DATE	`CID_Message.date` field is valid
CID_CALLINGLINEINDENTITY	`CID_Message.callingLineIndentity` field is valid
CID_CALLEDLINEINDENTITY	`CID_Message.calledLineIndentity` field is valid
CID_CALLINGPARTYNAME	`CID_Message.callingPartyName` field is valid
CID_FIRSTLINEINDENTITY	`CID_Message.firstLineIndentity` field is valid
CID_REDIRECTEDNUMBER	`CID_Message.redirectedNumber` field is valid
CID_COMPLEMENTARYCALLINGLINEINDENTITY	`CID_Message.complementaryCallingLineIndentity` field is valid
CID_REASONFORABSENCE	`CID_Message.reasonForAbsence` field is valid
CID_REASONFORABSENCEOFPARTY	`CID_Message.reasonForAbsenceOfParty` field is valid
CID_CALLTYPE	`CID_Message.callType field` is valid
CID_VISUALINICATOR	`CID_Message.visualInicator` field is valid

Table 3-21. Bit Masks in `CID_Message.validFields` (Continued)

Enumeration	Description
`CID_NETWORKMESSAGESYSTEMSTATUS`	`CID_Message.networkMessageSystemStatus` field is valid
`CID_EXTENSION`	`CID_Message.extension` field is valid
`CID_TYPEOFFORWARDEDCALL`	`CID_Message.typeOfForwardedCall` field is valid
`CID_TYPEOFCALLINGUSER`	`CID_Message.typeOfCallingUser` field is valid

3.3.4 Caller ID Error Codes

Enumeration constants `CID_Error` define currently available error codes that can be retrieved by `CID_getLastError()` function.

Table 3-22. Caller ID Error Codes

```
typedef struct
{
```

Enumeration Constant	Description
(a) generic error codes	
`CID_NOERROR`	no error
`CID_TIMEOUT`	state was broken due to the timeout
`CID_INVALIDSTATE`	state is not supported or not linked on instance creation (see Table 3-2 and Table 3-3)
(b) specific error codes for `CID_FSK` state	
`CID_CHECKSUMERROR`	checksum error was detected
`CID_ILLEGALLENGTH`	improper message length (less than 3 octets or more than 258 octets)
`CID_UNKNOWNTYPE`	unknown message format (see `CID_MessageType`)

```
}
CID_Error
```

3.4 Vendor-Specific Interface Functions

Table 3-23 summarizes the SPIRIT's API functions of CallerID.

The whole interface is placed in header files `iCID.h`, `CID.h`, `CID_spcorp.h`.

Table 3-23. CallerID-Specific Interface Functions

Name	Functionality	Section
`CID_setState`	Configures state of CID software and sets timeout for this state	3-21
`CID_getState`	Returns current state of CID software	3-22
`CID_getLastError`	Returns error code	3-23
`CID_receive`	Process samples to be received	3-23
`CID_transmit`	Process samples to be transmitted	3-24
`CID_parse`	Parses currently available data-link message into presentation layer structure and vice versa	3-24

3.4.1 Configure the State-of-CID Software

CID_setState *Configures the state of CID software and sets a timeout*

Function Prototype

```
XDAS_Bool CID_setState
(CID_Handle handle,
 CID_State state,
 XDAS_Int16 timeMsec,
 const ICID_Params* params)
```

Arguments

`handle`	Pointer to the CID object
`state`	New state of the CID software (see section 3.3.1)
`timeMsec`	Duration in msec to hold this state. Use 0 if you need to disable the timeout check.
`params`	Parameters of the CID object (see section 3.1.1). When there is no need to change the actual CID parameters during this call, use `NULL` pointer.

Description Configures state-of-CID software and sets timeout for this state. When timeout expires, software automatically selects `CID_DONOTHING` state.

Also, this function is used to change actual CallerID parameters “on-the-fly”. Parameters are copied into the internal structures so there is no need to store them in static memory and lock this memory block. Moreover, they can be allocated on stack and leave the scope upon execution of this routine.

Return Value Always returns `TRUE`

Restrictions Field `mOptions` in `params` (link-time configurable options) is always ignored so the set of selected options can be chosen on object creation only (see function `CID_create()`, section 3.2.3).

3.4.2 Get Current State of CID

CID_getState *Returns current state of CID software*

Function Prototype `CID_State CID_getState(ICID_Handle handle)`

Arguments `handle` Pointer to CID object

Description Returns current state of CID software. `CID_DONOTHING` value indicates that the previously established state was finished.

The reason for switching can be retrieved by calling `CID_getLastError()` (see section 3.4.3)

Return Value Current state of CID (see Table 3-17).

Restrictions Maximum timeout value of state (parameter `timeMsec` of `setState ()`) is limited by 4095 milliseconds.

3.4.3 Get Error Code

CID_getLastError *Determines the cause of state switching*

Function Prototype `CID_Error CID_getLastError (ICID_Handle handle)`

Arguments `handle` Pointer to CID object

Description Call this method to determine the cause of state switching. Returns `CID_NOERROR` if state was switched due to the normal completion of reception/transmission.

Return Value Returns error code according to Table 3-22.

Restrictions none

3.4.4 Process Samples to be Received

CID_receive *Process number of input samples to be received*

Function Prototype

```
XDAS_Bool CID_receive
(ICID_Handle handle,
 const XDAS_Int16 samples[],
 XDAS_Int16 len)
```

Description Process number of input samples. Signal processing is performed according to the CID state previously established by `CID_setState()`(see 3.4.1). While CID object is in the transmitter mode or in the state `CID_DONOTHING`, it does nothing and returns immediately.

Arguments

`handle` Pointer to CID object

`const XDAS_Int16 samples[]` Array of input samples (at sample rate 8 kHz)

`XDAS_Int16 len` Number of samples to be processed

Return Value Returns `TRUE` when reception is finished (see `CID_getState()`)

Restrictions The number of input samples for `receive()` must not exceed 300 (37.5 msec input buffer).

3.4.5 Process Samples to be Transmitted

CID_transmit *Performs signal processing in transmission mode*

Function Prototype

```
XDAS_Bool0  CID_transmit
(ICID_Handle handle,
 XDAS_Int16 samples[],
 XDAS_Int16 len0)
```

Arguments

`handle`	Pointer to CID object
`XDAS_Int16 samples[]`	Array of output samples (at sample rate 8 kHz)
`XDAS_Int16 len`	Number of samples to be processed

Description Perform signal processing in transmission mode according to the CID state previously set by `CID_setState()`. Buffer is filled with zeroes when the CID object is in the receiver mode or in the state `CID_DONOTHING`.

Return Value Returns `TRUE` when transmission is finished (see `CID_getState()`)

Restrictions none

3.4.6 Parse Data-link and Presentation Level Messages

CID_parse *Parses available data-link message into presentation layer structure*

Function Prototype

```
XDAS_Void CID_parse
(ICID_Handle handle,
 CID_Message* presentation,
 XDAS_Bool  direction)
```

Arguments

`handle`	Pointer to CID object
`presentation`	Presentation layer structure. See Table 3-19 for details.
`direction`	Conversion direction: 1 – convert data-link layer message into the presentation level. 0 – convert presentation level message into the data-link layer.

Description

Parses currently available data-link message into presentation layer structure and vice versa. Can be performed even when CallerID reception is failed. Member `validFields` in the `CID_Message` masks available members (see Table 3-21).

Reference to data-link message is set on object creation (section 3.4.3) or establishing the state of CID object (section 3.4.1) in the field `ICID_Params::mpMessage` (see Table 3-2).

Return Value

none

Restrictions

none

3.5 The CIDWRAPPER Class API Reference

The CIDWRAPPER class allows consecutive execution of CallerID states to provide the necessary timeouts, switching and error handling. This class is delivered in open sources and can be used or modified in any way without any submissions to SPIRIT Corp.

Table 3-24 summarizes the Caller ID Wrapper structure classes.

Table 3-24. CIDWRAPPER Class API Reference Table Summary

CIDWRAPPER API Type	Located in Table...
Caller ID Wrapper State	Table 3-25
Caller ID Wrapper Sequence	Table 3-26

3.5.1 Caller ID Wrapper State

Table 3-25. Caller ID Wrapper State

```
typedef struct
{
```

Parameter Type	Parameter Name	Description
XDAS_Bool	isCompleted	TRUE when sequence was completed
XDAS_Bool	isTransmitter	TRUE when Caller ID is transmitter now
CID_Error	lastError	last error state
XDAS_Int16	sequenceIndex	state being processed currently

```
}
CIDWRAPPER_State
```

3.5.2 Caller ID Wrapper Sequence

Table 3-26. Caller ID Wrapper Sequence

```
typedef struct
{
```

Parameter Type	Parameter Name	Description
CID_State	state	CID API state to be established
XDAS_Int16	timeoutMsec	timeout value for state
XDAS_Bool	isBreakOnError	break sequencing when error occurs

```
}
CIDWRAPPER_Sequence;
```

3.5.3 Caller ID Wrapper Functions

Table 3-27 lists the Caller ID Wrapper Functions.

Complete code is contained in the files "CIDWrapper.c", "CIDWrapper.h".

Table 3-27. CIDWRAPPER Functions

Return Type	Method Name	Parameters Type and Name	Description
void	create	CIDWRAPPER *pthis – pointer to CIDWRAPPER object CID_Handle cidHandle – existing handle to the CID object const CID_Sequence seq[] – array of CID_Sequence members.	Recreates CIDWRAPPER object and starts sequential CID operation. End of seq array is marked by seq[xxx].mState==CID_DONOTHING
CIDWRAPPER_State	getState	CIDWRAPPER *pthis – pointer to CID CIDWRAPPER object	Returns current state of CIDWRAPPER object.
void	receive	CIDWRAPPER *pthis – pointer to CID CIDWRAPPER object const XDAS_Int16 samples[] – array of input samples (at sample rate 8 kHz). XDAS_Int16 len – number of samples to be processed	A simple wrapper to the CID receive() method
void	transmit	CIDWRAPPER *pthis – pointer to CID CIDWRAPPER object XDAS_Int16 buffer[] – array of output samples (at sample rate 8 kHz). XDAS_Int16 length – number of samples to be processed	A simple wrapper to the CID transmit() method

Appendix A

Test Environment

Note: Test Environment Location

This chapter describes test environment for the CID object.

For TMS320C54CST device, test environment for standalone CID object is located in the Software Development Kit (SDK) in `Src\FlexExamples\StandaloneXDAS\CallerID`.

Topic **Page**

A.1 Description of Directory Tree

The SDK package includes the test project “CallerID.pjt” and corresponding reference test vectors. The user is free to modify this code as needed, without submissions to SPIRIT Corp.

Table A-1. Test Files for CID

File	Description
main.c	Test file
FileC5x.c	File input/output functions
..\ROM\CSTRom.s54	ROM entry address
Test.cmd	Linker command file
Vectors\output.pcm	Reference output test vectors

A.1.1 Test Vectors Format

All test vectors are raw PCM files with following parameters:

- ❏ Bits per sample - 16, Mono
- ❏ Word format - Intel PCM (LSB goes first)
- ❏ Encoding - Uniform
- ❏ Level - -2 dBF

A.1.2 Test Project

To build and run a project, the following steps must be performed:

Step 1: Open the project: `Project\Open`

Step 2: Build all necessary files: `Project\Rebuild All`

Step 3: Initialize the DSP: `Debug\Reset CPU`

Step 4: Load the output-file: `File\Load program`

Step 5: Run the executable: `Debug\Run`

Once the program finishes testing, the file *Output.pcm* will be written in the current directory. Compare this file with the reference vector contained in the directory *Vectors*.

Note: Test Duration

Since the standard file I/O for EVM is very slow, testing may take several minutes. Test duration does not indicate the real algorithm's throughput.

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