FORM 10-Q/A

Quarterly report pursuant to sections 13 or 15(d) [amend]

Filing Date: **1998-06-19** | Period of Report: **1997-09-30**
SEC Accession No. 0000950135-98-003934

FILER

SUMMA FOUR INC

CIK:**900095**| IRS No.: **020329497** | State of Incorp.:**DE** | Fiscal Year End: **0331**
Type: **10-Q/A** | Act: **34** | File No.: **000-22210** | Film No.: **98651067**
SIC: **3661** Telephone & telegraph apparatus

Mailing Address
25 SUNDIAL AVE
MANCHESTER NH 03103

Business Address
25 SUNDIAL AVE
MANCHESTER NH 03103-7251
6036254050

SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-Q/A
Amendment No. 1 to Form 10-Q

X --- QUARTERLY REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934 ---

For the quarterly period ended SEPTEMBER 30, 1997

__ TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the transition period from ---

Commission File Number 0-22210

SUMMA FOUR, INC.
(Exact name of registrant as specified in its charter)

Delaware	02-0329497
(State of Incorporation)	(IRS Employer Identification Number)

25 Sundial Avenue, Manchester, New Hampshire 03103
(Address of registrant's principal executive office)

(603) 625-4050
(Registrant's telephone number)

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes X No ---

Indicate the number of shares outstanding of each of the issuer's classes of common stock as of the latest practical date.

Common Stock, $.01 par value 5,752,399
Outstanding as of October 31, 1997

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2

SUMMA FOUR, INC.

INDEX TO FORM 10-Q/A

EXHIBIT NO.	DESCRIPTION
10.1	Lease Agreement, dated July 3, 1997, by and between the Registrant and Bay Business Centers, Inc.

10.2	Products and Services Agreement, dated August 4, 1997, by and between the Registrant and D2 Technologies Inc.
10.3	Software License and Maintenance Agreement, dated August 4, 1997, by and between the Company and D2 Technologies, Inc.
11.0	Statement Re: Computation of per Share Earnings (1)
27	Financial Data Schedule (1)

(1) Incorporation herein by reference to the Registrant's Form 10-Q for the Quarter Ended September 30, 1997 filed with the Securities and Exchange Commission on November 12, 1997.

SIGNATURES

Pursuant to the requirements of Securities Exchange Act of 1934, the registrant has duly caused this amendment to the report to be signed on its behalf by the undersigned thereunto duly authorized.

Summa Four, Inc.

Date: June 19, 1998

By: /s/ Jeffrey A. Weber

Jeffrey A. Weber
Vice President and Chief Financial Officer

EXHIBIT 10.1

LEASE AGREEMENT

1. PARTIES

This Lease, dated for reference purposes only, Thursday, July 3, 1997, is made by and between BAY BUSINESS CENTERS, INC., Lessor, and SUMMAFOUR hereinafter called Lessee.

2. PREMISES

Lessee hereby leases from Lessor the premises described as 2121 No. California Boulevard, Suite #290, Walnut Creek, CA 94596, Office #220 & #221.

3. TERM

A one year term shall commence on August 1, 1997, and shall continue until July 31, 1998. Lessee shall give a 60-day notice in writing of its intent to renew or cancel Lease Agreement, prior to termination date of July 31, 1998. If a 60-day notice is not rendered, Lessor will consider Lease Agreement to be renewed for an additional term, at the then going rate. Holdover - in the event Lessee holds over beyond the end of the Lease term, the monthly recurring charges shall be assessed at 150% their monthly rate and the holdover period shall be for no less than one month.

4. POSSESSION

In the event the offices are not available within 30 days of the commencement of the term, Lessee shall have the right to terminate the Lease without further obligation. The parties further agree that if the leased premises are made unusable, in whole or in part by fire or other casualty not due to negligence of Lessee, Lessor may at its option, terminate the lease upon notice to Lessee. In the event the leased premises are not repaired within 90 days, Lessee reserves the right to terminate the Lease. The monthly rent shall be abated on a per diem basis for the portions of the leased premises that are unusable. In the event that Lessor shall permit Lessee to occupy the leased premises prior to the commencement date of the term, such occupancy shall be subject to all of the provisions of this Lease Agreement. Such early possession shall not advance the termination date hereinabove provided.

5. RENT

Lessee agrees to pay Lessor the sum of $1490.00 per month plus $55.00 per phone set for phone equipment rental per month due on the first day of each month. Any installment

2

of rent or any other recurring charge due from Lessee not received by Lessor within five (5) days after such amount is due shall be assessed a late charge equal to ten percent (10%) of such overdue amount plus $50.00. Clerical Services and Other Services incurred shall be invoiced semi-monthly on the 15th and last day of each month. Payment for said services are due and payable within thirty (30) days of billing date. A late charge equal to two percent (2%) plus $10.00 will be assessed on said services if payment is not received within thirty (30) days of billing date. If an installment for rent or invoice for services is overdue more than thirty (30) days, Lessor has the right to discontinue all services upon the thirty-first (31st) day of delinquency. Billing inquiries and/or change of address should be directed towards: Bay Business Centers, Inc., Attn: Accounting Dept., 2010 Crow Canyon Road, Suite #100, San Ramon, California 94583. In the event this Lease Agreement term starts on a day other than the first of the month, the monthly recurring charges shall be prorated for the current month and collected with the first full month plus last month.

The monthly rental rate stated herein is predicated on providing office space and services, as provided in Paragraphs 13 and 14, for 2 person(s).

Additional Reception Service	$100.00/each additional person - w/o voice mail
(receiving calls & callers)	$125.00/each additional person - with voice mail

Lessee hereby agrees to notify Lessor in writing no less than thirty (30) days prior to addition of staff members for which Lessor will provide services.

6. PREPAID RENT & OPENING CHARGES

Concurrently with Lessee's execution of this Lease Agreement, Lessee shall pay the Lessor the sum of:

RECURRING CHARGES (1ST & LAST)
Office Rent(lst & last)(recurring charge) $2980.00
Additional Users (lst & last)(recurring charge) $0.00
Furniture: N/A

(lst and last)(recurring charge) $0.00
Mail Forwarding Service (lst & last)(recurring charge) $0.00
Storage Rental (lst & last) (recurring charge) $0.00
Additional Voice Mail Box Rental
($25/each/month)(lst & last)(recurring charge) $0.00
Voice Mail Paging (lst & last)(recurring charge) $0.00
Phone Line/ISDN Service - Dial Tone
(lst & last)(recurring charge) $360.00
Phone Equipment Rental (lst & last)(recurring charge) $220.00
Speed Dial (lst & last)(recurring charge) $0.00

3

Conference Calling (lst & last)(recurring charge) $0.00
Call Forwarding (lst & last)(recurring charge) $0.00
Delayed Call Forwarding (lst & last)(recurring charge) $0.00
Pacific Bell Directory Listing ($2/mo.)(lst & last)(recurring charge) ...$4.00
Copy Pkg. (lst)(recurring charge) $0.00
Conference Pkg. (lst)(recurring charge) $0.00
Administrative Pkg. (lst)(recurring charge) $0.00
Secretarial Pkg. (lst)(recurring charge) $0.00
Parking (lst & last)(recurring charge) $220.00

ONE-TIME/INSTALLATION CHARGES
Administrative Start-up Fee (one-time charge) $250.00
Additional Users Administrative Start-up Fee (one-time charge) $0.00
Cleaning Fee ($200/Ofc.)(one-time charge) $400.00
Furniture Move Fee (one-time charge) $0.00
Furniture Set-Up Fee (one-time charge) $0.00
Lobby Directory Listing (one-time charge) $40.00
Key Deposit ($65/set X 2 Key Set(s))(refundable) $130.00
Single Key Deposit (N/A) $0.00
Storage Installation (one-time charge) $0.00
Voice Mail Installation (one-time charge) $0.00
ISDN Installation (2 lines plus cable & installation) $1,000.00
Phone Line Installation (4 lines, one-time charge) $480.00
Fax/Modem Install (1 line, one-time charge) $185.00
Phone Equipment Programming (one-time charge) $370.00
Calling Feature Installation (one-time charge) $0.00

TOTAL $6,639.00
=========

*PHONE LINE SERVICE represents monthly fee for dial tone. PHONE LINE USAGE (outgoing calls) is a variable charge and will be billed semi-monthly, due within 10 days of statement date.

7. USE

The premises are to be used for sales and administrative purposes only.

8. CONDITIONS

Lessee shall not disturb, annoy, endanger or inconvenience other tenants in the building or suite, nor use the premises for any immoral, unlawful, or sleeping purposes, nor violate any law or ordinance or commit waste, nuisance or damage upon or about the property.

9. REPAIRS, MAINTENANCE AND ALTERATIONS

Lessee shall at all times during the term hereof, at its sole cost and expense, keep the premises and every part thereof in good condition and repair, except damage thereto by fire, earthquake, act of God or the elements. Lessee hereby waives the right to make repairs at Lessor's expense under any law, statute or ordinance with respect thereto now or hereafter in effect. Unless otherwise expressly provided herein, Lessor shall not be required to make any improvements or repairs of any kind or character on or to the leased premises during the term of this Lease Agreement; however, Landlord will provide routine maintenance for any damage or problems not caused by Lessee. Lessee shall return, upon expiration of this Agreement the premises in their original configuration, design, and condition to Lessor. Lessee shall, at its own cost and expense, repair or replace any damage or injury to the leased premises, or any part thereof, caused by Lessee or Lessee's agents, employees, invitees, licensees, or visitors; provided, however, if Lessee falls to make such repairs or replacements promptly, Lessor may, at its option, make such repairs or replacements, and Lessee shall reimburse the cost thereof to Lessor on demand, together with interest at the maximum annual rate permitted by law from the date of such work.

If Lessee vacates the premises and leaves the premises in a condition requiring painting, carpet cleaning, or other maintenance to restore the premises to leasable condition, a minimum fee of $200.00 per office will be assessed and

confirmed in the termination meeting (if conducted) or within 30 days of date of vacancy.

Lessee agrees to keep a floor mat under any and all chairs with rollers/wheels at all times to protect the carpeting.

10. ABANDONMENT

If Lessee abandons or vacates the premises, Lessor may at its option terminate this Lease Agreement, re-enter the premises and remove all property.

11. ESSENCE OF TIME

Time is of the essence of this Lease Agreement and all provisions hereof.

12. INSURANCE

Lessee shall indemnify and hold harmless Lessor as respects to any bodily injury or property damage arising out of their operations and business conducted on premises. Lessee shall maintain liability insurance in amounts no less than $300,000 combined single limit for bodily injury and property damage. Lessee shall provide Lessor with a certificate of insurance as evidence of the above conditions and Lessor shall be named as an additional insured.

13. SERVICES

Included in the monthly rental specified in Paragraph 5 herein, Lessee shall be entitled to the following clerical and administrative services:

Full-time Receptionist Service (8:30 a.m. - 5:00 p.m., Monday-Friday excluding holidays)	Mail Processing Service Incoming Mail Sorted Outgoing - daily mail 10 pcs.
Telephone Answering 8:30 a.m. - 5:00 p.m. Monday-Friday, by Receptionist, (excluding holidays)	Voice Mail 24 hrs./day, 7 days/week Complimentary 100 Voice Mail Msgs./Box

	Additional messages @ $.35/ea. Access to Office, Building, & Copier 24 hrs./day, 7 days/week
Hourly Office Rental/ Conference Room Facilities By Reservation 4 Hours/month included (non-cumulative)	Access to: Secretarial Services 8:30 a.m. - 5:00 p.m. Monday-Friday, (excluding holidays) (Billed as Utilized, see Exhibit B/C)

Lessee hereby agrees all telephone equipment AND line services will be coordinated by Lessor with Lessor's telephone vendor. Lessee shall not modify nor change outlets, telephone sets, or jacks.

14. SERVICES & NON-SERVICE ITEMS

Services and non-service items shall be invoiced semi-monthly on the 15th and last day of each month. Payment for said services are due and payable within thirty (30) days of billing date. A finance charge of 2% per month will be assessed for all services and recurring charges unpaid beyond 30 days of the invoice date.

At the end of a term, all charges and credits will be applied. It is understood freight bills and vendor charges may take up to 60 days to pass through Lessee, therefore a 90-day period may be required to reimburse credits or conclude final account balance.

If collection time is required due to delinquent account status a fee of $45/hour will be assessed for administrative time at a minimum of $9.00 per collection contact.

SERVICES

Secretarial Service See Exhibit B/C for Rates	Minimum billable unit 1/10 of an hour.
Word Processing (keyboarding) See Exhibit B/C for Rates	Minimum billable unit 3/10 of an hour.

Minimum per page 3/10
of an hour (input).
Editing - Minimum 2/10 of an hour.

Standard Turnaround - 1-3 pages (24 hrs.) 4 or more pages - turnaround determined by Bay Business Centers, Inc.

Lessee agrees that during the term of this Agreement and for six (6) months after its termination will not offer employment to or hire any of the employees of Lessor. If Lessee does not keep that agreement, Lessee will be liable to Lessor for damages in the sum of twenty-five percent (25%) of the annual compensation of each employee involved, it being mutually agreed by Lessee and Lessor that this provision for liquidated damages is reasonable and that the actual damage which would be sustained by Lessor as the result of a failure to keep the agreement would be, from nature of the case, impracticable or extremely difficult to fix.

Further, Lessee shall not provide, utilize, or sell any services or non-service items, which are provided by Bay Business Centers, Inc., as listed on Exhibit B/C to other tenants or clients of Bay Business Centers, Inc., or for any other person or company.

Lessee shall not contract with an independent contractor, temporary personnel agency, or individual for the purpose of providing secretarial, word processing, or any services Bay Business Centers, Inc. provides.

If Lessee wishes to employ an administrative assistant or clerical staff member, it is with the understanding an additional office must be leased from Bay Business Centers, Inc. and prior written approval is obtained from Bay Business Centers, Inc. for its use.

15. NOTICES

In every instance where it shall be necessary or desirable for the Lessee to serve any notice or demand upon the Lessor, such notice or demand shall be sent by United States "Registered" or "Certified" mail, postage prepaid, addressed to:

Ms. Marilyn L. Newton
BAY BUSINESS CENTERS, INC.
2010 Crow Canyon Road, Suite 100
San Ramon, CA 94583

or at such other address of Lessor, as may appear on the records of Lessee. Any notice or demand to be given by the Lessor to the Lessee shall be effective if mailed to (Lessee's administrative office):

Ms. Pam Carter
SUMMAFOUR
25 Sundial Avenue
Manchester, NH 03103

Notice mailed as aforesaid shall be deemed to have been served at the time of postal meter cancellation date.

16. OCCUPANCY/USE OF PREMISES

Lessee shall not assign this Lease nor permit the occupancy or use of any part thereof without the written permission of Lessor.

Lessee will not install or maintain a coffee maker or copier machine in Lessee's office. Lessee further acknowledges smoking is not permitted within the suite and must be restricted to outside of the suite.

17. ATTORNEYS FEES

In an event of any legal action or proceeding brought by either party against the other under this Lease Agreement, the prevailing party shall be entitled to recover all its costs and expenses, including without limitation the fees and costs of appeal, if any, of its attorneys of such action or proceeding in such amount as is reasonable.

LESSEE:	LESSOR:
SUMMAFOUR	BAY BUSINESS CENTERS, INC.
By: /s/ Thomas A. St. Germain	By: /s/ Marilyn Newton
Title: SVP	Title: President
Name Printed: THOMAS A. ST. GERMAIN	Name: Marilyn L. Newton

EXHIBIT 10.2

EFFECTIVE DATE: 4 August 97 _____
AGREEMENT #: _____

CONTRACT FOR PRODUCTS AND SERVICES AGREEMENT

THIS AGREEMENT is made and entered into as of the 4th day of August, 1997, (hereinafter "Effective Date") by and between Summa Four, Inc., a Delaware Corporation with its principal place of business at 25 Sundial Avenue, Manchester, New Hampshire, 03103-7251 (hereinafter "Summa Four"), and the Contractor whose name and address is set forth below (hereinafter "Contractor"):

Company: D2 TECHNOLOGIES, INCORPORATED. MR. DAVID WONG, PRESIDENT
Street: 104 WEST ANAPAMU STREET, SUITE J.
City: SANTA BARBARA
State: CALIFORNIA Zip: 93101

RECITALS

A. Summa Four is engaged in the business of developing, marketing, supporting and selling telephony Product(s), computer Product(s) and related accessories; and

B. Contractor is a company qualified in performing a wide variety of technical services; and

C. Summa Four desires to hire Contractor at will, to provide certain services or products (hereinafter referred to as the "Work Product") as shall be more fully described in an Appendix A attached to this Agreement; and

D. Contractor is desirous of performing the Services for Summa Four as an independent contractor pursuant to the terms hereof.

NOW THEREFORE, in consideration of the mutual promises herein contained, the Parties agree as follows;

1. TERM OF AGREEMENT. This Agreement shall have a maximum duration of 180 working days from the above stated Effective Date. Nevertheless, this Agreement and the Contractor's performance hereunder may be terminated by Summa Four at any time on written notice to Contractor. This Agreement may only be extended by mutual written Agreement of the Parties.

2. NATURE OF WORK. Unless otherwise directed by Summa Four, Contractor shall provide the Work Product set forth in Appendix A.

3. PAYMENT OF CONTRACTOR. During the duration of this Agreement, payment of the compensation is subject to Contractors' continuing satisfactory performance in accordance with Section 4 below. Summa Four shall compensate Contractor in accordance with the provisions of Appendix A.

4. RIGHT OF INSPECTION AND ACCEPTANCE. Contractor shall, at all times, perform services to Summa Four in a responsible and independent manner so as to meet the deliverable time frames of Appendix A. Furthermore, all Services shall be of the highest professional quality and all Work Product to be delivered hereunder shall conform to the specifications therefore or if no specifications have been agreed to by the Parties, be subject to Summa Four's complete satisfaction.

5. INDEMNIFICATION. Contractor hereby certifies that it has obtained all necessary authorizations, permits and approvals and that it is fully licensed and capable of performing the services as specified herein. As such, Contractor shall defend at its own expense all actions or claims made against Summa Four, its employees, or customers, including without limitation, all personal injury, property damage, or Product performance claims which may arise out of or in connection with this Agreement or Contractor's performance of the services for Summa Four and/or delivery of the Work Product. Furthermore, Contractor is solely responsible for and shall indemnify Summa Four against all liability, claim, expense and/or

cost in connection with its performance under this agreement including but not limited to the payment of all federal, state and local taxes or contributions which may be imposed on Contractor or Summa Four including unemployment insurance, social security and income tax levies associated with Contractor's performance under this Agreement.

6. INDEPENDENCE OF ACTION. Nothing herein shall be deemed to restrict Summa Four's right to perform the Work Product for itself or develop similar or like Work Product(s) or to retain other contractors or third parties to provide Similar Services and/or Work Product upon such terms and conditions as it deems appropriate.

7. TERMINATION OF AGREEMENT. This Agreement may be terminated at any time, for any reason, by Summa Four, except that in the event of any termination of this Agreement for the convenience of Summa Four and not for cause or other matters attributable to Contractor, Summa Four shall give 30 days prior written notice of termination. Upon any such termination, Contractor shall promptly deliver to Summa Four any and all Work Product (including but not limited to any other materials, products, supplies and/or Confidential

Information of or to be returned to Summa Four hereunder) completed as of the date of such termination. To the extent that any payment(s) are due therefor, such payment(s) shall be made in accordance with Articles 3, 4 and Appendix A hereof.

8. CONTRACTOR'S SERVICES FOR OTHERS. It is agreed that since Contractor, during the term of this Agreement, and any renewals hereof, will acquire or have access to Summa Four Confidential Information as hereinafter defined, Contractor agrees not to provide for a period of one year after the termination of this Agreement similar Services to other competitors of Summa Four in the development of a high density programmable switching system that directly competes with Summa Four's VCO product line.

9. NON-DISCLOSURE OF CONFIDENTIAL INFORMATION. The term Confidential Information, unless otherwise indicated, shall mean all information in tangible and/or intangible form disclosed to Contractor or learned by Contractor as a direct or indirect consequence of or through their relationship with Summa Four.

Accordingly, Contractor agrees to be independently bound by Summa Four's current Non-Disclosure Agreement which it has executed in conjunction with this Agreement.

10. REMEDIES. Summa Four reserves all right and remedies it may have in law or equity to enforce performance of this Agreement.

11. PROPRIETARY RIGHTS IN DATA AND DOCUMENTS.

a) Unless otherwise provided for herein, the Parties hereto mutually agree that all title to and ownership of the Work Product as well as any related proprietary rights, including but not limited to those relating to patents, copyrights, trademarks, or trade secrets in any Work Product provided by Contractor to Summa Four in accordance with this Agreement shall belong exclusively to Summa Four. Except for Article 11 b.) below, Contractor agrees that its performance of this Agreement and the resultant Work Product constitute a work for hire relationship. Contractor, shall protect, on behalf of Summa Four, all materials and written documents provided to it by Summa Four and/or which may have been independently generated by Contractor under this Agreement. Contractor agrees that upon termination or expiration of this Agreement for any reason whatsoever, Contractor shall promptly deliver to Summa Four all materials and written documents, as well as all Confidential Information, which Contractor has used, developed, maintained or had access to throughout this Agreement.

b) Appendix B. sets forth certain Contractor owned Algorithms (Algorithms) which shall be modified by Contractor under this Agreement for the use by Summa Four in conjunction with such Algorithms under a separate Product License and Support agreement to be entered into by the Parties. Contractor shall retain all title and ownership of such Algorithms as well as the modifications made thereto under this Agreement. Nevertheless, Contractor

shall grant to Summa Four a perpetual, fully paid, royalty free license to use such modifications (together with the Algorithms) in accordance with the terms of such Product License and Support agreement.

12. Indemnification for Patent and Proprietary Right Claims.

a) Contractor warrants to Summa Four that the Work Product provided by Contractor will not infringe upon or violate any patent, copyright, trade secret or any other proprietary or intellectual property right of any third party. In the event of a claim by a third party against Summa Four, or against any of its employees or customers, asserting or involving a patent, copyright, trade secret or proprietary or intellectual proprietary right violation which concerns the Work Product (except for that specified in Article 12b. below), or any related work tangible or intangible Work Product developed by Contractor for Summa Four, Contractor will defend at its sole expense and will indemnify and hold harmless Summa Four, its employees and its customers against any loss, costs, expense or liability arising out of such claim, whether or not such claim is successful.

b) Appendix B. sets forth certain Contractor owned Algorithms (Algorithms) which shall be licensed to Summa Four under a separate Product License and Support Agreement to be entered into by the Parties. Indemnification for Patent and Proprietary right claims for the algorithms specified in Appendix B is provided under the separate Product License and Support Agreement.

13. WARRANTY. Contractor warrants that the Work Product will perform substantially according to the specifications of Appendices A and C for 90 days after the completion of Integration as specified in Exhibit A.

14. ASSIGNMENT. Contractor may not assign its obligations or responsibilities under this Agreement without the written consent of Summa Four.

15. AGENCY. This Agreement does not appoint the Contractor as the agent or legal representative of Summa Four for any purpose whatsoever. The Contractor has no authority, expressed or implied, to assume or create any obligation or responsibility on behalf of, or in the name of Summa Four, or to bind or represent Summa Four in any manner whatsoever. Unless specifically provided for otherwise in this Agreement, the Contractor shall be solely

responsible for its actions and any and all obligations or liabilities incurred or assumed in the performance of this Agreement.

THE CONTRACTOR ACKNOWLEDGES THAT IT HAS READ THIS AGREEMENT AND UNDERSTANDS AND AGREES TO BE BOUND BY THIS AGREEMENT'S TERMS AND CONDITIONS. THE CONTRACTOR FURTHER AGREES THAT THIS AGREEMENT TOGETHER WITH ITS ATTACHED APPENDIX IS THE COMPLETE AND EXCLUSIVE STATEMENT OF THE UNDERSTANDING OF THE PARTIES REGARDING THIS MATTER AND THAT THIS AGREEMENT SUPERSEDES AND CANCELS ALL PREVIOUS AND CONTEMPORANEOUS WRITTEN AND ORAL AGREEMENTS AND COMMUNICATIONS RELATING TO THE SUBJECT MATTER OF THIS AGREEMENT. THIS AGREEMENT MAY ONLY BE MODIFIED IN WRITING, SIGNED BY AN AUTHORIZED REPRESENTATIVE OF BOTH PARTIES.

The validity, construction and interpretation of this Agreement and the rights and duties of the parties hereto shall be governed by and construed in accordance with the laws of the State of New Hampshire.

IN WITNESS WHEREOF, the parties have executed this Agreement on the day and year first above written.

CONTRACTOR	SUMMA FOUR, INC.
AUTHORIZED SIGNATURE /s/ David Y. Wong	AUTHORIZED SIGNATURE /s/ Dick Swee
NAME (Print or Type) David Wong	NAME (Print of Type) Dick Swee
TITLE President	TITLE Vice President, Engineering
DATE 4 August 1997	DATE 4 August 1997

Summa Four, Inc. AGREEMENT#: _____

APPENDIX A
TO
CONTRACT FOR PRODUCTS AND SERVICES AGREEMENT

1. OVERVIEW

The document defines the deliverables expected from D2 Technologies for the Service Platform Card Project.

The DSP engine that will be used for all deliverables will be the Texas instruments TMS320C548 66MlPS 1 44pQFP part. The DSP Service Resource Module will be the same for all deliverables in this document.

R1.1. All code delivered to Summa Four regarding the requirements defined in this document will be targeted toward the Texas Instruments TMS320C54x family, specifically the TMS320LC548. In the event of availability problems during development, the TMS320LC542 will be considered an optional device for initial development efforts only. All algorithm code will be created compatible between the two devices.

The requirements in this document supersede any contained within the Service Platform Card Engineering Marketing Requirements Document (SPC-EMRD) Summa Four Number 49001650100-0AR. The latter document may only be used for reference where subject material therein is not addressed within this document.

R1.2. The order of document priority for requirement definition is defined as follows (in order of importance, with 1 (one) as the first source):

1. This contract
2. SPC EMRD (49001650100)
3. Further detailed design documentation on specific design sub-sections.

2. GENERAL

R2.1. D2 will deliver VP-Open software and drivers that run on the Summa specific hardware and card architecture.

R2.2. In the interest of maintaining compatibility with the VP-Open software specification and interface standards, VP-Open modifications (if any) made for

Summa Four will not impair the hiture path of the product as other VP-Open compatible algorithms are added to the product's capabilities.

R2.3. D2 will deliver all software for the DSP engine section of the SPC card. This includes (as required), operating systems, diagnostic code, drivers, algorithms, and others as is required to implement the deliverables set forth in this document.

R2.4. Deleted.

R2.5. D2 will provide progress reports for deliverables against this contract via email to the Project Manager (randyr@summa4.com) and the Project Technical Lead (geyer@summa4.com)

R2.6. Where D2 is required to provide documentation or schedules, those items will be provided in hardcopy and softcopy form for Summa Four's permanent records.

R2.7. D2 will demonstrate the ability to generate the executable, downloadable code at Summa for each deliverable. Summa will be required to purchase the appropriate tools and compilers to this end.

R2.8. D2 will be responsible to send personnel as required for the following:
- o Debugging and Software Integration issues that cannot be reasonably resolved over the phone.
- o Demonstration and verification of each deliverable being met if on-site presence to meet same is required.
- o Instances during the algorithm verification phase where algorithm performance or capability is in question, as measured against the requirements in this document.
- o As is required during normal development efforts between two companies to ensure interdependencies to not become drawn out beyond the schedule requirements.
- o As is required during integration of the card software (Summa's) and the DSP software (D2's) on the alpha and beta (first and second spin) hardware.

R2.9. D2 will provide a dedicated technical contact for the period of this contract.

R2.10. D2 will request the quantity of alpha and beta (first and second spin) hardware platform that it requires for its own in-house development and verification. Any such hardware provided by Summa Four will be considered the property of Summa Four, and will be returned upon the completion of this contract or upon other demand of Summa Four, Inc.

R2.11. D2 will assist in the definition of development materials required for both development and continued maintenance of the deliverables within Summa Four (i.e. compilers, development platforms, etc.) which Summa Four will purchase.

R2.12. Source code will be delivered to Summa Four for VP-Open software, diagnostic software, and drivers.

R2.13. An escrow agreement will be executed to protect Summa Four in the event source code is not delivered for the algorithms themselves (see Attachment 2).

R2.14. All software deliverables to Summa Four that are centered around the SPC card architecture, including the drivers, diagnostics, and command/control/response interface protocol and method, will be considered confidential and proprietary and the intellectual property of Summa Four, Inc.

3. COMMAND/CONTROL/RESPONSE ARCHITECTURE

R3.1. The command, control, and response functions will be implemented with the serial protocol intended to support interaction with a single host processor (single host to multi-DSP) utilizing the capabilities of that host processor. The host processor will be a Motorola MPCMH860-50. D2 will work with Summa to implement this protocol within the DSP.

R3.2. D2 and Summa Four will create the necessary documentation (jointly or separately) to completely describe the intended architecture. The effort will begin with D2 providing Summa Four with a detailed 'API' for this interface which is based upon the configuration control and response parameters necessary to implement the algorithms and features detailed in Section 5, Diagnostic Requirements. Summa Four, jointly with D2, will provide the formal definition of the interface based on internal requirements for future product support.

R3.3. The documentation supplied in R3.3 will include definition of the approximate MIPs required to implement the protocol of choice deftned in the architecture chosen.

R3.4. Review and approval of all architectural documentation will be required from D2 and Summa Four before implementation, per our ISO and Software Development Processes.

4. BOOT ARCHITECTURE

R4.1. The 'Boot from TDM or BSP serial port' capability of the TMS320C548 will

be used for booting diagnostic code and application (algorithm) code. D2 will be responsible for implementing all of its deliverable with this as the sole boot mechanism. The will be no local FLASH, PROM, or other semi-permanent memory local and accessible to the DSP device (64K of SRAM will be available).

5. DIAGNOSTIC REQUIREMENTS

R5.1. D2 will deliver diagnostic code that performs the following functions:
- DSP Engine self-test (all DSP device verification and local device verification i.e. SRAM, etc.).
- Checksum downloaded image test.
- Loopback all data or individual timeslots from PCM interface back to PCM interface.
- Provide an "Echo Me Message" in the API.
- Generate a tone on a specified channel, and detect it on another channel.
- Report or verify checksum/fumware version/revision.
- Measure the period of time in between frame sync inputs (intermpts).

R5.2. The diagnostic code developed will reside in the run-time software algorithm deliverables.

R5.3. A separate diagnostic test code module (bootable and stand-alone) will be provided by D2 for use during engineering development for the purpose of proving the hardware platform and basic hostDSP processor communication and boot capability before algorithm integration occurs.

R5.4. Run-time code will be capable of implementing per-timeslot loopback Tx to Rx within the DSP for the purpose of implementing run-time diagnostics as required in the SPC-EMRD.

6. ALGORITHM REQUIREMENTS

R6.1. D2 will provide documentation for each algorithm deliverable which will contain information defining:
- The ported algorithm's performance (ports per DSP resource and MIPS per port, total MIPS of application code including performance of serial interface protocol, etc.)
- The command/control/response interface API subset that the algorithm supports and the rules surrounding the use of the same (if not defined

appropriately and completely within the documentation for the command/control/response interface).
- The algorithm's capabilities for the purpose of advertising to Summa's customers and verification during development test.

7. DTMF RECOGNITION ALGORITHM

R7.1. The following capabilities will be designed into the algorithm:
- Configurable A or [mu]-Law operation.
- Support Bellcore LSSGR section 6 and CCIT/TIITU Q.23 and Q.24 standards.
- Enhanced Noise immunity
- Enhanced Echo immunity

R7.2. It is a requirement that the maximum available features implemented by the algorithm be programmable by the host processor. The host processor will be responsible for maintaining and configuring the parameters surrounding the algorithm's requirements. The algorithm at a minimum will support the following as configurable on a per port, per call basis via the command/control/response interface:
- Frequency tolerance
- Level
- Twist
- Interdigit Time
- Digit Time (Tone Duration)
- Detection of Leading and Trailing Edges
- Capable of detecting sequences of digits with timeout control
- Maximum sequence size will be 40 digits
- Long tone detection, with relaxed detection parameters.

R7.3. Additionally, the algorithm will have these features:
- Elimination of tone bounce
- Supenor talk-off and talk-down performance
- A high-quality porting effort, designed to maximize the number of ports processed per DSP resource
- A minimum of 30 ports per DSP engine, given a DSP engine capacity of 66 MIPS and sufficient SRAM resources

8. CALL PROGRESS ANALYZER ALGORITHM

R8.1. The following capabilities will be designed into this algorithm:
o Support addition of expanded algorithm parameters within the algorithm's capabilities.

o Support for addition of new tones and tone types without algorithm code changes (addition implemented through programmability of algorithm parameters).
o Configurable A or [mu]-Law operation
o Meets or exceeds Bellcore specifications

R8.2. It is a requirement that the maximum available features implemented by the algorithm be programmable by the host processor. The host processor will be responsible for maintaining and configuring the parameters surrounding the algorithm's requirements. The algorithm at a minimum will support the following as configurable on a per port, per call basis via the command/control/response interface:
o All algorithm parameters, including but not limited to:
o Frequency
o Level
o Cadence

R8.3. The algorithm will use the cadence parameters including minimum and maximum timing requirements to determine tone rejection or acceptance. The algorithm shall not report a valid tone detection event if it is outside of the minimum and maximum allowable time window specified by the host processor.

R8.4. D2 will provide its "Call Progress Leamiprofile" capability to characterize CPA signals.

R8.5. Additionally, the algorithm will detect the following:
o 4 unique SITs (Special information Tones) as defined per country variation
o NU (Number Unavailable) tone
o Fax CNG (2 types) and CED as defined in CCITT T.23 specification
o Modem (6 types): Bell 103, 212, 208, V.22, V.32, V.34; transmit and receive for each.

R8.6. The minimum countries supported by the algorithm will be the following:

Argentina	Australia	Belgium
Chile	China	Columbia
Dominican Republic	Finland	Germany
Holland	Hong-Kong	India
Indonesia	Italy	Japan
Korea	Lebanon	Malaysia
Mexico	Morocco	Netherlands
New Zealand	Philippines	Puerto Rico
Singapore	South Africa	Spain
Sweden	Switzerland	Taiwan

Thailand	United Kingdom	United States
Vietnam		

R8.7 D2 will deliver the tone specifications for the above countries based on Summa Four supplied data or published ITU data. The specifications shall be mutually agreed to by D2 and Summa Four. D2 will affirm that it has performed laboratory testing to support all countries outlined above based on the tone specifications agreed to by D2 and Summa Four. Summa Four will loan a VCO-series switch to D2 for this testing.

9. MULTI-FREQUENCY RECOGNITION ALGORITHM

R9.1. The following capabilities will be designed into the algorithm:
o Compliant with Bellcore CCITT/ITU Q400, Q401, Q441, Q442, Q451, Q455, Q457, Q466, Q470, Q471, Q472, Q474, Q475, Q476, and Q478.
o Support all existing variants of MF recognition.
o Configurable A or [mu]-Law operation
o Compliant with Bellcore LSSGR section 6, TR-TSY-000506 Section 6.4,

TR-NWT-000506, and CCITT Q.321, Q.322, and Q.323.
o Generation of backwards MF signals.

R9.2. It is a requirement that the maximum available features implemented by the algorithm be programmable by the host processor. The host processor will be responsible for maintaining and configuring the parameters surrounding the algorithms requirements. The algorithm at a minimum will support the following as configurable on a per port, per call basis via the command/control/response interface as published in the CCITT/ITU specifications and as outlined in R1.7.11:
o Designation
o Frequency tolerance
o Timing (time-outs)
o Tone Pulse duration

R9.3. Additionally, the algorithm will have these features:
o Configurable "No-detect" threshold from European specifications.

R9.4. Tone generation capability will be required to implement the R2 portion of the algorithm.

R9.5. The DSP resource will be responsible to perform the complete R2 protocol, including tone recognition and tone generation for sequences of digits up to a maximum of 40.

13

10. DIGITAL TONE GENERATION ALGORITHM

Tone Generation includes static tones (continually repeating), such as BUSY, RINGBACK and DIAL; as well as the Outpulse channels, which are used for signaling (DTMF, MF, etc.).

R10.1. The SPC will support both types of Tone Generation. The algorithm shall support the following features:
o Full DTMF support (including 4th column), based on Bellcore LSSGR Section 6, CCITT Q.23, and other national standards.
o 6 Additional tone slots
o Configurable [mu]-Law or [mu]-Law generation.
o Support for tones of modulated amplitude.
o Support for four-tone mixes.
o Support for tones of non-constant frequency.
o Support for non-cyclic tones (ex: BONG, Call waiting, DIAL for Call Forwarding).
o Support for tones with adjustable timings.

R10.2. At a minimum, the following will be configurable on a per-port, per call basis via the command/contro1/response interface:
o Frequencies (up to 4)
o Level
o Twist
o Interdigit time
o Digit time (tone duration)
o The maximum outpulse sequence length will be 40 digits
o Modulation
o Frequency sweep

11. TESTING/TECHNOLOGY TRANSFER

R11.1. A test plan with expected and actual results for each of the algorithms will be provided by D2. The test plan will be reviewed for approval by Summa.

R11.2. D2 will provide a 2 day "Technology Transfer" at Summa Four. This will include training, a codeldesign walk-through, and a hands-on session for building and executing the code.

12. SCHEDULE/PAYMENT MILESTONES

A milestone is complete when the deliverable, along with associated documentation, is delivered to and accepted by Summa Four.

14

DELIVERABLE	TARGET DATE	PAYMENT

Progress reports	Weekly	
HDLC Low-level Code (Bit stuff/CRC)	7/21/97	21,034
Algorithm API documentation Algorithm Capabilities documentation Algorithm Performance Measurements (C54x)	7/21/97	12,000
HDLC link layer sw complete	7/21/97	18,800
Software External Design Spec draft	7/21/97	20,000
Software Internal Design Spec	8/14/97	6,000
Algorithm modifications complete	8/15/97	7,500
Nucleus software dev start	7/21/97	15,000
Nucleus sw dev complete	9/12/97	12,000
Diag software spec	7/14/97	2,000
Diag software complete	8/15/97	4,000
Test plan draft	8/22/97	3,000
Test plan complete (with results)	9/12/97	5,000
Pre-Integration Complete	9/15/97	8,000
Integration complete	11/10/97	19,000
Technology transfer start	11/14/97	2,000
Reimbursable expenses (travel, per diem etc.)	as expended	8,000
TOTAL		169,334

Compensation to Contractor for the completion and delivery of Work Product and Services (including integration services) shall be due on the acceptance of same in accordance with the Deliverable Schedule above. The fixed compensation shall be $169,334. Such compensation fee may be changed in the event of a material change in the breadth and/or scope of the Software Design Specification presently agreed upon by the parties and attached as Appendix C. Any such change in the Specification or the fees shall be subject to the mutual agreement of the parties. Contractor integration support shall include up to 2 one week trips to Summa Four headquarters in New Hampshire by one Contractor engineer and shall include services to support at least 2 major revisions of hardware (a major revision defined as one which requires revisions in the DSP software).

13. SUMMA FOUR SUPPLIED EQUIPMENT AND SUPPORT

Summa Four agrees to consign VCO and SPC/SRM hardware to DR as agreed by the parties to enable D2 to perform software testing and integration efforts on a timely basis. Such Equipment shall be consigned in accordance with Summa Four's standard consignment agreement. Summa Four shall also make available qualified engineering support at mutually agreeable times to assist D2 in its development,

integration and testing responsibilities under this agreement if either party fails to meet the performance schedule, the parties shall convene to establish a mutually agreed upon remedial plan to ensure timely completion of the contract. Such remedial plan may include adjustments to the contract in terms of compensation, payment schedules, credits etc, as appropriate.

APPENDIX B
TO

D2 OWNED TECHNOLOGY SPECIFICATION

DTMF Detection and Removal Algorithm	5007-A
Universal Tone Detection Algorithm	50030-A
Multifrequency Tone Detection Algorithm	50028-A
Tone Generation Algorithm	50015-A
Voice Activity Detection and AGC	50013-B

EXHIBIT C

EVP-SRM (DSP) Software Design
Specification

Table of Contents

<TABLE>
<S> <C>

</TABLE>

<TABLE>
<S> <C>

23

1. Introduction

1.1 Open Issues

1. Format of MFcR2 commands/status/parameters needs to be expanded to handle compelled signalling.

2. References and glossary need to be completed.

1.2 Change History

1.3 Purpose of Document

This document is the contract between the Digital Signal Processor (DSP, Service Engine) software developers, the system software developers, and the hardware developers as to what the DSP software does and how it interacts with the hardware and firmware on the Service Resource Module (SRM) and the Service Platform Card (SPC). This document details the architecture, functions, performance, and interface of all DSP functions that run on the DSP.

1.4 Intended Audience

This document is intended for system engineers, hardware engineers, and system software (firmware) engineers developing the SRM.

1.5 Related Documents

This document references the following D2 internal documents:

1. VP Open Software Interface Specification, D2 Technologies, Document Number 70001, February 1995.

2. VP Open System Component User's Guide, D2 Technologies, Document Number 70002, February 1995.

3. SRM Internal Software Design Specification, D2 Technologies, Document Number [TBD], July 1997.

4. HDLC Module: Detailed Software Design Specification, D2 Technologies, Document Number [TBD], June 199?.

This document references the following external documents:

24

1.

1.6 Glossary and Abbreviations

ANS	V.25 Modem Answering Signal
Bellcore	Bell Communications Research
CS4x	Abbreviation for Texas Instruments' family of fixed point digital signal processors based on the TM5320C54 core.
CNG	FAX Calling Tone
CP	Call Progress
CPE	Customer Premise Equipment
DSP	Digital Signal Processor or Digital Signal Processing
DTMF	Dual Tone Multi frequency
PCM	Pulse Code Modulation
RMS	Root Mean Square
SIT	Special Information Tone
SNR	Signal to Noise Ratio
TDM	Time Division Multiplex

25

2. DSP HARDWARE REQUIREMENTS

2.1 Overview

The hardware required for the Service Engine consists of four key components:

1. TMS320LC548PGE-66 processor.
2. Two Buffered Serial Ports
3. One Time Division Multiplexed Interface Serial Port
4. Program and data RAM.

The following sections shall outline the requirements for various subsystems outlined above.

2.2 The TMS320LC548 Processor

The SRM design requires:

1. A TMS320LC548PGE running at 66 MIPS. Additional ports per DSP can be supported if a DSP at a faster speed is used.
2. 64k x 16 of zero wait-state SRAM mapped into both program space (starting at program address 0x0000) and data space (also starting at data address 0x0000).
3. On-chip serial port interface to the TDM highway used for boot loading.

2.3 Two Buffered Serial Ports

The C548 processor has two buffered serial ports, which will be used to route voice data and HDLC messaging to the DSP from the Core Processor.

In the initial software, only one buffered serial port will be used. Where appropriate, however, command and status messages, as well as parameters, will be formatted to allow for usage of both buffered serial ports.

2.4 Interprocessor Communications

The DSP shall be loaded by the Core Processor using the DSP serial boot mode.

Communications between the DSP and the Core Processor is accomplished by using the first 8-bit PCM timeslot on the first buffered serial port of each DSP. The DSP and the Core Processor communicate using point-to-point HDLC protocol over this timeslot.

2.4.1 Loading DSP Programs

A two-stage boot load will be used to load DSP programs. Since the core processor is booting several DSPs with the same image, however, there shall be no signalling from the DSP to the Core Processor during boot.

This is achieved as follows:

- The runtime DSP image shall consist of a boot loader, then several (TBD) zeros, then the actual runtime image.
- The Core Processor shall utilize the standard method of booting the DSP through the TDM port with this image.
- The DSP, upon downloading the boot loader section, will begin executing the boot loader section.
- The boot loader section will reconfigure the memory map, interrupts, and interrupt vectors. Then, the boot loader will monitor the TDM port for the end of the zeros section. This zero section is present simply to allow for a delay between the end of the boot section and the beginning of the runtime image section. Its length will be determined by the maximum delay needed for the boot loader section to execute.
- When the actual runtime image begins to be sent over the TDM port, the boot loader will copy the image to the correct locations.
- When the image is completely downloaded, the boot loader branches to start executing the runtime image.

This method of dual-stage booting is advantageous because the Core Processor can send the same image to all DSPs that use a particular image, and no two-way communication is needed until after the boot. It also allows for booting code into sections of memory not addressable during the ROM boot.

2.4.2 Starting Communications

When the DSP executes the runtime image, the following steps are taken in order:

1. The DSP initializes control bits.
2. The DSP initializes (and preprocesses, if necessary) all parameters.
3. The DSP signals to the Core Processor that it is ready to accept commands.

2.4.3 Steady State Communications

All steady state communications is done using the HDLC protocol over the first timeslot on the first buffered serial port.

2.5 Emulator support

It is often necessary to use an emulator (Texas Instruments' XDS510) to debug the DSP during integration. To provide access for XD5510, there shall be a 14 pin JTAG connector as described in Appendix B of the TMS32054x DSP CPU and Peripherals Reference Set, Volume 1.

3. DSP Software Functions and Architecture

3.1 DSP Functions

The following signal processing functions shall be ported to the SPC.

1. Detection of DTMF signals.

2. Detection of MFR1, MFR2 Forwards, and MFR2 Backwards signals.

3. Detection of call progress (CP) tones and voice activity. CP tones consist of the standard call progress plan tones, in addition to Special Information Tones (SITs) and FAX Modem tones.

4. Generation of DTMF, MFR1, MFR2, call progress, and other tones.

5. Execution of compelled signalling protocols for MFcR2 signalling. This will allow for compelled signalling using any combination of R1, R2 Forwards, and R2 Backwards tones for generation and detection.

3.2 DSP Software Architecture

All DSP software conforms to the VP Open software architecture. All DSP modules work on 64 sample blocks of data (8 ms). in each 8 ms interval, the DSP performs the following functions:

1. Reads data from the buffered serial ports. This includes timeslot data as well as commands from the Core Processor.

2. Interprets the Core Processor commands into calls to selected DSP functions.

3. Sends data to the buffered serial ports. This includes voice data as well as status to the Core Processor.

The scheduling of these functions is handled by the Command and Status Module (CSM) according to the VP Open specification. Detailed description of the code is presented in the following sections, in addition to [3].

3.3 Command and Status Module

In addition to communication with external devices and controlling the data flow within the DSP, the CSM manages which modules are executed on the data. For each command from the Core Processor, the CSM defines a state consisting of a sequence of modules that are run.

The CSM is designed to handle multiple ports in different states. The state machine and the states are designed so that any state transition is allowed. HOWEVER, DUE TO MEMORY AND MIPS CONSTRAINTS, THERE WILL BE SEVERAL VERSIONS OF THE RUN TIME CODE, EACH OF WHICH SUPPORTS A SUBSET OF THE STATES. EACH DSP WOULD THUS BE DEDICATED TO A SUBSET OF THE TOTAL FUNCTIONALITY.

THE THREE SUBSETS OF FUNCTIONALITY WILL BE:

1. DTMF, MFR1, MFR2 FORWARDS, AND MFR2 BACKWARDS DETECTION

2. MFCR2 SIGNALLING AND TONE GENERATION

3. CALL PROGRESS DETECTION

3.4 Major States

3.4.1 DTMF DETECT

The DTMF DETECT state is used by the Core Processor to collect DTMF digits. In

this state, the DTMF detector detects DTMF digits. Reporting of DTMF digits to the Core Processor happens when the requisite number of digits has been collected, or when a time-out has occurred.

[Flow Chart depicting DTMF Detect state]

Figure 3-1: DTMF DETECT state]

30

3.4.2 MF DETECT

The MF DETECT state is used by the Core Processor to collect Multifrequency R1, R2 Forwards, and R2 Backwards digits. Note, however, this is not the state that does compelled signalling. In this state, the MFD detector only DETECTS MF digits. Reporting of detected digits to the Core Processor happens when the requisite number of digits has been collected, or when a time-out has occurred.

[Flow Chart depicting the MF Detect state]

Figure 3-2: MF DETECT State

31

3.4.3 CP DETECT

The CP DETECT state is used by the Core Processor to detect call progress, modem ANS, CNG, SIT, and other call progress-like tones. In this state, the UTD detector detects call progress tones and reports detection of the tones to the Core Processor.

[Flow Chart depicting CP Detect state]

Figure 3-3: CP DETECT State

3.4.4 TONEGEN

The TONEGEN state is used by the Core Processor to generate tones or series of tones. In this state, the GENF module is used to generate the tones.

[Flow Chart depicting Tonegen state]

Figure 3-4: TONEGEN State

3.4.5 MFcR2

The MFcR2 state is used by the Core Processor to do R2 compelled signalling. In this state, the MFD detector detects MF digits, and the GENF tone generator generates MF digits.

[Flow Chart depicting MFcR2 state]

Figure 3-5: MFcR2 State

3.4.6 IDLE

This state is used when a timeslot is not assigned to a voice port, or when there are no signals to be processed. In the IDLE state, there is no processing of Line In or Line Out.

3.5 Multi-port Management

Since all DSP modules are VP Open compatible, the DSP can easily support as many simultaneous phone ports as memory and processor load allow. For each port, memory is allocated for each module. This memory is referred to as the module's object. The module uses the object to maintain its internal state from call to call.

To run multiple ports, the CSM checks to see if there are any state transitions. If there are, the objects for that port are reinitialized as required. Next, the CSM runs all modules for each port with the appropriate data and module objects. The CSM schedules ports on a round robin basis with all ports completing processing on one block of data within the 8 ms block processing time. Finally, the CSM outputs the status and data for all ports and restarts the process by looking for new commands.

4. Signal Processing Algorithm Specification

This section lists the functional and performance requirement of the major DSP algorithms included in the DSP software.

4.1 HDLC Communications

All command, status, and configuration signalling between the Core Processor and the DSP will be sent over the first time slot on the first Buffered Serial Port, utilizing point-to-point HDLC communications.

This algorithm is presented in detail in [4].

4.2 Voice Activity Detection

Voice Activity Detection (VAD) detects voice activity, adapts to background ambient or line noise as well as the presence of echo, classifies voice activity as "early" versus "sustained", and assigns an "effort level" to the speaker that is independent of network loss.

This module is used to detect voice activity in the cP DeteCt state.

4.2.1 Functional requirements:

The Voice Activity Detector discriminates voice activity generated by a caller from background noise (acoustic and line noise) as well as echo and sidetones reflected back to the receive voice path. It also provides an "effort level"

quantity that indicates the level of effort of the caller. The functional and performance requirements are specified to cover a wide range of applications, such as voice activated recordings (as in voice messaging), outbound call classification, digital speech interpolation (DSI), and voice conferencing.

1. The Voice Activity Detector classifies every block of voice data (8 ms long) as "port active" (early detect), "speaker active" (port sustained), and "not active".

2. It provides a measurement that approximates the level of effort exerted by the caller. Such an approximation is made by normalizing the short term RMS of the voice signal by a longer term RMS value. The "effort level" varies between -32 dB and 31 dB, and is at 0 dB when the speaker is speaking at his/her "normal" level.

3. The Voice Activity Detector adapts to background noise up to -24 dBm. Adaptation is 200 ms when the noise level drops, and is approximately 1000 ms when noise rises.

4. The Voice Activity Detector screens out sidetone or echo as speech up to an ERL of -26dB.

4.2.2 Performance Requirements:

The accuracy of the voice Activity detector is measured by the rate of "false detection" (i.e. classifying noise or echo as voice activity) and "clipping" (i.e. classifying voice activity as noise or echo) under different ambient noise and echo conditions.

"Port active" detection under different ambient noise conditions:

1. No perceptible clipping at quiet to modest noise levels of -50 dBm to -40 dBm with nominal levels of speech activity (-20 dBm average power over 2 seconds of speech). No more than 5% of voice onsets is clipped for noisy conditions (noise level from -40 dBm to -30 dBm).

2. No more than 1% of "silence" periods is detected as speech for the modest noise condition. No more than 2% of "silence" is detected as port active for noisy conditions.

3. The performance goals above is met when noise levels change during the test.

"Speaker active" detection under different ambient noise conditions:

1. Speech activity that lasts more than tSUSTAIN is detected as "Sustained" or "Speaker Active".

2. The clipping requirements is better than "Port Activity" detection. Fewer than 0.50/0 of onsets/hour (2.5 per hour) for modest noise condition (-45 dBm) and fewer than 2 % (10 per hour) for high noise condition (-35 dBm) have perceptible clipping.

3. False detection performance (i.e., detecting noise as "speaker active") exceeds those of "port activity" due to tSUSTAIN criteria. No more than 1% (36 seconds per hour) of noise segments is misclassified as "sustained" for modest noise conditions, and no more than 2% (72 seconds per hour) of "silence" is detected as port active for noisy conditions.

"Port active" and "Speaker active" detection in the presence of echo:

1. Less than 1% of residual echo is detected as "port active" - (i.e. 36 sec. per hour) during normal operation of canceller.

2. Less than 0.1 % (i.e. 3.6 sec per hour) of residual echo is detected as "speaker active" or "port sustained" during normal operation of

canceller.

3. Clipping of input speech in the presence of echo is no higher than clipping in the presence of modest to high level of noise.

4.3 DTMF Detection

4.3.1 Functional requirements:

specifies the nominal frequencies for the DTMF digits that must be detected.

<TABLE>
<CAPTION>

	Nominal High Group Frequencies (Hz)			
	1209	1336	1477	1633
Nominal Low Group Frequencies (Hz)	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	*	0	#	D

</TABLE>

Table 4-1: Nominal DTMF Frequencies

1. Detect the presence of all 16 DTMF digits that are produced by different phones on the market under a broad range of network conditions.

2. DTMF digit information is provided as soon as the minimum duration is met. This information is called leading edge detection. This allows the earliest possible response to the digit, such as stopping voice output.

3. The trailing edge of a DTMF digit must be detected. This allows the system to delay any response (such as playing out voice) to the digit until the user has released the DTMF key. The criteria selected for trailing edge detection will debounce DTMF digits.

4. The DSP reports leading and trailing edge in the 8 ms block that they are detected. DTMF events are not buffered.

4.3.2 Performance requirements:

Table 4-2 consists of performance requirements taken from EIA-464A and Bellcore TR-TSY-000181. Also shown is D2's DTMF performance requirements, which is a superset of the EIA and Bellcore requirements.

<TABLE>
<CAPTION>

Characteristic	Bellcore	EIA/TIA-464A	D2
Frequency Deviation	+/-1.5% must accept; +/-3.5% must reject	+/-1.5% must accept; +/-3.5% must reject	Configurable choice of Four sets of must accept/must reject: +/-2.0% accept to +/-3.0% reject +/-2.5% accept to +/-3.5% reject; +/-3.0% accept to +/-4.0% reject; +/-3.5% accept to +/-4.5% reject
Minimum Tone Duration	40 ms must accept; 23 ms must reject	40 ms must accept	Configurable from 24 to 80 ms

Minimum Interdigital Interval	40 ms	40 ms	Configurable from 24 to 80 ms
Minimum Cycle Time	93 ms	93 ms	Configurable from 48 to 160
Accept Levels	0 to -36 dBm must accept; -55 dBm must reject	0 to -25 dBm must accept	0 dBm to configurable minimum (-25 to -45 dBm range)
Twist (ratio of high group power to low)	-8 to +4 dB	-8 to +4 dB	Separately configurable positive and negative twists: +/-4, 6, 8, 10, and 12 dB

<S>	<C>	<C>	<C>
Bellcore talkoff tape	Fewer than 670 total talkoffs; fewer than 330 talkoffs of digits 0-9; fewer than 170 talkoffs of signals* and #.	-	Fewer than 20 talkoffs (with default configuration of 2.5% to 3.5% frequency deviation; 40 msec min tone duration; +/-8 dB twist; -45 dBm min accept level)
Mitel talkoff tape	-	-	0 talkoffs (with default configuration)
SNR	23 dB	15 dB	15 dB
Impulse Noise	Fewer than 14 missed or split digits in Bellcore Impulse Noise Tape No. 201	Fewer than 10 errors in 10,000 tones for EIA test #1; fewer than 500 errors in 10,000 tones for test #2	Pass both Bellcore and EIA/TIA-464A impulse noise requirements
Echo	16 dB Signal-to-Echo ratio at 20 ms; 24 dB at 45 ms	10 dB Signal-to-Echo ratio at 20 ms	Pass both Bellcore and EIA/TIA-464A echo requirements
Dial Tone	DTMF Detection in the presence of dial tone at -15 dBm per dial tone frequency	DTMF Detection in the presence of dial tone at -16 dBm per dial tone frequency	Pass both Bellcore and EIA/TIA-464A requirements for detection of DTMF digits in the presence of dial tone

Table 4-2: DTMF Performance Requirements

Other performance requirements:

1. A leading edge of DTMF digit is signaled during the block in which the minimum duration is met, and the trailing edge is signaled during the block in which the minimum debounce interval is met.

2. Talk-down: DTMF detection must work reliably in the presence of echo (for the maximum allowable output voice level) and with varying levels of DTMF

signals (due to network loss). D2's DTMF detector combined with the echo must meet the performance requirements of Figure 4-1 in the presence echo generated by playing pause-removed voice (male and female) at -18 dBm ASL (averaged over 3 seconds) over a telephone circuit with 15 dB echo return loss (ERL).

[Graph depicting DTMF Talk-down Acceptance Curve]

Figure 4-1: DTMF Talk-down Acceptance Curve

3. Debounce test: Long tones (generated by "hard" key presses) must not be detected as multiple tones in the presence of echo interference or line noise. Combined with the echo canceller, the DTMF detector is required to reliably "debounce" all DTMF digits above -18 dBm in the presence of voice levels below -15 dBm (ASL) and a telephone circuit with echo return loss (ERL) of 15 dB.

4. Double-talk talk-off: Many voice processing hardware or semiconductor manufacturers signficantly degrade the "talk-off" performance of their detector in the presence of voice echo or sidetone to achieve a high level of talk-down performance. This strategy is acceptable in a pure digit-in-voice-out scenario, but for voice conferencing or voice recognition applications, voice could be present in the both the transmit and receive path. In such cases, the DTMF detector must be very robust against "talk-off" in double-talk situations. The talk-off requirements for D2's DTMF detector under double- talk is fewer than 66 talkoffs for the Bellcore talk-off tape.

4.4 Tone Generation

The tone generation module can be programmed to generate any single, dual or amplitude modulated tone required to meet international telecommunications specifications. This functionality is provided by the GENF module, which produces the sum or product of two independently generated sine waves as its output. Each sine wave can be individually parameterized.

4.4.1 Functional requirements:

The GENF module is designed to generate a wide range of DTMF, Call Progress Signals, MF R1/R2, and miscellaneous tones. In order to meet or exceed

international telecommunication specifications, GENF must meet or exceed the following functional requirements.

1. Independent arguments shall be supplied for each frequency for dual tones that GENF generates. Single tones are generated by specifying that one of the dual tone's frequencies is 0 Hz.

2. Independent arguments shall be supplied for the carrier and modulation frequencies for amplitude modulated tones that GENF generates.

3. Arguments shall be supplied that allow the frequency of a tone to be set in the range of 0 to 4000 Hz in 1 Hz units. 4. Arguments shall be supplied that allow the output power to be set in the range of +3 to -50 dBm in 0.5 dB steps.

5. Arguments shall be supplied that allow an amplitude modulated tone's modulation percentage to be set in the range of 0 to 300% in 1% units.

6. The tone duration (make time) shall be specified in 1 ms units. Tone durations shall be specified in the range of 0 to 8191 ms.

7. An unlimited tone duration shall be specified by setting the make duration to -1.

8. The silence duration between tones (break time) shall be specified in 1 ms units. Silence durations shall be specified in the range of 0 to 8191 ms.

9. An unlimited silence duration shall be specified by setting the make

duration to -1 and setting both frequencies of a dual tone to 0 Hz.

10. The GENF module shall allow tones to be generated that meet or exceed EIA/TIA-464 requirement for DTMF and call progress tone generation.

11. The GENF module shall allow tones to be generated that meet or exceed CCITT Blue Book Volume VI Fascicle VI.4 recommendations Q.3l0-Q.490 requirements for MF R1 and R2 tone generation.

12. The GENF module shall generate tones with one to three unique caence pairs (on/off pairs).

4.4.2 Performance Requirements

1. Frequency accuracy shall exceed 1 Hz.

2. Level accuracy shall exceed 0.5 dB.

3. Timing information shall exceed 1 ms accuracy.

4.5 Universal Tone Detector

4.5.1 Overview

The Universal Tone Detector (UTD) is a high configurable tone detector. By changing parameters, this algorithm can classify a wide range of single and dual tone call progress signals generated in a wide variety of countries.

4.5.2 General

Since different tones need different detection heuristics, and tones may have multiple specifications, each tone is tagged with a tone category identifier.

Tone Category	Call Process Signal
1	Modem
2	FAX CNG
3	Audible Ringback
4	Busy
5	Reorder or Congestion
6	Number Unobtainable
7	SIT
8	Dial tone
9	Unknown Tone

Table 4-3: Tone Categories

In addition to specifying a tone category, the parameters include a value that is returned to the application when the tone is detected. This parameter need not be unique. This allows multiple specifications to report the same tone event to the application.

UTD is table driven. Using this approach, the tone detector searches parameter tables for a matching tone. When a tone matches, the tone code determines the

heuristics necessary to completely classify the tone. Also, the tones must be specified in a way that a set of parameters corresponds to either a single tone, a dual tone, or an amplitude modulated tone.

Code	Tone Type
0	Single Tone

1	Dual Tone
2	Modulated Tone

Table 4-4: Call Progress Tone Types

4.5.3 General Functional Requirements

UTD functionally combines a single tone detector and a dual/modulated tone detector into a single module. UTD combines the results of these detectors into a single result.

UTD has the following requirements.

1. The DSP shall indicate that the first ringback has started after at least 400 ms of ringback like signal has been processed, as long as no other tone type is early detected. If more than one type of tone is early detected, the first ringback reporting shall be delayed until either cadence information disqualifies the other types, or tone precedence is used as a 'tie-breaker'.

2. The DSP shall indicate ringback has stopped when ringback is no longer detected.

3. The DSP shall indicate a busy tone has been detected after the requisite number of make and break intervals have been processed, and no other tone category is still a candidate for detection.

4. The DSP shall indicate a reorder tone has been detected after the requisite number of make and break intervals have been processed, and no other tone category is still a candidate for detection.

5. The DSP shall indicate a number unobtainable tone has been detected after the requisite number of make and break intervals have been processed, and no other tone category is still a candidate for detection.

6. In the event that more than one tone is a candidate for detection, detection is delayed until all characteristics that may disqualify any of the candidates are tested (for example, waiting for multiple cadence pairs to occur). If there is still more than one potential tone after all differentiating features have been exhausted, then the tone with the highest precedence is detected. Also, if the tone ceases prior to singling out one candidate tone, then the tone with the highest precedence is detected. Precedence is shown in Table 4-6.

7. The DSP shall supply an early detect flag. This flag shall be valid after the detector has processed no more than 72 ms of a tone. If more than one tone category is early detected, then the early detect flag shall indicate the tone category with the highest precedence.

8. The DSP shall indicate that a modem has been detected if a single tone falls within the specified frequencies for modem tones, the minimum make interval has been exceeded while the average tone power is in excess of the minimum power requirement, and no other tone category is still a candidate for detection.

9. The DSP shall indicate that a FAX CNG tone has been detected if a single tone falls within the specified frequencies for a CNG tone, the requisite number of on/off cadences have been processed, and no other tone category is still a candidate for detection.

10. The DSP shall indicate that a SIT tone has been detected if at least two of the three segments of possible SIT tones have been detected for at least the minimum interval in excess of the minimum power requirement.

11. The DSP shall indicate that an Unknown tone has been detected when it has been determined that a tone has been detected that falls within the specified frequencies for an Unknown tone, the minimum duration has been exceeded, and the tone does not match and other category tones.

4.5.3.1 Tone Detector Performance Requirements

4.5.3.1.1 Single Tones

There are four types of parameters that shall be used to control single tone detection. The variation of each parameter shall be limited by the constraints listed in Table 4-5.

	Minimum	Maximum
Frequency	300 Hz	3300 Hz
Bandwidth	0 Hz	1800 Hz
Duration	100 msec	32760 msec
Minimum Power Level	-45 dBm	3 dBm

Table 4-5: Single Tone Detection Constraints

The frequency detection range shall be specified the Frequency and Bandwidth parameters. Figure 4-2 shows the relationship of these parameters. Note that the bandwidth specification is symmetric about the center frequency.

The Frequency and Bandwidth parameters define a "must detect" range. The detector shall not use frequency criteria to reject any tones which are within the range specified Frequency/Bandwidth parameters. Tones whose frequencies are outside but close to frequency range may be detected.

[Graph depicting frequency domain for a Single Tone]

Figure 4-2: Frequency Domain Representation of tone parameters for a Single Tone

If the Power Level of the detected parameter is greater than the minimum power specified by the parameters, the signal shall not be rejected by Power Level heuristics.

Duration parameters are used to set the allowable duration of a tone. Minimum and maximum tone durations may be specified (make durations). Also, minimum and maximum silence durations between tones may be specified.

4.5.3.1.2 Dual Tones

Dual tones are created by summing two sinusoids. Since each tone can be isolated in the frequency domain, dual tones are specified as a pair of single tones.

Parameters for each tone of a dual pair use the same constraints as single tones. Namely, frequency 1 is the center frequency of the lower tone, and bandwidth1

specifies its frequency tolerance. The same is true for frequency2 and bandwidth2 for the high tone. Figure 4-3 shows the definition of the frequency and bandwidth parameters for a dual tone.

[Graph depicting frequency domain for a Dual Tone]

Figure 4-3: Frequency Domain Representation of Tone Parameters for a Dual Tone

Not all dual tones are detectable by UTD. A dual tone shall detected only when the difference between the two component frequencies is greater than 10 Hz and less than 230 Hz.

4.5.3.1.3 Amplitude Modulated Tones

Amplitude modulated tones are created by multiplying two sinusoids. When analyzed in the frequency domain, a modulated tone looks like three tones. Figure 4- 4 shows the frequency spectrum for a modulated tone.

The tone whose frequency is the average of the other tones is the carrier. The other two tones can be referred to as side lobes. For amplitude modulated tones, frequency1 and bandwidth1 specify the low sidelobe and its tolerance, while frequency2 and bandwidth2 specify the high sidelobe and its tolerance.

[Graph depicting frequency domain for a Modulated Tone]

Figure 4-4: Frequency Domain Representation of Tone Parameters for an Amplitude Modulated Tone

As with dual tones, not all modulated tones will be detected by UTD. Modulated tones shall be detected if the difference between the carrier frequency and the sidelobes is between 10 Hz and 230 Hz.

4.5.3.1.4 Precedence

By assigning a detection precedence to the classification process, tone frequency ranges can overlap. When a tone's parameters fall into a range shared by two or more signals. The signal is classified as the one with the highest precedence.

Precedence	Call Progress Signal
1	Modem
2	FAX CNG
3	Audible Ringback
4	Busy
5	Reorder or Congestion
6	Number
7	Unobtainable
8	SIT
	Dial Tone

Table 4-6: Tone Detection Precedence

Table 4-6 shows the precedence of typical tones that the UTD module detects. Modem signals have the highest precedence, and Unknown tones have the lowest. Therefore, the frequency range of unknown tones can safely overlap the other tone ranges without causing tomes to be misclassified. If the range for Unknown tones is allowed to be the maximum range allowed by the detector, any detected tone that is unclassified would be designated as Unknown.

4.5.3.1.5 North American Call Progress Signal Detection

Function Requirements:

The tables below specify the frequencies, power levels, and cadence of the Bellcore and EIA-464A call progress tones.

Frequency (Hz)	Power Level (dBm)

Name	350	440	480	620	Per Frequency	Combined
Audible Ring		X	X		-22.5+/-1.5	
Busy			X	X	-27+/-1.5	
Dial Tone	X	X			-17.5 to -15	-13 to -14.5
Intercept		X		X	-20+/-1.5	
Reorder			X	X	-27+/-1.5	

Table 4-7: Call Progress Tone Frequency and Power Requirements

Audible ring (ring-back)	repetition of the tone on for 0.8 to 2.2 seconds, and off for 2.7 to 4.4 seconds
Busy	repetition of the tone on for 0.5+/-0.05 seconds, and off for 0.5+/-0.05 seconds
Dial	steady uninterrupted
Intercept	repetition of an alternating sequence of the two frequencies each being on for 0.16 to 0.30 seconds with a total cycle time of 0.5+/-0.05 seconds
Reorder (fast busy)	repetition of the tone on for 0.25+/-0.025 seconds, and off for 0.25+/-0.025 seconds

Table 4-8: Call Progress Tone Cadence

Performance Requirements

1. Frequency Deviation: Even though the generator is required to meet a frequency tolerance per tone of +/-0.5%, the detector needs to allow for a wider frequency tolerance due to variations in generators and line distortions. The CP detector detects all tones whose component frequencies deviate less than 1% from nominal.
2. Twist: The CP detector detects all tones whose twist is less than +/-4 dB.
3. Dynamic Range: The CP detector exhibits a minimum dynamic range of 25 dB.
4. Cadence: The CP detector must detect call progress tones whose cadence is within +/-10%.
5. Talkoff: The CP detector makes no false detections in 12 hours of testing with voice at -15 to -18 dBm ASL.

4.5.3.1.6 FAX CNG Tone Detection

The standard connection protocol for automatic connection of a FAX modem requires that the calling FAX modem generate a calling tone (CNG). Hence for incoming calls, the EVP software has to detect a CNG signal. When CNG is detected, EVP alerts the Core Processor to redirect the call to a FAX machine or a FAX modem embedded within the call processing system.

Functional Requirements:

Detect the presence of the FAX calling tone (CNG). A CNG signal is defined as follows:

[Graph depicting fax calling tone]

Figure 4-5: Fax calling tone (CNG)

a) The CNG tone is within 38 Hz of nominal frequency.

b) The timing tolerance of a CNG tone is +/-15%.

c) The power of a CNG tone is between 0 and -43 dBm.

Performance Requirements:

1. The detector does not miss any CNG signals on a prerecorded tape containing 50 CNG tone samples collected from 5 different FAX machines.

2. The detector does not miss any CNG signals from the same FAX machines connected to a local CO with a noise level of less than -45 dBm.

3. The detector misses less than 0.5% of CNG signals (generated at -10 dBm) when compressed voice is output at a level of -15 dBm or less (average over 3 seconds) into a network whose ERL is greater than 15 dB.

4. The detector does not falsely detect more than 1 CNG tone per 5 hours of voice (based on Bellcore recorded talk radio voice tapes.)

4.5.3.1.7 Modem Tone Specification

All answering modems that conform to the ITU V.25 answering sequence present a 2100 Hz tone 1.8 to 2.5 seconds after answering the telephone line. Figure 4-6 and Figure 4-7 show the timing of the answering tone (ANS). In Figure 4-6, the 2100 Hz tone reverses phase every t intervals. These phase reversals disconnect echo cancelers and echo suppressors from the network. According to ITU G.164, phase reversal shall be accomplished such that the phase is within 180+/-10 degrees in 1 ms

and that the amplitude of the 2100 Hz tone is not more than 3 dB below its steady state value for more than 400 usec.

[Graph depicting tuning for answering Modem with Phase reversal]

Figure 4-6: Timing for Answering Modem with Phase Reversal

[Graph depicting timing for answering Modem without Phase reversal]

A timing diagram for an answering modem without phase reversal is shown in Figure 4-7. The timing is identical with that of phase reversing tone except for the reversal timing.

Figure 4-7: Timing for Answering Modem without Phase Reversal

Table 4-9 contains the nominal frequency, power, and duration requirements for

	Minimum	Maximum	Unit
Frequency	2085	2115	Hz
Duration	2.6	4.0	seconds

Power	-18.0	-6.0	dBm0

generating modem tones as derived from V.25 and G.164.

Table 4-9: Modem Tone Generation Requirements

Performance Requirements:

1. The detector does not miss any modem answer tone on a pre-recorded tape containing 50 modem answer tone samples collected from 5 different data modems.

2. The detector does not miss any modem answer tone signals from the same data modem connected via a local CO with a noise level of less than -45 dBm.

3. The detector does not miss more than 0.5% of modem answer tones (generated at -10 dBm) when compressed voice is played at a level of - 15 dBm (ASL) or lower into a network connection with ERL greater than 15 dB.

4. The detector does not falsely detect the presence of a modem answer tone more than once per 5 hours of voice (using Bellcore recorded talk radio voice tapes).

5. There is no talkdown performance requirement. The near end is always silent and does not interfere with far end modem ANS signals.

6. There shall be fewer than 1 talkoff in 5 hours of call classification when the detector is programmed with the recommended parameters. Assuming that each call is resolved within an average time of 10 seconds, there shall be less than 1 talkoff in 1800 calls.

4.5.3.1.8 Three Tone Sequences

Most countries that generate Special Information Tones (SIT) use a three tone sequence. SIT sequences are generated by various central offices or common carrier switching points to indicate a problem with the dialed call. A SIT tone sequence generally precedes a recorded voice announcement such as "the number you have dialed is no longer in service..." and is provided specifically for the purpose of detection of the problem type by an automated device.

There are two popular types of SIT sequences. The first type is used mainly it Europe. It consists of a sequence of three tones of identical durations. The second type is the one used in North America. There are several North American SIT sequences that are encoded using various combinations of frequency and duration for each of the three tones. The encoding has been standardized by Bellcore.

Performance Requirements:

1. The UTD shall handle both types of sequences.

2. There is no talkdown performance requirement. The near end is always silent and does not interfere with far end SIT signals.

3. There shall be fewer than 1 talkoff in 5 hours of voice when the detector is programmed with the recommended parameters. Assuming that each voice call is has an average of 2 seconds of voice, there shall be fewer than 1 talkoff in 9000 calls.

4.5.3.1.9 Unknown Tone

Any single tone, dual tone, amplitude modulated tone or single tone sequence that is not classified as a CP, SIT, CNG or modem ANS tone, shall be reported as an unknown tone.

Performance Requirements:

1. Talkdown performance requirement [TBD]

2. There shall be fewer than 1 talkoff in 5 hours of voice when the detector is programmed with the recommended parameters (minimum tone duration 400 ms). Assuming that each voice call is has an average of 2 seconds of voice, there shall be fewer than 1 talkoff in 9000 calls.

4.6 Multifrequency Tone Detection (MFD)

The MFD algorithm module detects the presence of R1, R2 Forward, and R2 Backward Multifrequency (MF) tones under a broad range of network conditions and under international telecommunications specifications.

4.6.1 Functional requirements:

Table 4-10, Table 4-11, and Table 4-12 specify the nominal frequencies for the MF digits that must be detected.

F1(Hz)	F2 (Hz) 900	1100	1300	1500	1700
700	1	2	4	7	Spare
900	-	3	5	8	Spare
1100	-	-	6	9	KP
1300	-	-	-	0	Spare
1500	-	-	-	-	ST

Table 4-10: Nominal MF R1 Frequencies and corresponding digit definitions

F1(Hz)	F2 (Hz) 1500	1620	1740	1860	1980
1380	1	2	4	7	11
1500	-	3	5	8	12
1620	-	-	6	9	13
1740	-	-	-	10	14
1860	-	-	-	-	15

Table 4-11: Nominal MF R2 Forward Frequencies and corresponding combination numbers

F1(Hz)	F2 (Hz) 1020	900	780	660	540
1140	1	2	4	7	11
1020	-	3	5	8	12
900	-	-	6	9	13

780	-	-	-	10	14
660	-	-	-	-	15

Table 4-12: Nominal MF R2 Backward Frequencies and corresponding combination numbers

1. Be configurable to detect either R1, R2 forward, or R2 backward MF digits on a per-call basis.

2. Detect the presence of all 15 R1, 15 R2 Forward, and 15 R2 Backward digits under a broad range of network conditions.

3. MF digit information is provided as soon as the minimum duration is met. This information is called leading edge detection. This allows the earliest possible response to the digit, such as in compelling signalling.

4. The trailing edge of a MF digit must be detected. This allows the system to delay any response (such as in compelled signalling) to the digit until it is removed. The criteria selected for trailing edge detection will debounce MF digits.

5. The DSP reports leading and trailing edge in the 8 ms block that they are detected. MF events are not buffered.

4.6.2 Rl Detection Performance requirements:

Table 4-13 consists of MF Rl tone detection performance requirements taken from CCITTJITU Q310-Q331 and Bellcore TR-NWT-000506. Also shown is D2's MF R1 performance requirements, which is a superset of the CCITT and Bellcore requirements.

<TABLE>
<CAPTION>

	Requirement		
CHARACTERISTIC	BELLCORE	CCITT/ITU	D2
<S>	<C>	<C>	<C>
Frequency Deviation	+/-(1.5%+ 5 Hz) must accept	+/-1.5% must accept	Configurable choice of three sets of must accept frequency tolerance: +/-(1.5% + 5 Hz), +/-(1.5% + 10 Hz), +/-(1.5% + 15 Hz)
Tone Duration	KP signal: >54 ms must accept; <30 ms must reject All others: > 30 ms must accept; < 10 ms must reject	<30 ms must accept <10 ms must reject -	Minimum duration is configurable in 4 ms steps, from 28 ms up. Can be configured for >30 ms must accepts, < 10 ms must reject
Minimum Interdigital Interval	Must accept interdigital intervals > 25 ms. - Must bridge interdigital intervals < 10 ms	Must accept interdigital intervals > 20 ms -	Minimum interdigital interval is configurable in 4 ms steps. Can be configured for > 20 ms accept; < 10 ms bridge - -
Minimum Cycle Time	Up to 10 pulses per second (100 ms cycle time)	-	> 10 pulses per second (< 100 ms cycle time)
Accept Levels	0 to -25 dBm must accept < -35 dBm must reject -	-	Minimum power is configurable from -25 dBm to -45 dBm per frequency
Twist (ratio of high group	< 6 dB twist must accept	< 6 dB twist must accept	< 6 dB twist must accept

power to low)	-	-	-
SNR (white noise)	20 dB	-	20 dB
Impulse Noise	Fewer than 14 missed or split digits in Bellcore Impulse Noise Tape No. 201	-	Fewer than 14 missed or split digits in Bellcore Impulse Noise Tape No. 201
Disturbing Frequencies	Detection in the presence of 2A-B and @b-A modulation products 28 dB below each frequency component level of the signals.	-	Detection in the presence of 2A-B and @b-A modulation products 28 dB below each frequency component level of the signals.

</TABLE>

Table 4-13: MFD R1 Detection Performance Requirements

4.6.3 R2 Detection Performance Requirements

Table 4-14 shows the MF R2 tone detection performance requirements taken from CCITT/ITU Q400-490. The MFD module is required to pass all CCITT/ITU requirements.

<TABLE>

CHARACTERISTICS	CCITT/ITU REQUIREMENT	CCITT/ITU REQUIREMENT
<S> Frequency Deviation	<C> +/-10 Hz must accept	<C> Configurable choice of three sets of must accept frequency tolerance: +/-10 Hz, +/-15 Hz, +/-20 Hz
Tone Duration	Must reject signals < 7 ms -	Must reject signals < 7 ms -
Minimum response time for R2 compelled signalling	detect delay + generate delay < 70 ms - detect delay + decision delay + generate delay < 80 ms -	detect delay + generate delay < 70 ms - detect delay + decision delay + generate delay < 80 ms -
Accept Levels	-5 dBm0 to -31.5 dBm0 must detect; -38.5 dBm0 must reject	Minimum power is configurable from -25 dBm to -45 dBm per frequency
Twist (ratio of high group power to low)	< 5 dB twist must accept for adjacent - frequencies; < 7 dB twist must accept for non- - adjacent frequencies 20 dB twist must reject	< 5 dB twist must accept for adjacent - frequencies; < 7 dB twist must accept for non- - adjacent frequencies; 20 dB twist must reject
Disturbing Frequencies	Must not falsely detect due to any one or more valid R2 frequencies at -55 dBm per frequency. In the presence of a valid R2 tone, no missed detections and no false detections due to any of the remaining frequencies at 20 dB below the highest of the MF tone pair. Must not falsely detect due to: 1. Any 1 or 2 pure sine waves, each at -38.5 dBm0, 300-3400	Must not falsely detect due to any one or more valid R2 frequencies at -55 dBm per frequency. In the presence of a valid R2 tone, no missed detections and no false detections due to any of the remaining frequencies at 20 dB below the highest of the MF tone pair. Must not falsely detect due to: 1. Any 1 or 2 pure sine waves, each at -38.5 dBm0, 300-3400

	Hz.	Hz.
	2. Any 1 or 2 pure sine waves, each at -42 dBm, 300-3400 Hz.	2. Any 1 or 2 pure sine waves, each at -42 dBm 300-3400 Hz.
	3. Forward detector: Any 2 pure sine waves, each at -5 dBm, 330-1150 Hz or 2130-3400 Hz.	3. Forward detector: Any 2 pure sine waves, each at -5 dBm, 330-1150 Hz or 2130-3400 Hz.
	4. Backward detector: Any 2 pure sine waves, each at -5 dBm, 1300-3400 Hz.	4. Backward detector: Any 2 pure sine waves, each at -5 dBm, 1300-3400 Hz.
Transmitted signal interference	Must not falsely detect due to generation of outgoing MF digits.	Must not falsely detect due to generation of outgoing MF digits.

</TABLE>

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Table 4-14: MFD R2 Detection Performance Requirement

4.7 MFcR2 compelled signalling

In order to pass the CCITT requirements for compelled signal timing, the following additional requirements are made ON the MFD detector:

1. The MFD detector shall detect the leading edge of an R2 digit after processing no more than 24 ms of the digit.

2. The MFD detector shall detect the trailing edge of an R2 digit after processing no more than 16 ms of the silence following the digit.

5. CONFIGURATION PARAMETERS

The DSP uses various configuration parameters controlled by the Core Processor. These configuration parameters specify frequencies, powers, durations, and thresholds used for detection and generation of tones and voice data. This section defines the various parameters and their format in DSP memory.

5.1 Global Parameters

Global Parameters are those that must be defined for the DSP as a whole. Table 5-1 lists the global parameters and their descriptions.

NAME	Description
p0DBINA	digital rms of a 0 dBm sine wave incident at A/D for A-Law PCM
p0DBOUTA	digital rms of a 0 dBm sine wave incident at D/A for A-Law PCM
p0DBINM	digital rms of a 0 dBm sine wave incident at A/D for [mu]-Law PCM
p0DBOUTM	digital rms of a 0 dBm sine wave incident at D/A for [mu]-Law PCM
[tau]HANGOVER	Maximum inactivity before speech flag resets
[tau]SUSTAIN	Minimum duration of speech before sustained

Table 5-1: global parameters

Legal parameter values:

1. p0DBINA is a 14-bit code that represents the 0 dBm power level of a 1 kHz sine wave at the network interface for A-Law channels.

2. p0DBOUTA is a 14-bit code that represents DSP power level required to generate a 0 dBm signal at the network interface for A-Law channels.

3. p0DBINM is a 14-bit code that represents the o dBm power level of a 1 kHz sine wave at the network interface for [mu]-Law channels.

4. p0DBOUTM is a 14-bit code that represents DSP power level required to generate a 0 dBm signal at the network interface for [mu]-Law channels.

5. tHANGOVER is a parameter that sets the maximum time, [tau]HANG-OVER, that the speech sustained flag may be asserted while voice activity is absent. The maximum time is given by the following formula: [tau]HANGOVER*8msec.

6. tSUSTAIN is a parameter that sets the minimum duration, [tau]SUSTAIN, that a voice activity must be present before it is considered sustained speech. The duration is given by the following formula: tSUSTAIN= [tau]SUSTAIN*8msec.

5.2 DTMF Detection Parameters

DTMF detection is configured on a per-channel basis using a set of DTMF Collection Specifications. Each Collection Specification contains all configurable parameters for DTMF detection. There are 35 default Collection Specifications, and are referenced by ID, numbered 1 to 35 (Collection ID #0 is reserved to mean "use the previous default collection specification"). There also is one 'working' Collection Specification per timeslot.

The DSP maintains the following context for each channel:

- ID of it's current default DTMF Collection Specification
- It's working' DTMF Collection Specification, which is the one used for detection

5.2.1 DTMF Collection Specifications

DTMF Collection Specifications contain the following fields:

1. k: The number of digits to collect before initial report: 1 to 16

2. N: The total number of digits to collect: 1 to 40

3. MIN_POWER: The minimum allowable power per frequency (a value of 0 = - 25 dBm; a value of 21 = -45 dBm)

4. MIN_MAKE: The minimum duration of a valid DTMF digit, in ms (0 to 255).

5. MIN_BREAK: The minimum interdigital silence duration, in ms (9 to 255).

6. IDTO: Inter-digit Timeout. A timeout will be reported if the silence between two DTMF digits exceeds IDTO seconds. Range is 0 seconds (disables) to 255 seconds.

7. PSC: Permanent Signal Condition. A timeout will be reported if the duration of a DTMF digit exceeds PSC. Range is 0 seconds (disables) to 255 seconds.

8. FDTO: First Digit Timeout. A timeout will be reported if the time to collect the first digit exceeds FDTO. Range is 0 seconds (disables) to 255 seconds.

9. TDTO: Total Digit Timeout. A timeout will be reported if the time to collect all digits exceeds TDTO. Range is 0 seconds (disables) to 255

seconds.

10. ED: End Digit. Detection of this DTMF digit ends DTMF collection (if the ED bit in the Control Word is set).

11. CD: Cancel Digit. Detection of this DTMF digit causes the DSP to delete all collected digits and restart DTMF detection (if the CD bit in the Control Word is set).

12. POS_TWIST: Maximum allowable ratio of high tone power to low tone power. Choices are 0 (2 dB), 1(4dB), 2(6 dB), 3 (8 dB), 4 (10 dB), and 5 (12 dB)

13 NEG-TWIST: Maximum allowable ratio of low tone power to high tone power. Choices are 0 (2 dB), 1 (4 dB), 2 (6 dB), 3 (8 dB), 4 (10 dB), and 5 (12 dB)

58

14. CW: Control Word - a 8-bit mask with the following format:

7	6	5	4	3	2	1	0
DE	P	UE	UC	RD	IN	FT	

Table 5-2: Control Word Bit Definitions

o bit 1,0: FT = frequency tolerance:
00 = 2.0% must accept / 3.0% must reject
01 = 2.5% must accept / 3.5% must reject
10 = 3.0% must accept / 4.0% must reject
11 = 3.5% must accept / 4.5% must reject

o bit 2:IN = initial notification. If this bit is set, the DSP will make the initial report when k digits are collected.

o bit 3:RD = report durations. If this bit is set, the DSP will report on and off durations for each digit detected. Durations will have a granularity of 8 ms.

o bit 4:UC = use cancel code. If this bit is set, the DSP will reset DTMF collection when the cancel code is detected.

o bit 5:UE = use end code. If this bit is set, the DSP will end DTMF collection when the end code is detected.

o Bit 6:P = PCM type: This is how the Core Processor configures the PCM type for this channel.
1 = ALaw
0 = [mu]Law

o bit 7: DE = detection edge:
1 = leading edge detection
0 = trailing edge detection

The size in bits and the range of each field in the Collection Specifications is shown in Table 5-3. Table 5-4 shows the format of each channel's DTMF parameter context. The 'Default CS ID' field contains the ID for one channel's default collection spec. Words 2-7 of Table 5-4 contain the channel's working Collection Specification, and are the exact format of the default Collection Specifications (which are each 6 words long).

59

Field	Units	unsigned	Size (bits)	Range

k	number of digits	unsigned	4	1 to 16
N	number of digits	unsigned	6	1 to 40
MIN_POWER	(-25 -#) dBm	unsigned	5	0 to 20
MIN_MAKE	ms	unsigned	8	0 to 255
MIN_BREAK	ms	unsigned	8	0 to 255
IDTO	s	unsigned	8	0 to 255
PSC	s	unsigned	8	0 to 255
FDTO	s	unsigned	8	0 to 255
TDTO	s	unsigned	8	0 to 255
ED	DTMF digit	unsigned	4	0 to 15
CD	DTMF digit	unsigned	4	0 to 15
POS TWIST	2*(# + 2) dB	unsigned	4	0 to 4
NEG_TWIST	2*(# + 2)dB	unsigned	4	0 to 4
CW	8-bit mask	bit mask	8	0 to 255
			87 bits 6 words	

Table 5-3:DTMF Collection Specification Parameter Units

<TABLE>

<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>								<C>							
1												Default CS ID				
2				k						N						
3	MIN_POWER								MIN_MAKE							
4	MIN_BREAK								CW							
5	IDTO								PSC							
6	FDTO								TDTO							
7	POS_TWIST				NEG_TWIST				ED				CD			

</TABLE>

Table 5-4: Internal DTMF parameter channel context

5.2.2 DTMF Detection Parameter Memory Usage

For N channels of DTMF, the total memory usage for DTMF channel context and Collection Specifications is N*7+35*6+ = 210+7N 16-bit words. For all 63 channels, this is 651 words. For 30 channels, this is 420 words.

5.3 MF Detection Parameters

MF detection is configured on a per-channel basis using a set of MF Collection Specifications. These Collection Specifications each contain all configurable parameters for MF detection. There are 35 default Collection Specifications, and are referenced by ID, numbered 1 to 35. there also is one 'working' Collection Specification per timeslot.

The DSP maintains the following context for each channel:

- ID of it's current default MF Collection Specification
- It's 'working' MF Collection Specification, which is the one used for detection

5.3.1 MF Collection Specifications

MF Collection Specifications contain the following fields:

1. TD: (T)ype of MF tones to (D)etect (a 2-bit field):
   00b = not defined
   01b = R1
   10b = R2 Forwards
   11b = R2 Backwards

2. k: The number of digits to collect before initial report: 1 to 16

3. N: The total number of digits to collect: 1 to 40

4. MIN_POWER: The minimum allowable power per frequency (a value of 0 = - 25 dBm; a value of 21 = -45 dBm)

5. MIN_MAKE: The minimum duration of a valid MF digit, in ms (0 to 255).

6. MIN_BREAK: The minimum interdigital silence duration, in ms (0 to 255).

7. IDTO: Inter-digit Timeout. A timeout will be reported if the silence between two MF digits exceeds IDTO seconds. Range is 0 seconds (disables) to 255 seconds.

8. PSC: Permanent Signal Condition. A timeout will be reported if the duration of an MF digit exceeds PSC. Range is 0 seconds (disables) to 255 seconds.

9. FDTO: First Digit Timeout. A timeout will be reported if the time to collect the first digit exceeds FDTO. Range is 0 seconds (disables) to 255 seconds.

10. TDTO: Total Digit Timeout. A timeout will be reported if the time to collect all digits exceeds TDTO. Range is 0 seconds (disables) to 255 seconds.

11. ED: End Digit. Detection of this MF digit ends MF collection.

12. CD: Cancel Digit. Detection of this MF digit causes the DSP to delete all collected digits and restart MF detection.

13. CW: Control Word - an 8-bit mask with the following format:

7	6	5	4	3	2	1	0
DE	P	UE	UC	RD	IN	FT	

Table 5-5: Control Word Bit Definitions

- bit 1,0: FT = must accept frequency tolerance:
  00 = +/-(1.5%+10) Hz for R1; +/-10 Hz for R2
  01 = +/-(1.5%+15) Hz for R1; +/-15 Hz for R2
  10 = +/-(1.5%+20) Hz for R1; +/-20 Hz for R2
  11 = not defined

- bit 2: IN = initial notification. If this bit is set, the DSP will make the initial report when k digits are detected.

- bit 3: RD = report durations. If this bit is set, the DSP will report on and off durations for each digit detected. Durations will have a granularity of 8 ms.

- bit 4: UC = use cancel code. If this bit is set, the DSP will end MF collection when the end code is detected.

- bit 5: UE = use end code. If this bit is set, the DSP will end MF collection when the end code is detected.

- Bit 6: P = PCM type:
  1 = Alaw
  0 = [mu]Law

- bit 7: DE = detection edge:
  1 = leading edge detection
  0 = trailing edge detection

14. TT, ISTT, IS: These fields are ignored in this state. They are included to allow the same Collection Specification format be used for MfcR2 signalling.

The size in bits and the range of each field in the Collection Specifications is shown in Table 5-6. Table 5-7 shows the format of each channel's MF parameter context. The 'Default CS ID' field contains the ID for this channel's default collection spec. Words 2-7 of Table 5-7 contain this channel's working Collection Specification, and are the exact format of the default Collection Specifications (which are each 6 words long).

Field	Units	unsigned	Size (bits)	Range
TT	type of MF	unsigned	2	0 to 3
TD	type of MF	unsigned	2	0 to 3
k	number of digits	unsigned	4	1 to 16
N	number of digits	unsigned	6	1 to 40
MIN_POWER	(-25 - #) dBm	unsigned	5	0 to 20
MIN_MAKE	ms	unsigned	8	0 to 255
MIN_BREAK	ms	unsigned	8	0 to 255
IDTO	s	unsigned	8	0 to 255
PSC	s	unsigned	8	0 to 255
FDTO	s	unsigned	8	0 to 255
TDTO	s	unsigned	8	0 to 255
ISTT	state transition fa	unsigned	4	0 to 10
IS	state	unsigned	4	0 to 5
ED	DTMF digit	unsigned	4	0 to 15
CD	DTMF digit	unsigned	4	0 to 15
CW	8-bit mask	bit mask	8	0 to 255
			91 bits 6 words	

Table 5-6: MF Collection Specification Parameter Units

<TABLE>

<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>								<C>							
1									|		|	Default CS ID				
2	TT		|	TD		|	k		|		|	N			
3			|	MIN_POWER					|	MIN_MAKE					
4	MIN_BREAK								|	CW					
5	IDTO								|	PSC					
6	FDTO								|	TDTO					

7	ISTT	IS	ED	CD

</TABLE>

Table 5-7: Internal MF parameter channel context

5.3.2 MF Detection Parameter Memory Usage

For N channels of MF Detection, the total memory usage for MF channel context and Collection Specifications is N*7+35*6 = 210+7N 16-bit words. For all 63 channels, this is 651 words. For 30 channels, this is 420 words.

5.4 Call Progress Detection Parameters

Call progress detection is configured using CP Tone Groups and CP Collection Specifications. CP Tone Groupos reference CP Tone Specifications, which each describe a tone to detect. CP Collection Specifications contain other detection parameters, such as timeouts and PCM type.

5.4.1 CP Tone Groups

There are 35 CP Tone Groups, which allow for 35 separate groupings of tones to be configured at any one time. The CP Tone Groups are referenced by ID, which number from 1 to 35.

Each CP Tone Group is thirty 16-bit words long, with each word containing the ID of a CP Tone Specification. This allows for a maximum of thirty CP Tone Specification Ids. If a particular CP Tone Group has less than thirty CP Tone Specifications, then the CP Tone Specification IDs occupy the first part of the CP Tone Group, and the remaining words are '0.'

Although the CP Tone Group only needs 9 bits to store each CP Tone Specification ID, 16 bits are reserved for each CP Tone Specification ISD. This is done so the DSP can replace these fields with 16-bit addresses.

An example CP Tone Group, as it would exist in the DSP's memory, follows. In this example, 26 CP Tone Specifications are used:

<TABLE>

<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>															
1	CP Tone Specification ID #1															
2	CP Tone Specification ID #2															
3	CP Tone Specification ID #3															
4	CP Tone Specification ID #4															
5	CP Tone Specification ID #5															
6	CP Tone Specification ID #6															
7	CP Tone Specification ID #7															

8	CP Tone Specification ID #8															
9	CP Tone Specification ID #9															
10	CP Tone Specification ID #10															
11	CP Tone Specification ID #11															
12	CP Tone Specification ID #12															
13	CP Tone Specification ID #13															
14	CP Tone Specification ID #14															
15	CP Tone Specification ID #15															
16	CP Tone Specification ID #16															
17	CP Tone Specification ID #17															
18	CP Tone Specification ID #18															
19	CP Tone Specification ID #19															
20	CP Tone Specification ID #20															
21	CP Tone Specification ID #21															
22	CP Tone Specification ID #22															
23	CP Tone Specification ID #23															
24	CP Tone Specification ID #24															
25	CP Tone Specification ID #25															
26	CP Tone Specification ID #26															
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

</TABLE>

Table 5-8: Example CP Tone Group

Although there is wasted space associated with a CP Tone Group with less than 30 CP Tone Specifications, there is an advantage to fixed-length CP Tone Groups: it is much easier to address, delete, add, and replace CP Tone Groups during run time when they are a fixed length.

5.4.2 CP Tone Specifications

There are two types of CP Tone Specifications: Normal and SIT. Normal CP Tone Specifications are 21 words long. Although SIT Tone Specifications are only 18 words long, the DSP needs 28 words of space after translating to values used by the Universal Tone Detector.

The DSP can handle up to 10 unique Normal CP Tone Specifications per CP Tone Group (10*35=350 Normal CP Tone Specifications), and up to one unique SIT CP Tone Specification per CP Tone Group (1*35=SIT CP Tone Specifications).

CP Tone Specifications are referenced by ID, numbered 1 to 385. The first 350 are Normal CP Tone Specifications, and the last 35 (IDs #351 - #385) are SIT CP Tone Specifications.

Table 5-9 and Table 5-10 show the format and definitions for all fields in Normal CP Tone Specifications and SIT CP Tone Specifications. See Section 4.5 for more information on the format of tones detected by UTD.

Word	Value	Units	Range
1	Tone Category	Category Number	1 to 9
2	Tone Type	Tone Type	0 to 2
3	Return Value	Return Code	0 to 32767
4	Required Cadences	Cadence Number	0 to 32767
5	Frequency 1	Hz	300 to 3300
6	Frequency 1 Deviation	Hz	0 to 1500
7	Frequency 2	Hz	0 to 1500
8	Frequency 2 Deviation	Hz	300 to 3300
9	Min Make 1	ms	100 to 32767
10	Max Make 1	ms	100 to 32767
11	Min Break 1	ms	0, 100 to 32767
12	Max Break 1	ms	0, 100 to 32767
13	Min Make 2	ms	0, 100 to 32767
14	Max Make 2	ms	0, 100 to 32767
15	Min Break 2	ms	0, 100 to 32767
16	Max Break 2	ms	0, 100 to 32767
17	Min Make 3	ms	0, 100 to 32767
18	Max Make 3	ms	0, 100 to 32767
19	Min Break 3	ms	0, 100 to 32767
20	Max Break 3	ms	0, 100 to 32767
21	Min Power	dBm	0 to -45

Table 5-9: Normal CP Tone Specification format

Word	Value	Units	Range
1	Tone Category	Category Number	6
2	SIT Type	SIT Type	1, 2
3	Return Value	Return Code	0 to 32767
4	Frequency 1	Cadence Number	300 to 3300
5	Bandwidth 1	Hz	0 to 1500
6	Frequency 2	Hz	300 to 3300
7	Bandwidth 2	Hz	0 to 1500
8	Frequency 3	Hz	300 to 3300
9	Bandwidth 3	Hz	0 to 1500
10	Frequency 4	Hz	300 to 3300
11	Bandwidth 4	Hz	0 to 1500
12	Frequency 5	Hz	300 to 3300
13	Bandwidth 5	Hz	0 to 1500
14	Short Min	ms	0, 100 to 32767
15	Short Max	ms	0, 100 to 32767
16	Long Min	ms	0, 100 to 32767
17	Long Max	ms	0, 100 to 32767
18	Min Power	dBm	0 to -45
19	Reserved	--	--
20	Reserved	--	--
21	Reserved	--	--
22	Reserved	--	--
23	Reserved	--	--
24	Reserved	--	--
25	Reserved	--	--
26	Reserved	--	--

27	Reserved	--	--
28	Reserved	--	--

Table 5-10: SIT CP Tone Specification format

69

5.4.3 CP Collection Specifications

Each CP Collection Specification contains the following parameters:

1. ID: This is a unique identifier for a default collection specification, numbered 1 to 35.

2. P: The type of PCM to use on this channel:
   1 = ALaw
   0 = [mu]Law

3. PSC: Permanent Signal Condition" 0 (disables) to 127 seconds (7 bits unsigned)

4. TC: Tone Cessation Reporting:
   1 = Report when a tone is no longer present (falling edge reported)
   0 = Don't report when a tone is no longer present (no falling edge reported)

5. FDTO: First Digit Timeout 0 (disables) to 127 seconds (7 bits unsigned)

The formal of the CP Detection Collection Specification is shown in Table 5-11. note that the ID is not contained in the formal. For default collection specifications, the ID is simply the index of this collection specification in the block of memory that contains all default collection specifications.

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S> 1	<C> P	|	PSC						| TC	|	FDTO				

Table 5-11: CP Detection Collection Specification format

5.4.4 CP Detection Channel Context

The DSP maintains the following context for each channel:
- Current working CP Collection Specification, which is the one used for detection
- ID of its current default CP Collection Specification
- ID of the CP Tone Group to use for this channel

70

Table 5-12 shows the format of each channel's CP Detect parameter context.

	High Byte	Low Byte

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	P	PSC							TC	FDTO						
2	Default CP Collection Spec ID								CP Tone Group ID							

</TABLE>

Table 5-12: CP Detection Channel Context

5.4.5 CP Detection Parameter Memory Usage

For 30 channels of Call Progress Detection, the total memory usage for the CP Detection Parameters in 9475 16-bit words. Table 5-13 shows a breakdown of this memory usage.

<TABLE>

<CAPTION>

Section	Number of entries	Size per entry	Memory Usage
Channel context	30	2	60
Default Collection Specifications	35	1	35
CP Tone Groups	35	30	1050
Normal CP Tone Specifications	350	21	7350
SIT CP Tone Specifications	35	28	980
		Total Memory Usage:	9475

</TABLE>

Tabel 5-13: CP Detection Parameter Memory Usage

5.5 Tone Generation Parameters

Tone Generation uses four types of structures to convey what tone (or tones) is (are) to be generated: Simple Tone Specifications, Special Tone Specifications, Special Case Templates, and User-Defined Tone Groups:

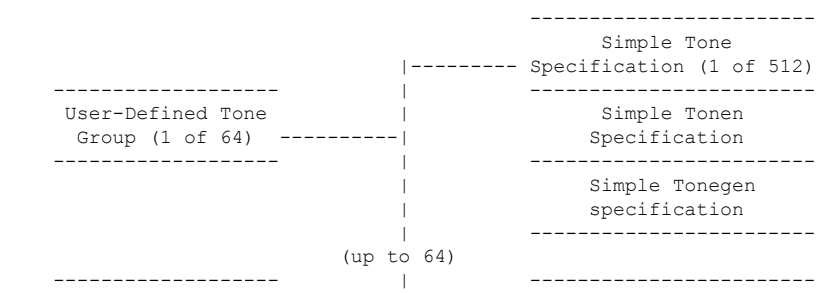
- SIMPLE TONE SPECIFICATIONS: These are used to generate tones that are single, dual, or amplitude modulated, with one to three cadences, and unchanging frequency and power.

- SPECIAL CASE TONE TIMPLATES: These are used to generate tones with up to four frequencies, or with time varying frequency or power levels.

- SPECIAL TONE SPECIFICATIONS: These are grouping of Special Case Tone Templates that are to be generated in order. This allows for generation of complex tones (e.g. 'bong' or SIT tones).

- USER-DEFINED TONE GROUPS: These are a collection of Simple Tone Specifications and Special Tone Specifications, grouped together to define a related set of tones (e.g. a group of tones that defines a country's tone plan).

Figure 5-8 shows this hierarchy.



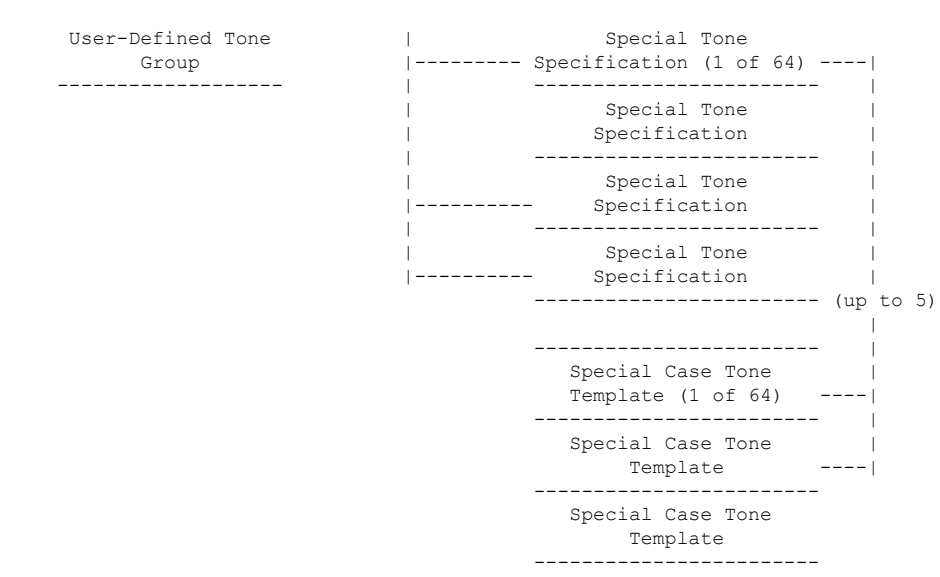


Figure 5-8: Tone Generation Parameter hierarchy

The following sections show the format and definitions of the fields contained in each level of tone specification.

5.5.1 Simple Tone Specifications

There are 512 Simple Tone Specifications, which allows for an average of 14 to 15 unique simple tones per country (assuming 35 countries).

Each Simple Tone Specification has the following characteristics:

- A Simple Tone Specification is referenced by ID, which corresponds to the order in which it occurs in memory (ID = 1 to 512).
- To allow for easy addition and deletion of Simple Tone Specifications, each Simple Tone Specification will be a fixed length of 10 words (16 bits/word).
- Simple Tone Specifications are used to generated single, dual, and amplitude modulated tones, with unchanging frequency and power levels, with one to three cadence pairs.

Table 5-14 shows the format for Simple Tone Specifications.

<TABLE>

<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>															
1	Repeat Count (0 = repeat indefinitely)															
2	T	|	Frequency 1 (HZ)													
3	Frequency 2 (Hz)															
4	Power 1				|	Power 2, or modulation %									
5	make 1 (ms)															
6	break 1 (0 for continuous)															
7	make 2 (0 for single cadenced tone)															

8	break 2
9	make 3 (0 for double cadenced tone)
10	break 3

Table 5-14: Simple Tone Specification Format

o T is the Type of tone:

T = 0: single/dual tone. Low byte in word #4 contains the power of the second frequency.
T = 1: amplitude modulated tone. Low byte in word #4 contains the modulation percentage (in %). Frequency 1 is the carrier frequency, and Frequency 2 is the modulation frequency.

o Units for Power 1 and Power 2 are 0.5 dBm. Allowable values are +6 to -100, which allows for +3 to -50 dBm.

5.5.1.1 Special Tone Specifications

are handled using Special Tone Specifications.

There are 64 Special Tone Specifications, which allows for an average of 1 to 2 unique special tones per country (assuming 35 countries).

Each Special Tone Specification has the following characteristics:

o A Special Tone Specification is referenced by ID, which corresponds to the order in which it occurs in memory. (ID = 513 to 576)

o To allow for easy addition and deletion of Special Tone Specifications, each Special Tone Specification will be a fixed length of 5 words (16 bits/word).

o Special Tone Specifications are used to generated tones that have changing frequencies, cadences or power levels, and tones with more than two frequencies.

Table 5-15 shows the format for Special Tone Specifications.

<TABLE>
<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S> 1	<C> R	| Special Case Template ID #1														
2	Special Case Template ID #2 (0xFFFF if none)															
3	Special Case Template ID #3 (0xFFFF if none)															
4	Special Case Template ID #4 (0xFFFF if none)															
5	Special Case Template ID #5 (0xFFFF if none)															

</TABLE>

Table 5-15: Special Tone Specification Format

o R is the repeat flag:

R = 0: generate each of the Special Case Tone Templates in order, then silence.
R = 1: generate each of the Special Case Tone Templates in order,

then repeat.

5.5.2 Special Case Tone Templates

Special Case Tone Templates are used when generating special tones using Special Tone Specifications, defined in Section 5.5.1.1 above.

Special Case Tone Templates define tones with one to four frequencies, at different power levels. The first one or two frequencies can vary in frequency, and the tone power can be exponentially decayed. The tone also has a cadence and a repeat count defined.

Each Special Case Tone Template is ten 16-bit words long, and has the format shown in Table 5-16.

<TABLE>
<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>															
1	T1	|						Frequency 2 (Hz)								
2								Frequency 2 (Hz)								
3	T2	|						Frequency 3 (Hz) () if not tripe/quadruple tone)								
4								Frequency 4 (Hz)								
5					Power 1						|			Power 2, or modulation %		
6					Power 3						|			Power 4, or modulation %		
7				delta frequency 1(Hz/s)							|			delta frequency 2 (Hz/s)		
8														repeat count (0 = infinite)		
9							make time (ms) () for continuous)									
10								break time (ms)								

</TABLE>

Table 5-16: Special Case Tone Template Format

o Tl and T2 are the types for the first and second frequency pairs:
T1 = 0: single/dual tone. Low byte in word #5 contains the power of Frequency 2.
T1 = 1: amplitude modulated tone. Low byte in word #4 contains the modulation percentage (in %). Frequency 1 is the carrier frequency, and Frequency 2 is the modulation frequency.
T2 = 0: single/dual tone. Low byte in word #6 contains the power of Frequency 4.

T2 = 1: amplitude modulated tone. Low byte in word #6 contains the modulation percentage (in %). Frequency 3 is the carrier frequency, and Frequency 4 is the modulation frequency.

o Units for Power 1, 2, 3, and 4 are 0.5 dBm. Allowable values ARE +6 to -100, which allows for +3 to -50 dBm.

o Decay constant affects all tones. This is an exponential decay, which uses the following formula:

A(t) = Ao * e(-8t/[tau]), where:
A(t) = tone amplitude at time t
Ao = initial tone amplitude
t = time in ms
[tau]= decay constant in 8 ms units

o Delta frequency 1 and delta frequency 2 affect Frequency 1 and Frequency 2, respectively. This changes the generated frequency every 8 ms by the rate specified in Hz/s. Continuous phase is maintained.

There is a unique ID associated with each Special Case Tone Template. There can be a maximum of 64 Special Case Templates defined at any given time, and they are referenced by ID, numbered 577-641.

5.5.3 User-defined Tone Groups

Tone specifications and can be grouped together to form User-defined Tone Groups. Each Tone Group contains the IDs of up to 64 Simple and/or Special tone specifications. This allows tone generation commands to outpulse tones, using 6 bit numbers (which correspond to a tone specification's location within a tone group).

There are up to 64 Tone Groups, and each is referenced by Tone Group ID (0 to 63).

The format of User-defined Tone Groups is as follows:

<TABLE>
<CAPTION>

	High Byte						Low Byte								
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>															
Tone 0	0	0	0	0	0	0	Tone Specification ID #1									
Tone 1	0	0	0	0	0	0	Tone Specification ID #2 (or 0)									
Tone 2	0	0	0	0	0	0	Tone Specification ID #3 (or 0)									
	0	0	0	0	0	0	Tone Specification ID #4 (or 0)									
	0	0	0	0	0	0										
Tone 63	0	0	0	0	0	0	Tone Specification ID #64 (or 0)									

</TABLE>

Table 5-17: User-defined Tone Group Format

5.5.3.1 User-defined Tone Groups for DTMF. MF generation

Four User-defined Tone Groups are reserved for DTMF, MFR1, R2 Forwards and R2 Backwards tone generation. These tone groups have only 16 Tone Specification IDs, and therefore the individual tone specifications can be referenced using 4 bit numbers (which correspond to a tone specification's index within a tone group).

These special user-defined Tone Groups have the following IDs:

Tonegen Group Tone Type	User-Defined Tonegen Group ID
DTMF	0
MFR1	1
MFR2 Forwards	2
MFR2 Backwards	3

Table 5-18: IDs for reserved User-defined Tone Groups

5.5.4 Tone Generation Parameter Memory Usage

The total DSP memory usage for the Tone Generation Parameters is 10176 16-bit words, and is organized as follows.

Section	ID numbering	16-bit words per Specification	Number of Specifications	Memory Usage
Simple Tone Specifications	0 to 511	10	512	5120
Special Case Templates	512 to 575	10	64	640
Special Tone Specifications	576 to 640	5	64	320
Tone Groups	0 to 63	64	64	4096

Table 5-19: Tone Generation Parameter Memory Usage

5.6 MFcR2 Signalling Parameters

MFcR2 signalling is configured on a per-channel basis using several sets of configuration parameters:

- MF Collection Specifications are used for detection parameters.
- User-defined Tone Groups are used for generation parameters.
- State Transition Tables contain all configurable information regarding the appropriate Actions and State Transitions in response to any Event.
- Actions each contain a one or more Processes.
- Processes are a set of atomic functions that are required to perform the MFR2 protocol.

The DSP maintains the following context for each channel:

- ID of its current default Collection Specification
- Its 'working' Collection Specification, which is the one used for detection

5.6.1 MF Collection specifications

The MF Collection Specifications defined in Section MF Collection Specifications are also used for MFcR2 signalling. Three fields that were ignored in the MF Detect state are now defined:

1. TT: (T)ype of MF tones to (T)ransmit (a 2-bit field). This specifies which User-defined Tone Group to use for tone generation. See Section User-defined Tone Groups for DTMF, MF generation for details:
   00b = not used (DTMF)

01b = R1
1Ob = R2 Forwards
11b = R2 Backwards

2. ISTT: Initial State Transition Table D. This specifies which state transition table to use for MF forward compelled signalling (1 to 10; 0 = unconfigured).

3. S: Initial State. This specifies the starting state within the state transition table for MF Forward compelled signalling (1 to 5; 0 = unconfigured).

Table 5-20 shows the format of each channel's MFcR2 parameter context. The 'Default CS ID' field contains the ID for this channel's default collection spec. Words 2-7 contain this channel's working Collection Specification, and are the exact format of the default Collection Specifications (which are each 6 words long).

<TABLE>
<CAPTION>

	High Byte							Low Byte							
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<S>	<C>															
1												Default CS ID				
2	TT			TD				k				N				
3	MIN_POWER								MIN_MAKE							
4	MIN_BREAK								CW							
5	IDTO								PSC							
6	FDTO								TDTO							
7	ISTT				IS				ED				CD			

</TABLE>

Table 5-20: Internal MRcR2 parameter channel context

5.6.2 MFcR2 State Transition Tables

MFcR2 Forward signalling is implemented using a programmable state machine. When a channel begins forward signalling, it is given an initial State Transition Table, and an initial State within that table. The State Transition Table contains all States needed to implement a given country-specific MFcR2 protocol. Each State defines the appropriate Actions and State Transitions to be executed due to the detection of all Events.

State	Event								
	0	1	2	3	4	. .	13	14	15
1	1A (A/ST)	(A/ST)	(A/ST)	(A/ST)	(A/ST)	. .	(A/ST)	(A/ST)	(A/ST)
2	1A (A/ST)	(A/ST)	(A/ST)	(A/ST)	(A/ST)	. .	(A/ST)	(A/ST)	(A/ST)
3	1A (A/ST)	(A/ST)	(A/ST)	(A/ST)	(A/ST)	. .	(A/ST)	(A/ST)	(A/ST)
4	1A (A/ST)	(A/ST)	(A/ST)	(A/ST)	(A/ST)	. .	(A/ST)	(A/ST)	(A/ST)
5	1A (A/ST)	(A/ST)	(A/ST)	(A/ST)	(A/ST)	. .	(A/ST)	(A/ST)	(A/ST)

Table 5-21: MFcR2 State Transition Table Format

Each field in the state transition table is defined as follows:

1. State: There are 5 states in each State Transition Table, numbered 1 to 5.

2. Event 0: This column contains the initial actions (IA) to be performed when transitioning to a particular state.

3. Events 1-15: These columns define the actions (A) and state transitions (ST) to execute when the MF digits 1-15 are detected.

4. IA, A: These entries contain the ID of an Action to be performed

5. ST: This is a state to transition to, numbered 1 to 5. If ST = 0, there is no state transition required upon detection of this Event in this State. If ST is nozero, transition to that state and execute the Initial Action for that state.

Each State Transition Table is referenced by State Transition Table ID, numbered 1 to 10.

5.6.3 Actions

Actions consist of an Action ID, the number of Processes in this Action, and a list of Processes that are executed in the order. Actions are referenced by Action ID, numbered 1 to 200. Actions are all 50 bytes long. Processes are variable length, depending on the process ID, in one byte increments.

The format of the Actions is as follows:

[Table depicting MFcR2 Action Format]

Table 5-22: MFcR2 Action Format

5.6.4 Processes

Processes are the atomic building block for MFcR2 signalling. The set of defined processes allows for construction of any potential actions that need to be performed for all variations of MFcR2 signalling.

The following table shows the process ID, name, length (process ID plus process data), and format for each process.

<TABLE>

<CAPTION> PID	Process Name	Length (bytes)	Format (each <field> is 1 byte)	Description
<S> 1	<C> I: Ignore	<C> 1	<C> <1>	<C> Ignore this event
2	E: Error	1	<2>	Report severe error condition
3	STRSWC: Switch Current String	2	<3><new string index>	Switch current digit string to the one given
4	SETDIG: Set digit index	2	<4><new digit index>	Set digit index in current string to the one given
5	OFFDIG: Offset digit index	2	<5><offset>	Adjust digit index in current string by the offset given
6	INCDIG: Add one to digit index	1	<6>	

</TABLE>

<TABLE>

<S>	<C>	<C>	<C>	<C>
7	STTSWC: Switch state transition table	4	<7><new STT><start state><execute initial state action>	Switch to new state transition table and new state in that table. Optionally run the initial action in that state.
8	PATMTC: Patten Match	N+2	<8><number digits = N><digit 1><digit 2>..<digit N> (N <=[TBD])	Determine if the last N digits match this pattern. If true, execute the next process. If false, execute the process after that.
9	SNDDIG: Send digit	2	<9><digit>	If <digit> = <end digit>, then report collected digits to controller
10	SNDAT: Send digit at given digit index	2	<10><digit index>	Send digit at digit index <digit index> in current string
11	REPORT: Report to controller	2	<11><Report ID>	Send the <Report ID> report to the controller
12	RESET: Reset protocol	12	<12>	Reset the protocol. Restart in the initial state given in the working collection spec.
13	NOP	1	<13>	No operation (**THIS IS A DUPLICATION OF THE IGNORE PROCESS)
14	ERROR: kill the call	1	<14>	send no status, discard collected digit, go to idle
15	STORE	1	<15>	Save digit in collected digit string
16	CHKCNT	1	<16>	Is the number of collected digits = number requested? If true, execute the next process. If false, execute the process after that.
17	REPDIG	1	<17>	Report collected digits to controller

</TABLE>

<TABLE>

<S>	<C>	<C>	<C>	<C>
18	CLREND	1	<18>	Store digit in collected digit string. If collection complete, send end flag and report digit to controller
19	REENTER	2	<19><reenter count>	Counter is initially 0 when MFcR2 begins. If Counter < Reenter Count, increment Counter,

				execute the next process, and skip the process after that. If Counter = Reenter Count, skip the next process and execute the process after that.
20-127	Reserved	--	--	--

</TABLE>

Table 5-23: Process Definitions

5.6.5 MFcR2 Signalling Parameter Memory Usage

The total memory usage for the MFcR2 Signalling Parameters is 8820 16-bit words, and is distributed as shown in Table 5-24.

[Table depicting MFcR2 Signalling Parameter Memory Usage]

Table 5-23: MFcR2 Signalling Parameter Memory Usage

6. DSP Time and Space Requirements

Currently, the time and space requirements are being tabulated in a separate document. They will be included here in a future release of this document.

Table 6-1: DSP C54x MIPS Requirements by State

Table 6-2: DSP Memory Requirements

Table 6-3: Glossary of DSP Software Module Names

7. Command Messages

Commands from the Core Processor are used to update all parameters and configurations, run diagnostic tests, and drive the state transitions for the major states in Section 3.4.

7.1 Command String Format

The Core Processor issues commands to the DSPs using the first timeslot on the first buffered serial port using point-to-point HDLC protocol. Each command consists of a variable length command string, which is composed of the following fields: a command type (CMD_type) command subtype (CMD_subtype), the channel number (CMD_channel), the message length in bytes (CMD_length), and command parameters (CMD_params).

- CMD_type and CMD_subtype are each 4 bits long, and together they combine for the first byte of all command messages. CMD_type is in the high nibble.
- CMD_channel is one byte long for commands that are channel specific; for commands that have no associated channel, the CMD_channel field is 0

bytes long (not present).

o CMDJength is one byte long for all command messages

o The CMD_params field's length is variable, N one byte increments. For certain CMD3ype / CMD_subtype combinations, the CMD_params field is 0 bytes long (not present).

The command string shall have one of the following structures, depending on whether the CMD_channel field is present:

1	CMD_type	CMD_subtype
2	CMD_channel	
3	CMD_length	
4+	CMD_params	

Table 7-1: Command structure when CMD channel is present

1	CMD_type	CMD_subtype
2	CMD_length	
3+	CMD_params	

Table 7-2: Command structure when CMD_channel is not present

7.2 Command Message Definitions

Table 7-3 shows the legal values for the CMD_type field.

CMD type (HEX)	Function	Description
0x0	IDLE	Enter IDLE state
0x1	Diagnostic Test	Execute diagnostics
0x2	DTMF Detection	DTMF detection command
0x3	MF Detection	MF detection command
0x4	CP Detection	CP detection command
0x5	Tone Generation	Tone generation command
0x6	MFcR2 Signalling	MFcR2 signalling command
0x7 - 0xF	Not Used	Reserved for future expansion

Table 7-3: Legal CMD_type values.

Defined values for the CMD_subtype field are dependent on the CMD_type function. Similarly, the defined values for the CMD_params field are dependent on the CMD_type and CMDE_subtype values. The following subsections define all legal combinations of CMD_subtype and CMD_params for each CMD_type.

7.2.1 IDLE (0x0) Commands

The IDLE command tells the DSP to place one (or all) channels in the IDLE state. Table 7-4 describes the meanings of all IDLE commands. Note that if CMD_subtype = 0, then all channels are to enter the IDLE state.

Field	Length	Value	Description
CMD type	4 bits	0x0	IDLE type
CMD subtype	4 bits	0x00 -0x3F	Channel to enter IDLE state (0=all channels)
CMD channel	0 bytes	-	Not present (channel is in CMD subtype field)
CMD length	1 byte	0x02	Length of this message
CMD params	0 bytes	(none)	Not present

Table 7-4; IDLE (x0x) commands

7.2.2 DIAGNOSTIC TEST (0x1) Commands

The run-time DSP image performs the following diagnostic tests:

1. Version: The DSP will supply the checksum and DSP software version upon request.

2. TDM Loopback: The DSP will transmit on a given channel the received data from that (or another) channel. If the DSP is commanded to do TDM loopback with the HDLC channel, an error status is generated.

3. HDLC Echo: The HDLC Module will transmit back to the 860 whatever it receives.

4. Timer Test: The DSP will set a timer for a duration which a known number of frame syncs should be detected.

5. Performance Measure: The DSP will supply an abstract number indicating the amount of idle time on the DSP for the last loop of the CSM.

The following tables show the formats for the various runtime diagnostic test commands.

7.2.2.1 DIAGNOSTIC TEST - Version (0x10) Command

Upon receipt of this command, the DSP will respond with a diagnostic status containing the checksum and software version of the DSP code. CMD_channel is 0, and there is no CMD_params section.

Field	Length	Value	Description
CMD_type	4 bits	0x1	DIAGNOSTIC TEST type
CMD_subtype	4 bits	0x0	Version subtype
CMD_channel	1 byte	0x00	Command is not channel specific
CMD_length	1 byte	0x03	Length of this message
CMD_params	0 bytes	(none)	0-length CMD_params section

Table 7-5: DIAGNOSTIC TEST - Version (0x10) Command

7.2.2.2 DIAGNOSTIC TEST - TDM Loopback (0x11) Command

Upon receipt of this command, the DSP will copy the data input on a given TDM channel to the output on another TDM channel. If one of the commanded TDM channels is an HDLC channel, then an error status is sent. CMD_channel contains the input TDM channel to use, and CMD_params contains the output TDM channel to use.

Field	Length	Value	Description
CMD type	4 bits	0x1	DIAGNOSTIC TEST type
CMD subtype	4 bits	0x1	TDM Loopback subtype
CMD channel	1 byte	0x01 to 0x3F	Input TDM channel to use
CMD length	1 byte	0x04	Length of this message
CMD params	1 byte	0x01 to 0x3F	Output TDM channel to use

7.2.2.3 DIAGNOSTIC TEST - HDLC Echo (0x12)Command

Upon receipt of this command, the HDLC module will transmit back to the 860 whatever it receives. CMD_channel is 0, and there is no CMD-params section.

Field	Length	Value	Description
CMD type	4 bits	0x1	DIAGNOSTIC TEST type
CMD subtype	4 bits	0x2	HDLC Echo subtype
CMD channel	1 byte	0x00	Command is not channel specific
CMD length	1 byte	0x03	Length of this message
CMD params	0 bytes	(none)	0-length CMD_params section

7.2.2.4 DIAGNOSTIC TEST - Measure Performance (0x13) Command

Upon receipt of this command, the DPS will provide a perforance indicator which will represent the amount of idle time on the DSP for the last loop of the CSM. CMD_channel is 0, and there is no CMD-params section.

Field	Length	Value	Description
CMD type	4 bits	0x1	DIAGNOSTIC TEST type
CMD subtype	4 bits	0x3	Measure Performance subtype
CMD channel	1 byte	0x00	Command is not channel specific
CMD length	1 byte	0x03	Length of this message
CMD params	0 bytes	(none)	0-length CMD_params section

Table 7-6: DIAGNOSTIC TEST - TDM Loopback (0x11) Command

7.2.2.3 DIAGNOSTIC TEST - HDLC Echo (0x12) Command

Upon receipt of this command, the HDLC module will transmit back to the 860 whatever it receives. CMD_channel is 0, and there is no CMD_params section.

TABLE 7-7: DIAGNOSTIC TEST - HDLC ECHO (0X13) COMMAND

Upon receipt of this command, the DSP will provide a performance indicator which will represent the amount of idle time on the DSP for the last loop of the CSM. CMD_channel is 0, and there is no CMD_params section.

Field	Length	Value	Description
CMD type	4 bits	0x1	DIAGNOSTIC TEST type
CMD subtype	4 bits	0x3	Measure Performance subtype
CMD channel	1 byte	0x00	Command is not channel specific
CMD length	1 byte	0x03	Length of this message
CMD params	0 bytes	(none)	0-length CMD_params section

Table 7-8: DIAGNOSTIC TEST - Measure Performance (0x13) Command

7.2.3 DTMF Detection (0x2) Commands

For the DTMF CMD_type, the values for CMD_subtype are as follows:

1. CMD_type = COLLECTION SPECIFICATION DOWNLOAD (0x0)

2. CMD_subtype = SETUP (0x1)

3. CMD_subtype = EXECUTION (0x2)

The format of each command follows.

7.2.3.1 DTMF/COLLECTION SPECIFICATION DOWNLOAD (0x20)

For this command, the CMD_params field contains an ID of the Collection Specification, followed by all DTMF Collection Specification parameters. Upon receipt of this command, the DSP will copy the values to the default DTMF Collection Specification with this ID.

Table 7-9 shows the format of the DTMF/COLLECTION SPECIFICATION DOWNLOAD command.

Field	Length	Value	Description
CMD _type	4 bits	0x2	DTMF DETECTION type
CMD _subtype	4 bits	0x1	Collection Specification Download
CMD _channel	1 byte	0x00	Command is not channel specific
CMD _length	1 byte	0x0E	Length of this message
CMD _params	11 bytes	*	All Collection Specification values

Table 7-9: ASDF REMOVE CMD_CHANNEL DTMF/COLLECTION SPECIFICATION DOWNLOAD (0x20) Command

Table 7-10 shows the format of the CMD_params section of this command. See Section 5.2.1 for field definitions.

Byte	Bits 76543210
0	Collection Spec ID
1	CW | k
2	DE | N
3	P | FT | MIN_POWER
4	MIN_MAKE
5	MIN_BREAK
6	IDTO | PSC
7	FDTO
8	TDTO
9	POS_TWIST | NEG_TWIST
10	ED | CD

Table 7-10: CMD _params section format for DTMF/COLLECTION SPECIFICATION DOWNLOAD (0x20) Command

7.2.3.1 DTMF/SETUP (0x21)

The DTMF/SETUP command is used to configure a given channel and to start executing DTMF detection on that channel. The format of the DTMF/SETUP command follows:

Field	Length	Value	Description
CMD _type	4 bits	0x2	DTMF

CMD _subtype	4 bits	0x1	SETUP
CMD _channel	1 byte	0x01 - 0x3F	Channel
CMD _length	1 byte	(N+3)	Length of this message
CMD _params	N bytes	*see below	*see below

Table 7-11: DTMF/SETUP (0x21) Command Format

The CMD _params section of the DTMF/SETUP command consists of an execution flag (EX), the default collection spec identifier to use (ID, and the number of digits to collect (N). Optionally, the CMD _params section contains other collection spec parameters. These parameters each have their own parameter ID (1 byte long), and parameter filed (1 byte long). The format of the CMD _params section for this command follows:

Byte	Bits						
	7	6	5	4	3	2	1
0	EX			ID			
1				N			
2+	optional param ID / param pairs						

Table 7-12:

- If the EX bit is 1, then execution is to start after processing this command. Otherwise, the DSP will wait for an execution command separately, and maintain the configuration specified in this command.

- If the ID field is 0, use the previous configuration. If there is no previous configuration, then the DSP will generate an error status. If the ID field is nonzero, then configure this channel with this ID's default collection spec.

- N ranges from 1 to 40. The DSP will generate an error status if N is outside this range.

If optional parameters are included in the DTMF/SETUP command, then the DSP will update the working copy of the collection spec for this channel with the parameters. The allowable values for each optional parameter follows:

Parameter ID (1 byte)	Parameter(s), bit locations 7654321
0	k
1	MIN_POWER
2	MIN_MAKE
3	MIN_BREAK
4	CW
5	IDTO
6	PSC
7	PFTO
8	TDTO

9	POS_TWIST |	NEG_TWIST
10	ED |	CD
11-255	Reserved	

Table 7-13: ASDF UPDATE TABLE FOR NEW FORMAT Parameter ID/Parameter definitions for DTMF/SETUP command

7.2.3.3 DTMF/EXECUTE (0x22)

The DTMF/EXECUTE is used to change the execution status only for a given channel. The format of the DTMF/EXECUTE command follows:

Field	Length	Value	Description
CMD _type	4 bits	0x2	DTMF DETECTION type
CMD _subtype	4 bits	0x3	EXECUTE subtype
CMD _channel	1 byte	0x01 - 0x3F	Channel
CMD _length	1 byte	0x04	Length of this message = 4 bytes
CMD _params	1 byte	0x00, 0x01, or 0x02	START, STOP, ABORT

Table 7-14: ASDF UPDATE TABLE FOR CORRECT SUBTYPE DTMF/EXECUTE (0x22) Command Format

- If CMD _params = 0x00 (START), the DSP will start DTMF collection with the current configuration on the channel specified by CMD channel.
- If CMD _params = 0x01 (STOP), the DSP will stop DTMF collection on the channel specified by CMD _params = 0x02 (ABORT), the DSP will stop DTMF collcection on the channels specified by CMD _channel, and discard any previously unreported digits detected.

7.2.4 MF Detection (0x3) Commands

For the MF CMD _type, the values for CMD _subtype are as follows:

1. CMD _subtype = COLLECTION SPECIFICATION DOWNLOAD (0x0)
2. CMD _subtype = SETUP (0x1)
3. CMD _subtype = EXECUTION (0x2)

The format of each command follows.

7.2.4.1 MF/COLLECTION SPECIFICATION DOWNLOAD (0x30)

For this command, the CMD _params field contains an ID of the Collection Specification, followed by all MF Collection Specification parameters. Upon receipt of this command, the DSP will copy the values to the default MF Collection Specification with this ID.

Table 7-15 shows the format of the MF/COLLECTION SPECIFICATION DOWNLOAD Command.

Field	Length	Value	Description

Field	Length	Value	Description
CMD _type	4 bits	0x3	MF DETECTION type
CMD _subtype	4 bits	0x0	Collection Specification Download
CMD _channel	0 bytes	-	Command is not channel specific
CMD _length	1 byte	0x0F	Length of this message
CMD _params	13 bytes	*	All Collection Specification values

Table 7-15: MF/COLLECTION SPECIFICATION DOWNLOAD (0x30) Command

Table 7-16 shows the format of the CMD _params section of this command. See Section 5.2.1 for field definitions.

(1 byte)	Bits 7 6 5 4 3 2 1 0
0	Collection Spec ID
1	TT | TD | K
2	| N
3	| MIN_POWER
4	MIN_MAKE
5	MIN_BREAK
6	CW
7	IDTO
8	PSC
9	FDTO
10	TDTO
11	ISTT | IS
12	ED | CD

Table 7-16: CMD _params section format for MF/COLLECTION SPECIFICATION DOWNLOAD (0x30) Command

7.2.4.2 MF/SETUP (0x31)

The MF/SETUP command is used to configure a given channel and to start executing MF detection on that channel. The format of the MF/SETUP command follows:

Field	Length	Value	Description
CMD _type	4 bits	0x3	MF
CMD _subtype	4 bits	0x1	SETUP
CMD _channel	1 byte	0x01 -0x3F	Length of this message
CMD _length	1 byte	*see below	*see below
CMD _params	*see below	*see below	All Collection Specification values

Table 7-17: MF/SETUP (0x31) Command Format

The CMD _params section of the MF/SETUP command consists of an execution flag (EX), default collection spec identifier to use (ID), and the number of digits to collect (N). Optionally, the CMD _params section contains other parameters. These optional parameters each have their own parameter ID (1 byte long), and parameter field (1 byte long). The format of the CMD _params section for this

command follows:

Byte	Bits							
	7	6	5	4	3	2	1	0
0	EX							
1				N				
2+	optional param ID / param paris							

Table 7-18

- If the EX bit is 1, then execution is to start after processing this command. Otherwise, the DSP will wait for an execution command separately, and maintain the configuration specified in this command.

- If the ID field is 0, use the previous configuration. If there is no previous configuration, then the DSP will generate an error status. If the ID field is nonzero, then configure this channel with this ID's default collection spec.

- N ranges from 1 to 40. The DSP will generate an error status if N is outside this range.

If optional parameters are included in the MFR1/SETUP command, then the DSP will update the working copy of the collection spec for this channel with the parameters.

The allowable values for each optional parameter follows:

<TABLE>
<CAPTION>

Section	ID numbering	16-bit words per Specification	Number of Specifications	Memory Usage
<S>	<C>	<C>	<C>	<C>
Simple Tone Specifications	0 to 511	10	512	5120
Special Case Templates	512 to 575	10	64	640
Special Tone Specifications	576 to 640	5	64	320
Tone Groups	0 to 63	64	64	4096

</TABLE>

Table 7-19: Parameter ID/Parameter definitions for MF/SETUP command

Again, see Section 5.2.1 for field definitions.

7.2.4.3 MF/EXECUTE (0x33)

The MF/EXECUTE command is used to change the execution status only for a given channel. The format of the MF/EXECUTE command follows:

Field	Length	Value	Description
CMD _type	4 bits	0x3	MF DETECTION type
CMD _subtype	4 bits	0x3	EXECUTE subtype
CMD _channel	1 byte	0x01 - 0x3F	Channel
CMD _length	1 byte	0x04	Length of this message = 4 bytes
CMD _params	1 byte	0x00, 0x01, or 0x02	START, STOP, ABORT

Table 7-20: MF/EXECUTE (0x33) Command Format

- If CMD _params = 0x00 (START), the DSP will start MF collection with the current configuration on the channel specified by CMD _channel.
- If CMD _params = 0x01 (STOP), the DSP will stop MF collection on the channel specified by CMD _channel, and report any previously unreported digits detected.
- If CMD _params = 0x02 (ABORT), the DSP will stop MF collection on the channels specified by CMD _channel, and discard any previously unreported digits detected.

7.2.5 CP Detection (0x4) Commands

For the Call Progress CMD _type, the values for CMD _subtype are as follows:

1. CMD _subtype = SETUP (0x0)
2. CMD _subtype = EXECUTION (0x1)
3. CMD _subtype = COLLECTION SPEC DOWNLOAD (0x2)
4. CMD _subtype = NORMAL CP TONE SPEC DOWNLOAD (0x3)
5. CMD _subtype = SIT CP TONE SPEC DOWNLOAD (0x4)
6. CMD _subtype = TONE GROUP DOWNLOAD (0x5)

The format of each CMD _subtype follows.

7.2.5.1 CP Detection/SETUP (0x40)

The CP Detection/SETUP command is used to configure a given channel and to start executing CP Detection on that channel. The format of this command is as follows:

Field	Length	Value	Description
CMD _type	4 bits	0x4	CP Detection
CMD _subtype	4 bits	0x0	SETUP
CMD _channel	1 byte	0x01 - 0x3F	Channel
CMD _length	1 byte	6, 8, 10, 12, or 14	Message Length
CMD _params	1 byte	*see below	*see below

Table 7-21: CP Detection /SETUP (0x40) Command Format

The CMD _params section of the CP Detection/SETUP command has the following format:

	Parameter(s), bit locations							
Word	7	6	5	4	3	2	1	0
1								EX
2	CP Collection Spec ID							
3	CP Tone Group ID							
4	Optional Param ID 1							

5	Param 1
6	Optional Param ID 2
7	Param 2
8	Optional Param ID 3
9	Param 3
10	Optional Param ID 4
11	Param 4

Table 7-22: CP Detection /SETUP CMD _params section

- Word 1: EX is an execution flag:
  EX = 1: start executing CP Detection after configuring on this channel
  EX = 0: configure this channel, but do not start executing
- Word 2: CP Collection Spec ID:
  CP Collection Spec ID nonzero: This is the new default collection spec. All working values are reinitialized to these defaults. CP Collection Speci ID = 0, then error. At startup, default is set to 0.
- Word 3: CP Tone Group ID: This is the tone group to use on this channel.
- Word 4-11:
  These are the optional parameters, which allow for modification of the working copy of the collection specification. Table 7-23 shows the format of each optional Parameter ID/Parameter pair.

Parameter ID								Parameter							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
						0	0								P
						0	1				PSC				
						1	0								TC
						1	1				FDTO				

Table 7-23: CP Detection/SETUP Param ID/Param values

7.2.5.2 CP Detection/EXECUTE (0x41)

The CP Detection/EXECUTE command is used to change the execution status only for a given channel. The format of the CP Detection/EXECUTE command follows:

Field	Length	Value	Description
CMD _type	4 bits	0x4	CP Detection
CMD _subtype	4 bits	0x1	EXECUTE
CMD _channel	1 byte	0x01 - 0x3F	Channel
CMD _length	1 byte	0x04	Message Length
CMD _params	1 byte	0x00 or 0x01	START (0) OR STOP (1)

Table 7-24: CP Detection/EXECUTE (0x42) Command Format

- If CMD _params = 0x01 (START), the DSP will start CP Detection with the current configuration on the channel specified by CMD _channel.
- If CMD _params = 0x01 (STOP), the DSP will stop CP Detection on the channel specified by CMD _channel.

7.2.5.3 CP Detect/COLLECTION SPEC DOWNLOAD (0x42)

For this command, the CMD _params field contains an ID of the Collection Specification, followed by all CP Detection Collection Specification parameters. Upon receipt of this command, the DSP will copy the values to the default CP Detect Collection Specification with this ID.

Table 7-25 shows the format of the CP Detection/COLLECTION SPEC DOWNLOAD command.

Field	Length	Value	Description
CMD _type	4 bits	0x4	CP Detect
CMD _subtype	4 bits	0x2	Collection Spec Download
CMD _channel	1 byte	0x00	Command is not channel specific
CMD _length	1 byte	0x06	Length of this message
CMD _params	3 bytes	*	All Collection Specification values

Table 7-25: CP Detect/COLLECTION SPECIFICATION DOWNLOAD (0x42) Command Format

Shows the format of the CMD _params section of this command.

Byte	Bits 7	6	5	4	3	2	1	0
1	Collection Spec ID							
2	P			PSC				
3	TC			FDTO				

Table 7-26: CP Detect/COLLECTION SPECIFICATION DOWNLOAD Command CMD _params Section Format

7.2.5.4 CP Detection NORMAL CP TONE SPEC DOWNLOAD (0x43)

For this command, the CMD _params field contains an ID of the Normal CP Tone Specification, followed by all fields in the Normal CP tone Specification. Upon receipt of this command, the DSP will copy the values to the default Normal CP Tone Specification with this ID, then do any preprocessing needed to enable detection of this tone.

shows the format of the CP Detection NORMAL CP TONE SPEC DOWNLOAD command.

Field	Length	Value	Description
CMD _type	4 bits	0x4	CP Detect
CMD _subtype	4 bits	0x3	Normal CP Tone Spec download
CMD _channel	1 byte	0x00	Command is not channel specific
CMD _length	1 byte	0x2F	Length of this message
CMD _params	44 bytes	*	Tone Specification ID and values

Table 7-27: CP Detect/NORMAL CP TONE SPEC DOWNLOAD (0x43)

Command Format

[TBD] Need to add format of CMD _params section for this command

7.2.5.5 CP Detection SIT CP TONE SPEC DOWNLOAD (0x44)

For this command, the CMD _params field contains an ID of the SIT CP Tone Specification, followed by all fields in the SIT CP Tone Specification. Upon receipt of this command, the DSP will copy the values to the default SIT CP Tone Specification with this ID, then do any preprocessing needed to enable detection of this tone.

shows the format of the CP Detect/ SIT CP TONE SPEC DOWNLOAD Command.

Field	Length	Value	Description
CMD _type	4 bits	0x4	CP Detect
CMD _subtype	4 bits	0x4	SIT CP Tone Spec download
CMD _channel	1 byte	0x00	Command is not channel specific
CMD _length	1 byte	0x2F	Length of this message
CMD _params	44 bytes	*	Tone Specification ID and values

Table 7-28: CP Detect/SIT CP TONE SPEC DOWNLOAD (0x44) Command Format

[TBD] Need to add format of CMD _params section for this command

7.2.5.6 CP Detection TONE GROUP DOWNLOAD (0x45)

For this command, the CMD _params field contains an ID of the Tone Group, followed by all fields in the Tone Group. Upon receipt of this command, the DSP will copy the values to the Tone Group with this ID, then do any preprocessing needed to enable detection of tones in this group.

shows the format of the CP Detect/TONE GROUP DOWNLOAD (0x45) command.

Table 7-29: CP Detect/TONE GROUP DOWNLOAD (0x45)
Command Format

[TBD] Need to add format of CMD _params section for this command

7.2.6 Tone Generation (0x5) Commands

For the Tone Generation CMD _type, the values for CMD _subtype are as follows:

1. CMD _subtype = TRANSMIT TONE (0x0)

2. CMD _subtype = OUTPULSE DIGITS (0x1)

3. CMD _subtype = STOP EXECUTION (0x2)

4. CMD _subtype = DOWNLOAD SIMPLE TONE SPEC (0x3)

5. CMD _subtype = DOWNLOAD SPECIAL CASE TEMPLATE (0x4)

6. CMD _subtype = DOWNLOAD SPECIAL TONE SPEC (0x5)

7. CMD _subtype = DOWNLOAD USER-DEFINED TONE GROUP (0x6)

7.2.6.1 Tone Generation TRANSMIT TONE (0x50)

The Tone Generation TRANSMIT TONE command is used to generate singular tones (as opposed to outpulsing a series of tones). When the DSP processes this command, it will begin generating the tone specified in the command. Upon completion of the tone (if not infinite duration), the DSP will generate silence to the channel. The format of this command is shown below.

Field	Length	Value	Description
CMD _type	4 bits	0x5	Tone Generation
CMD _subtype	4 bits	0x0	Transmit Tone
CMD _channel	1 byte	1-63	Channel
CMD _length	1 byte	5	Length of this message
CMD _params	2 bytes	1-64 1-64	Tone Group ID Tone Index

Table 7-30: Tone Generation TRANSMIT TONE (0x50) Command Format

7.2.6.2 Tone Generation OUTPULSE DIGITS (0x51)

The Tone Generation OUTPULSE DIGITS command is used to generate a series of tones from one Tone Group. When the DSP processes this command, it will begin outpulsing the tones specified in the command. Upon completion of the tones, the DSP will generate silence to the channel. If the Report Completion flag (RC) is set, the DSP will also report tone completion.

If the Tone Group specified in this command is 0-3 (special DTMF, MFR1, MFR2-Forwards and MFR2-Backwards Tone Groups), then the tones are specified in 4 bit numbers (0 to 15). Otherwise, they are specified in 8 bit numbers. The format of this command is shown below.

Field	Length	Value	Description
CMD _type	4 bits	0x5	Tone Generation
CMD _subtype	4 bits	0x1	Outpulse Digits
CMD _channel	1 byte	1-63	Channel
CMD _length	1 byte	*see below	Length of this message
CMD _params	*see below	*see below	*see below

Table 7-31: Tone Generation OUTPULSE DIGITS (0x50) Command Format

The format of the CMD _params section for this command is shown below.

(DTMF, MFR1, MFR2 Tone Groups)

Byte	7	6	5	4	3	2	1	0
1	Tone Group = 0, 1, 2, or 3							
2	RC	Number of Digital (1 to 40)						
3	Tmake in ms (if 0, default = 50 ms)							
4	Tbreak in ms (if 0, default = 50 ms)							
5	digit 1				digit 2			

6	digit 3	digit 4
7	-	-
	-	-
<=24	-	-
<=44		

(User-Defined Tone Groups)							
7	6	5	4	3	2	1	0
Tone Group: 4 to 63							
RC	|	Number of Digits (1 to 40)					
Tmake in ms (if 0, default = 50 ms)							
Tbreak in ms (if o, default = 50 ms)							
digit 1							
digit 2							
digit 3							
-							
-							
-							
-							

Table 7-32: CMD _params section format for

Tone Generation/OUTPULSE DIGITS (0x51) Command

7.2.6.3 Tone Generation STOP EXECUTION (0x52)

The Tone Generation STOP EXECUTION command is used to cease tone generation. When it processes this command, the DSP will transition to the IDLE state on the given channel. The format of this command is shown below.

Field	Length	Value	Description
CMD _type	4 bits	0x5	Tone Generation
CMD _subtype	4 bits	0x2	Stop Execution
CMD _channel	1 byte	1-63	Channel
CMD _length	1 byte	3	Length of this message
CMD _params	0 bytes	-	No parameters

Table 7-33: Tone Generation STOP EXECUTION (0x52) Command Format

7.2.6.4 Tone Generation DOWNLOAD SIMPLE TONE SPEC (0x53)

The Tone Generation DOWNLOAD SIMPLE TONE SPEC command is used to update Simple Tone Specifications. When it processes this command, the DSP will copy the parameters to the location of the Simple Tone Spec with the commanded ID.

The format of this command is shown below.

Field	Length	Value	Description
CMD _type	4 bits	0x5	Tone Generation
CMD _subtype	4 bits	0x3	Download Simple Tone Spec
CMD _channel	0 bytes	-	No Channel
CMD _length	1 byte	24	Length of this message
CMD _params	22 bytes	-	Simple Tone Spec ID and values

Table 7-34: Tone Generation DOWNLOAD SIMPLE TONE SPEC (0x53) Command

[TBD] need to add format of CMD _params section for this command

106

7.2.6.6 Tone Generation DOWNLOAD SPECIAL TONE SPEC (0x52)

The Tone Generation DOWNLOAD SPECIAL TONE SPEC command is used to update Special Tone Specifications. When it processes this command, the DSP will copy the parameters to the location of the Special Tone Specification with the commanded ID.

The format of this command is shown below.

Field	Length	Value	Description
CMD type	4 bits	0x5	Tone Generation
CMD subtype	4 bits	0x5	Download Special Tone Spec
CMD channel	0 bytes	-	No Channel
CMD length	1 byte	12	Length of this message
CMD _params	10 bytes	-	Special Tone Spec ID and values

Table 7-36: Tone Generation DOWNLOAD SPECIAL TONE SPECIFICATION (0x55)

Command Format

[TBD] need to add format of CMD_params section for this command

7.2.6.7 TONE GENERATION DOWNLOAD USER-DEFINED TONE GROUP (0X56)

The tone Generation DOWNLOAD USER-DEFINED TONE GROUP command is used to update User-defined tone Groups. When it processes this command, the DSP will copy the parameters to the location of the User-defined Tone Group with this commanded ID.

The format of this command is shown below.

Field	Length	Value	Description
CMD type	4 bits	0x5	Tone Generation
CMD Subtype	4 bits	0x6	Download User-defined Tone Group
CMD channel	0 bytes	-	No Channel

CMD length	1 byte	132	Length of this message
CMD _params	130	-	User-defined tone Group ID and values

Table 7-37: Tone Generation DOWNLOAD USER-DEFINED TONE GROUP (0x56) Command Format

[TBD] need to add format of CMD-params section for this command

7.2.7 MFcR2 Signalling (0x6) Commands
For the MF cR2 CMD _type, the values for CMD _subtype are as follows:

1. CMD_subtype = COLLECTION SPECIFICATION DOWNLOAD (0x0)

2. CMD_subtype = SETUP (0x1)

3. CMD_subtype = EXECUTION (0x2)

The format of each command follows:

7.2.7.1 MFCR2/COLLECTION SPECIFICATION DOWNLOAD (0X60)

For this command, the CMD _params field contains an ID of the Collection Specification, followed by all MF Collection Specification parameters. Upon receipt of this command, the DSP will copy the values to the default MF Collection Specification with this ID.

Table 7-38 shows the format of the MFcR2/COLLECTION SPECIFICATION DOWNLOAD command.

Field	Length	Value	Description
CMD type	4 bits	0x6	MFcR2 Signalling
CMD subtype	4 bits	0x0	Collection Specification Download
CMD channel	0 bytes	-	Command is not channel specific
CMD length	1 byte	0x0F	Length of this message
CMD _params	13 bytes	*	All Collection Specification values

Table 7-38: MFcR2/COLLECTION SPECIFICATION DOWNLOAD (0x60) Command

Table 7-39 shows the format of the CMD _params section of this command. See Sections 5.2.1 and 5.3.1 for field definitions.

	Bits							
Byte	7	6	5	4	3	2	1	0
0	Collection Spec ID							
1	TT			TD			k	
2	N							
3	MIN POWER							
4	MIN_MAKE							

5	MIN_BRAKE	
6	CW	
7	IDTO	
8	PSC	
9	FDTO	
10	TDTO	
11	ISTT	IS
12	ED	CD

Table 7-39: CMD_params section format for MFcR2 / COLLECTION SPECIFICATION DOWNLOAD (0x30) Command

7.2.7.2 MFcR2/SETUP (0x61)

The MFcR2/SETUP command is used to configure a given channel and to start executing MFcR2 signalling on that channel. The format of the MFcR2/SETUP command follows:

Field	Length	Value	Description
CMD type	4 bits	0x6	MFcR2
CMD subtype	4 bits	0x1	SETUP
CMD channel	0 byte	0x01 - 0x3F	Channel
CMD length	1 byte	*see below	Length of this message
CMD_params	*see below	*see below	*see below

Table 7-40: MFcR2/SETUP (0x61) Command Format

The CMD_params section of the MFcR2/SETUP command consists of the default collection spec identifier to use (ID, and the number of digits to collect (N). Optionally, the CMD _params section contains other parameters. These optional parameters each have their own parameter ID (1 byte long), and parameter field (1 byte long). The format of the CMD _params section for this command follows:

Bits							
Byte 7	6	5	4	3	2	1	0
0	EX			ID			
1					N		
2+	optional param ID / param pairs						

Table 7-41

o The EX bit is disabled for MFcR2 signalling. This is because there is other information that is needed before signalling can begin. The DSP will wait for an execute command separately, and maintain the configuration specified in this command.

o If the ID field is 0, use the previous configuration. If there is no previous configuration, then the DSP will generate an error status. If the ID field is nonzero, then configure this channel with this ID's default collection spec.

o N ranges from 1 to 40. The DSP will generate an error status if N is outside this range.

If optional parameters are included in the MFcR2/SETUP command, then the DSP will update the working copy of the collection spec for this channel with the parameters. The allowable values for each optional parameter follows:

Bits							
Byte	7	6	5	4	3	2	1	0
0	Collection Spec ID							
1	TT			TD			k	
2	N							
3	MIN POWER							
4	MIN_MAKE							
5	MIN_BRAKE							
6	CW							
7	IDTO							
8	PSC							
9	FDTO							
10	TDTO							
11	ISTT				IS			
12	ED				CD			

Table 7-42: Parameter ID/Parameter definitions for MFcR2/SETUP command

Again, see Sections 5.2.1 and MF Collection Specifications for field definitions.

7.2.7.3 MFCR2/EXECUTE (0X63)

The MFcR2/EXECUTE command is used to start executing either forwards or backwards compelled signalling for a given channel. If this is a start execution command, then this command also contains other information needed to execute. The format of the MF/EXECUTE command follows:

Field	Length	Value	Description
CMD type	4 bits	0x6	MFcR2 Signalling

CMD subtype	4 bits	0x3	EXECUTE
CMD channel	1 byte	0x01 - 0x3F	Channel
CMD length	1 byte	*see below	*see below
CMD _params	1 byte	*see below	*see below

Table 7-40: MFcR2/SETUP (0x61) Command Format

For this CMD type / CMD _subtype, the CMD_params field format is defined by the first byte in the CMD _params section. The defined values are as follows:

- CMD_params = 0x00: Start executing Forward Signalling. Additional data is present in the CMD_params section for this command -- see below.
- CMD_params = 0x01: Start executing Backward Signalling. No other information is needed. CMD_params is 1 btye long.
- CMD_params = 0x02: Stop executing MFcR2 signalling. No other information is needed. CMD_params is 1 byte long.
- CMD_params = 0x03: Reset execution of MFcR2 signalling. No other information is needed. CMD_params is 1 byte long.

Each of the different formats for CMD_params are defined below:

7.2.7.3.1 MFcR2/EXECUTE - Start Forward Signalling

For this command, the CMD_params section contains the digit strings that will be requested by the backwards register. The CMD_params section has the following format:

Bits								
Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
2	Number of digit strings							
3	Length of first string							
4	first string of digits - 4 bits each (Round up to the nearest byte)							
5								
*	Length of second string							
*	Second string of digits - 4 bits each							
*								
	Length of next string							
<=31	Last string of digits - 4 bits each							

Table 7-44: CMD_params format for MFcR2/EXECUTE -- Start Forward Signalling Command

7.2.7.3.2 MFcR2/EXECUTE - Start Backward Signalling

For this command, the CMD_params section contains the backward signalling flag. The number of digits to collect, next digit, and cancel digit information is all contained in the collection specification.

	Bits							
Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1

Table 7-45: CMD_params format for MFcR2/EXECUTE -- Start Backward Signalling Command

7.2.7.3.3 MFcR2/EXECUTE - Stop MFcR2 Signalling

	Bits							
Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	0

Table 7-46: CMD_params format for MFcR2/EXECUTE -- Stop MFcR2 Signalling Command

7.2.7.3.4 MFcR2/EXECUTE - Reset MFcR2 Signalling

For this command, the CMD_params section contains the reset flag. Upon receipt of this command, the DSP will cease MFcR2 signalling, discard any collected digits, and restart MFcR2 signalling.

	Bits							
Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	1

Table 7-47: CMD_params format for MFcR2/EXECUTE -- Reset <FcR2 Signalling Command

8. Status Messages

8.1 Status String Format

The DSPs send status to the Core Processor using the first timeslot on the first buffered serial port using point-to-point HDLC protocol. Each status message consists of a variable length status string, which is composed of the following fields: a status type (STAT_type), status subtype (STAT-subtype), the channel number (STAT_channel), the message length in bytes (STAT_length), and status parameters (STAT_params).

- The STAT_type and STAT_subtype fields are each 4 bits long, and combine for the first byte of all status messages. STAT_type is in the high nibble.
- STAT_channel is one byte long for status messages that are channel specific; for status messages that have no associates channel, the STAT_channel field is 0 bytes long (not present).
- STAT_length is one byte long for all status messages.

o The Stat_params field's length is variable, in one byte increments. Note that for certain STAT_type/STAT_subtype combinations, the STAT_params field is 0 bytes long (not present).

The status string shall have one of the following structures, depending on whether the STAT_length field is present:

115

1	STAT_type	STAT_subtype
2	STAT_channel	
3	STAT_length	
4+	STAT-params	

Table 8-1: Status structure when STAT_channel is present

1	STAT_type	STAT_subtype
2	STAT_length	
3+	STAT-params	

Table 8-2: Status structure when STAT_channel is present

8.2 Status Message Definitions

Table 8-3 shows the legal values for the STAT_type field.

STAT_type(HEX)	Function	Description
0x0	IDLE	Confirmation of entering IDLE state
0x1	Diagnostic Test	Confirmation/results of diagnostics
0x2	DTMF Detection	DTMF detection status
0x3	MFR1 Detection	MFR1 detection status
0x4	CP Detection	CP detection status
0x5	Tone Generation	Tone generation status
0x6	MFcR2 Signalling	MFcR2 signalling status
0x7 - 0xF	Not Used	Reserved for future expansion

Table 8-3: Legal STAT_type values.

Defined values for the STAT_subtype field are dependent on the STAT-type function. Similarly, the defined values for the STAT_params field are dependent on the STAT_type and STAT_subtype values. the following subsections define all legal combinations STAT_subtype and STAT_params for each STAT_type.

8.2.1 IDLE (0x0) Status

116

Table 8-4 describes the meanings of all IDLE status messages. STAT_subtype contains the channel number of the channel that has entered the IDLE state (0 for all channels).

Field	Length	Value	Description
STAT type	4 bits	0x0	IDLE type
STAT subtype	4 bits	0x00 - 0x3F	Channel that entered IDLE state (0 = all channels
STAT channel	0 bytes	-	Not present (channel is in STAT subtype field)
STAT length	1 byte	0x02	Length of this message
STAT _params	0 byte	(none)	Not present

Table 8-4: IDLE status

8.2.2 DIAGNOSTIC TEST Status

Table 8-5 describes the meanings of all DIAGNOSTIC TEST status messages.

STAT_type	STAT_subtype	STAT_params	Description
0x1	0x0	TBD	TBD
	0x1	TBD	TBD
	0x2	TBD	TBD
	0x3	TBD	TBD
	.	TBD	.
	0x3F	TBD	TBD

Table 8-5: DIAGNOSTIC TEST status

8.2.3 DTMP Detection (0x2) Status Messages

For the DTMF STAT_type, the values for STAT_subtype are as follows:

1. STAT_subtype=DIGIT Report (without times) (0x0)
2. STAT_subtype=DIGIT REPORT (with times) (0x1)

3. STAT_subtype=ERROR (0x2)

The format of each status message follows.

8.2.3.1 DTMF/DIGIT REPORT (WITHOUT TIMES) (0X20)

For this status message, the STAT_params field contains the event flags, the number of digits detected, and the digits detected.

<TABLE>
<CAPTION>

Byte	Field	Value	Description
<S>	<C>	<C>	<C>
1	type/subtype	0x20	DTFM/DIGIT REPORT (without times)
2	channel #	1-63	STAT_channel
3	length	< = 24	STAT_length
4	parameters	Event Flags	*See below
5		Number of Digits	n = 0 to 40
6		Digit 1/2	4 bits per digit
.		Digit 3/4	
.		.	
< = 25		Digit n-1/n	

</TABLE>

Table 8-6

The event flags are defined as follows:

Bits							
7	6	5	4	3	2	1	0
0	RA	ED	CD	TDTO	PSC	IDTO	FDTO

Table 8-7

- FDTO: First digit timeout occurred
- IDTO: Inter digit timeout occurred
- PSC: Permanent signal condition occurred

- TDTO: Total digit timeout occurred
- CD: Cancel digit detected
- ED: End digit detected
- RA: Resource Attached

8.2.3.2 DTMF/DIGIT REPORT (WITH TIMES) (0X21)

For this status message, the STAT_params field contains the event flags, the number of digits detected, the digits detected, and the start and stop times for the detected digits. Times will be reported in units of 1 ms, but will have a granularity of 8 ms.

<TABLE>
<CAPTION>

Byte	Field	Value	Description
<S>	<C>	<C>	<C>
1	type/subtype	0x21	DTFM/DIGIT REPORT (with times)
2	channel #	1-63	STAT_channel
3	length	< = 24	STAT_length
4	parameters	Event Flags	*See below
5		Number of Digits	n = 0 to 40
6		Digit 1/2	Digits 1 and 2; four bits per digit
7		Make 1 (high byte)	Duration
8		Make 1 (low byte)	
9		Break 1 (high byte)	Duration of ms of first interdigit silence
10		Break 1 (low byte)	
.		Make 2 (high byte)	Duration of ms of digit 1
.		Make 2 (low byte)	
.		Break 2 (high byte)	Duration of ms in first interdigit silence
.		Break 2 (low byte)	
.		Digit 3/4	
.		Make 3 (high byte)	

.		.	
<=365		.	

</TABLE>

119

Table 8-8

8.2.3.3 DTMF/DIGIT ERROR (0X22)

For this status message, the STAT_params field contains the error type.

Byte	Field	Value	Description
1	type/subtype	0x22	DTFM/DIGIT REPORT (without times)
2	channel #	1-63	STAT_channel
3	length	4	STAT_length
4	parameters	Error Code	*See below

Table 8-9

Asdf add error codes

8.2.4 MF Detection (0x3) Status Messages

For the MF STAT_type, the values for STAT_subtype are as follows:

1. STAT_subtype = DIGIT REPORT (without times) (0x0)
2. STAT_subtype = DIGIT REPORT (with times) (0x1)
3. STAT_subtype = ERROR (0x3)

The format of each status message follows.

8.2.4.1 MF/DIGIT REPORT (WITHOUT TIMES) (0X30)

For this status message, the STAT_params field contains the event flags, the number of digits detected, and the digits detected.

Byte	Field	Value	Description
1	type/subtype	0x30	DTFM/DIGIT REPORT (without times)
2	channel #	1-63	STAT_channel
3	length	< = 24	STAT_length
4	parameters	Event Flags	*See below
5		Number of Digits	n = 0 to 40
6		Digit 1/2	4 bits per digit

120

.		Digit 3/4	
.		.	
<=25		Digit n-1/n	

Table 8-10

The event flags are defined as follows:

Bits							
7	6	5	4	3	2	1	0
0	RA	ED	CD	TDTO	PSC	IDTO	FDTO

Table 8-11

- FDTO: First digit timeout occurred
- IDTO: Inter digit timeout occurred
- PSC: Permanent signal condition occurred
- TDTO: Total digit timeout occurred
- CD: Cancel digit detected
- ED: End digit detected
- RA: Resource Attached

8.2.4.2 MF/DIGIT REPORT (WITH TIMES) (0X31)

For this status message, the STAT_params field contains the event flags, the number of digits detected, the digits detected, and the start and stop times for the detected digits.

Byte	Field	Value	Description
1	type/subtype	0x21	MF/DIGIT REPORT (with times)

2	channel #	1-63	STAT_channel
3	length	< = 24	STAT_length
4	parameters	Event Flags	*See below
5		Number of Digits	n = 0 to 40
6		Digit 1/2	Digits 1 and 2; four bits per digit
7		Make 1 (high byte)	Duration in ms of digit 1
8		Make 1 (low byte)	
9		Break 1 (high byte)	Duration of ms of first interdigit silence
10		Break 1 (low byte)	
.		Make 2 (high byte)	Duration of ms of digit 1
.		Make 2 (low byte)	
.		Break 2 (high byte)	Duration of ms in first interdigit silence
.		Break 2 (low byte)	

.		Digit 3/4	
.		Make 3 (high byte)	
.		.	
<=365		.	

</TABLE>

Table 8-12

8.2.4.3 MF/DIGIT ERROR (0X32)

For this status message, the STAT_params field contains the error type.

<TABLE>
<CAPTION>

Byte	Field	Value	Description
<S>	<C>	<C>	<C>
1	type/subtype	0x32	MF/ERROR
2	channel #	1-63	STAT_channel
3	length	4	STAT_length
4	parameters	Error Code	*See below

</TABLE>

Table 8-13

122

Asdf add error codes

8.2.5 CP Detection (0x4) Status Messages

For the CP DETECTION STAT_type, the values for STAT_subtype are as follows:

1. STAT_subtype = TONE DETECTED (0x0)
2. STAT_subtype = EVENT (0x1)
3. STAT_subtype = ERROR (0x2)

The format of each status message follows.

8.2.5.1 CP DETECT/TONE DETECTED (0X40)

For this status message, the STAT_params field contains the return value for the tone detected.

Byte	Field	Value	Description
1	type/subtype	0x40	CP Detect/TONE DETECTED
2	channel #	1-63	STAT_channel
3	length	< = 24	STAT_length
4	parameters	RET_VAL	Return value for detected tone

Table 8-14

8.2.5.3 CP DETECT/EVENT (0X41)

For this status message, the STAT_params field contains the event flag mask.

Byte	Field	Value	Description
1	type/subtype	0x41	CP Detect/EVENT

2	channel #	1-63	STAT_channel
3	length	4	STAT_length
4	parameters	Event Flag ID	*See below

Table 8-15

The event flag ID values are defined as follows:

123

Event ID	Description
0	PSC timeout flag
1	TDTO flag
2	Tone cessation flag
3	Resource attached

Table 8-16

8.2.5.3 CP DETECT/ERROR (0X42)

For this status message, the STAT_params field contains the event flag mask.

Byte	Field	Value	Description
1	type/subtype	0x42	CP Detect/ERROR
2	channel #	1-63	STAT_channel
3	length	4	STAT_length
4	parameters	number of errors	number of errors
5		error ID	
6		<error value>	.
		error ID	.
.		..	.

Table 8-17

The error IDs and error values are defined as follows:

Error ID	Length	Error Name	Error value
0x0	1	Collection spec does not exist	<none>
0x1	2	Tone group does not exist	<tone group ID>
0x2	2	Tone specification does not exist	<tone spec ID>
0x3	1	Algorithm not configured	<none>
0x4	1	Max channels exceeded	<none>

124

0x5	1	Illegal channel	<none>
0x6-0xFF		reserved	

Table 8-18

8.2.6 Tone Generation (0x5) Status Messages

For the Tone Generation STAT_type, the values for STAT_subtype are as follows:

1. STAT_subtype = OUTPULSE COMPLETE (0x0)

2. STAT_subtype = ERROR (0x1)

The format of each status message follows

8.2.6.1 TONE GENERATION/OUTPULSE COMPLETE (0X50)

The DSP may be required to report completion of an outpulsing of tones.

The format of the Tone Generation/OUTPULSE COMPLETE status message is as follows:

Byte	Field	Value	Description
1	type/subtype	0x50	Tone Gen/OUTPULSE COMPLETE
2	channel #	1-63	STAT channel
3	length	3	STAT length

Table 8-19

8.2.6.2 TONE GENERATION/ERROR (0X51)

For this status message, the STAT_params field contains the event flag mask.

125

Byte	Field	Value	Description
1	type/subtype	0x51	Tone Generation/ERRORS
2	channel #	1-63	STAT channel
3	length	4+	STAT length
4	parameters	Error ID	*see below
		Error ID	

Table 8-20

The error ID values are defined as follows:

Error ID	Description
0x0	Tone specification does not exist
0x1	Algorithm not configured
0x2	Illegal channel
0x3-0xFF	Reserved

Table 8-21

8.2.7 MFcR2 Signalling (0x6) Status Messages

For the MFcR2 STAT_type, the values for STAT_subtype are as follows:

1. STAT_subtype = DIGIT REPORT (0x0)

2. STAT_subtype = ERROR (0x3)

The format of each states message follows.

8.2.7.1 MFCR2/DIGIT REPORT (0X60)

For this status message, the STAT_params field contains the event flags, the number of digits detected, and the digits detected.

Byte	Field	Value	Description
1	type/subtype	0x60	MFcR2/DIGIT REPORT
2	channel #	1-63	STAT channel
3	length	<= 24	STAT length
4	parameters	Event Flags	*see below
5		Number of Digits	n = 0 to 40
6		Digit 1/2	4 bits per digit
		Digit 3/4	
<= 25		Digit n-1/n	

Table 8-22

The event flags are defined as follows:

	Bits						
7	6	5	4	3	2	1	0
0	RA	ED	CD	TDTO	PSC	IDTO	FDTO

Table 8-23

- FDTO: First digit timeout occurred
- IDTO: Inter digit timeout occurred
- PSC: Permanent signal condition occurred
- TDTO: Total digit timeout occurred
- CD: Cancel digit detected
- ED: End digit detected
- RA: Resource Attached

127

8.2.7.2 MFCR2/ERROR (0X32)

For this status message, the STAT_params field contains the error type.

Byte	Field	Value	Description
1	type/subtype	0x62	MFcR2/ERROR
2	channel #	1-63	STAT channel
3	length	4	STAT length
4	parameters	Error Code	*see below

Table 8-24

EXHIBIT 10.3

SOFTWARE LICENSE AND MAINTENANCE AGREEMENT

This Software license and maintenance agreement ("Agreement") is entered into effective as of August 4, 1997 (the "Effective Date") by and between D2 Technologies, Inc., a California corporation with offices at 104 West Anapamu Street, Santa Barbara, CA 93101 ("D2"), and Summa Four Inc., a Delaware corporation with offices at 25 Sundial Avenue, Manchester, New Hampshire 03103-7251 ("LICENSEE").

WHEREAS, D2 has previously developed certain software and designs capable of performing certain voice processing functions;

WHEREAS, LICENSEE is developing a product which requires certain software functions and designs capable of performing certain voice processing functions;

WHEREAS, D2 desires to license to LICENSEE certain of its software technology for use in connection with Licensee's products:

WHEREAS, D2 is further willing to provide certain maintenance and support services to LICENSEE in relation to such software technology;

NOW THEREFORE, in consideration of the mutual promises and covenants contained herein, the parties agree as follows:

1. DEFINITIONS

1.1 "Licensed Technology" shall mean software licensed to LICENSEE by D2 as listed in Exhibit A.

1.2 "DSP" shall mean digital signal processing.

1.3 "Runtime License Fee" shall have the meaning set forth in Article 2.2(iii).

1.4 "Specifications" shall mean D2's specifications of the Licensed Technology which are attached hereto as Exhibit A.

1.5 "Update" shall mean a new release of a software product which typically includes bug fixes and/or minor feature changes, but does not include substantial new functionality.

1.6 "New Version" in this Agreement shall mean a new release of Licensed Technology that provides significant performance enhancements, including new releases of software product optimized for different members of the same DSP processor family which is based on the same core architecture and instruction set.

1.7 "Defect" shall mean any failure of Licensed Technology to meet the Specification as a result of a material failure (including an error or "bug" that is material) of the Licensed Technology. "Material" is defined as priority A, B, and C in Article 6.3.

1.8 "Source Code" shall mean all computer programming instructions relating to a software product in a form readable by humans and typically prepared by a programmer. Source Code includes associated procedural code, comments, utilities, tools, notes, data diagrams and related and supporting technical documentation.

1.9 "Object Code" shall mean software code resulting from the translation or processing of Source Code by a computer into machine language or intermediate code, which thus is in a form that would not be convenient to human understanding of the program logic, but which is appropriate for execution or interpretation by a computer.

1.10 "Licensed Source Code" shall mean Source Code for Licensed Technology.

1.11 "Licensee Product" shall mean the product being developed by LICENSEE as described in Exhibit B, which utilizes Licensed Technology. LICENSEE shall own all rights, title and interest in Licensee Product. D2 shall have no rights to Licensee Product.

1.12 "End User" shall mean a person or business entity that purchases, leases or otherwise properly obtains the right to use or distribute a Licensee Product directly from LICENSEE or through one or more intermediaries.

2. LICENSED TECHNOLOGY

2.1 Ownership. Subject to the rights granted to LICENSEE in this Agreement, D2 owns all right, title and interest in and to the Licensed Technology. Notwithstanding the foregoing, LICENSEE shall retain all right, title and interest in and to modifications to the Licensed Source Code made by LICENSEE pursuant to the license in Article 2.2 below, subject always to D2's ownership rights in the underlying Licensed Technology.

2.2 License to LICENSEE.

(i) Subject to the terms and conditions of this Agreement, D2 hereby grants LICENSEE a perpetual non-exclusive, worldwide license, to use Licensed Technology in Object Code format only as an incorporated part of the Licensee Product. For this purpose, LICENSEE may also modify, create derivative works, of and reproduce and have reproduced the Licensed Technology, and to develop, use, market and distribute (directly or through third parties) Licensed Technology, or modifications or derivative works of the Licensed Technology created by or for LICENSEE.

(ii) In consideration for the right to modify, develop and completely own derivative works of the Licensed Technology set forth in Article 2.2 (i) above, LICENSEE shall pay D2 a license fee (the "Development License Fee") as set forth in Exhibit C. Final acceptance testing shall be completed by the parties according to Article 4 of this Agreement.

(iii) LICENSEE shall pay D2 a license fee ("Runtime License Fee") as set forth in Exhibit C for each copy of the Licensed Technology that LICENSEE distributes to end users directly or through third parties for such end-user's use in connection with Licensee's Product. The Runtime License Fee shall be paid by LICENSEE quarterly for Licensee Products which have been paid for by Licensee's end-user customer in the prior quarter. To the extent Licensee accepts returns or is required to provide refunds to its customers (and to the extent additional Licensee Products are delivered to customers for warranty or maintenance/support purposes), such circumstances will either entitle Licensee to obtain a credit against future Runtime License Fees owed or, in the case of warranty/maintenance or support deliveries, no Runtime License Fees shall be due at all.

(iv) LICENSEE is also granted a limited non-transferable non-exclusive license to Licensed Source Code to perform software maintenance functions according the terms set forth in Article 7 of this Agreement.

(v) D2 shall provide LICENSEE with master copies of the Licensed Technology, in Source Code and Object Code format, promptly after such software has been completed, tested and approved for release by D2

and Licensee. In any event, D2 shall deliver all Licensed Technology completely tested and approved for performance in accordance with the specifications.

2.3 End User License. LICENSEE shall ensure that all Licensed Technology distributed by LICENSEE shall be subject to a shrink-wrap agreement or other end user agreement which contains a provision substantially similar to the provision set forth in Exhibit D.

3. ADDITIONAL TECHNOLOGY LICENSE

3.1 New Functions. In the event that LICENSEE requires any additional functionality or technology substantially different from those set forth in Exhibit A or otherwise made available by D2 to other Licensees, D2 shall license such additional functionality or technology to LICENSEE at D2's then best price to its other Licensees. Such additional technology licenses shall be subject to the same terms of this agreement except for an amendment to the product specification and price schedule of Exhibits A and C. Any other new licensing terms shall be negotiated in advance and included in said amendment.

3.2 Different Processors.

(A) "Supported Processors": If D2 offers or plans to offer all or part of Licensed Technology on a processor ("Supported Processor") different from the Texas Instruments (TI) TMS320C54x family of processors, D2 shall make available to LICENSEE such new versions of Licensed Technology under the same terms of this Agreement subject to the license fees as follows:

(i) The development license fees for any part or all of Licensed Technology for each "Supported Processor" shall be 50% of that for the TMS320C54x processor family as listed in Exhibit C.

(ii) The per-processor runtime license fees for any "Supported Processor" shall be the same as that specified in Exhibit C for the TI TMS320C54x.

(iii) The runtime license fee CAP in exhibit C shall be cumulative across the TI TMS320C54x, TMS32OC55x, TMS330C6x, and other TI processors based on the same core processor architecture. For processors other than the TI processors listed in this Article 3.2A(iii) ("additional supported processors"), the runtime license fee CAP and buy-out license fee in Exhibit C shall be increased by 25% for each "additional supported processor." The CAP for Licensed Technology shall be cumulative across all "Supported Processors" (including "additional supported processors") utilized by LICENSEE. If the cumulative inflation index (according to government published Consumer Price Index) exceeds 25% from the effective date of this Agreement to the time when D2 makes available Licensed Technology for an "additional supported processor", D2 and LICENSEE agree to negotiate in good faith reasonable incremental runtime license fees for Licensed Technology used in such "additional supported processor.

(B) "Unsupported Processors". If LICENSEE requires versions of Licensed Technology on a processor other than the "Supported Processors", D2 agrees to negotiate in good faith with LICENSEE an agreement to develop such a version of Licensed Technology. Such an agreement shall include appropriate development license fees and runtime license fees as well as special engineering service fees.

4. ACCEPTANCE

Upon delivery of the Licensed Technology to Licensee, D2 will have tested and verified that such Licensed Technology shall perform in accordance with an acceptance specification agreed to by D2 and LICENSEE. The acceptance specification shall be completed no later than 90 days after the effective date of this Agreement and shall be attached to this agreement as Exhibit F. Upon successful completion of the acceptance testing, LICENSEE shall make the final "Development License Fee" payment described in Exhibit C LICENSEE shall, within thirty (30) days after delivery of any Licensed Technology, either accept such Licensed Technology or reject such Licensed Technology because of nonconformance with the Specifications. LICENSEE shall provide D2 with written notification of any rejection of Licensed Technology which explains the basis for such rejection. If completion of testing is precluded or delayed due to performance deficiencies, incompatibilities or other Defects in the Licensed Technology, D2 shall immediately and without any additional payment, correct such Defects.. All corrected versions of the Licensed Technology shall be subject to the acceptance procedures set forth above in this Article 4.

5. REPORTS, AUDITS

5.1 Reports. Within thirty days after the end of each calendar quarter during the term of this Agreement, LICENSEE shall provide D2 with written reports setting forth the number of LICENSEE Products containing the Licensed Technology that were licensed to end users by LICENSEE in such calendar quarter as more particularly described in Article 2.2 (iii) above.

5.2 Audits. LICENSEE shall maintain records of its distribution of Licensee Products containing the Licensed Technology, for a period of one year after the date on which LICENSEE distributes the Products to which such records pertain. D2 may audit such records by engaging an independent public audit firm, approved in advance by Licensee, upon thirty days written notice, provided that (i) no more than one such audit may be made in any twelve month period, (ii) D2 may only audit LICENSEE's records for a particular time period once, and (iii) D2 shall be responsible for ensuring that the auditor executes and abides by LICENSEE's confidentiality agreement.

6. MAINTENANCE AND SUPPORT

6.1 Maintenance and Support Obligation, Fees. On the date of expiry of the Warranty period defined in Article 8.3, and on any anniversary of the expiry date, LICENSEE may in its sole discretion pay D2 a "Maintenance and Support Fee" according to Exhibit C. In return for payment of such fee, D2 shall provide LICENSEE with the maintenance and support set forth in this Article 6 for a period of twelve months (the "Contract Year"). In any event, D2 shall provide support and maintenance services to Licensee during the Warranty period in breadth and scope which is no less than the support and maintenance services described in this Article. D2 shall make available to LICENSEE the maintenance and support services according to the terms of this Article 6 for a minimum of five years after Acceptance of Licensed Technology.

6.2 Maintenance. Maintenance to be provided by D2 to LICENSEE shall include without limitation the following services;

(i) D2 shall update and maintain the Licensed Technology throughout the term of this Agreement. It is intended that D2 shall release at least 1 Update or New Version release during each 12 month calendar year. Upon the releases of any Update or New Version of the Licensed Technology (including manuals), D2 shall promptly notify and deliver to LICENSEE such Update or New Version.

(ii) D2 will initially deliver to LICENSEE one (1) copy of any Updates or New Versions to the Licensed Technology and one (1) set of corresponding manuals for each copy of the Licensed Technology for which LICENSEE has paid the appropriate development license fees and maintenance fees

pursuant to Exhibit C as soon as such Updates or New Versions and corresponding manuals become available and shall maintain such Updates or New Versions throughout this agreement.

6.3 Error Correction. If D2 becomes aware of any Defect in the Licensed Technology, D2 shall promptly provide LICENSEE with written notice of such Defect. D2 shall have no obligation to actively monitor the Licensed Technology for Defects after such software has been accepted by LICENSEE. D2 shall work diligently to promptly correct Defects in accordance with the following schedule; "days" shall mean calendar days.

ERROR PRIORITY (1)	RESPONSE (2)	CLOSURE (3)
Emergency (A)	24 hours	7 days
Critical (B)	2 days	14 days

Non-Critical (C)	30 days	Next Update or New Version

(1) Priority:

-A- Catastrophic product or module Defects that do not have a viable detour or work around available.

-B- Defects that have been substantiated as a serious inconvenience to LICENSEE or an End User. This includes any priority A Defect for which a viable detour or work around is available.

-C- All other problems that LICENSEE and an End User can easily avoid for which there is no urgency for a resolution.

(2) Response: Response consists of providing, as appropriate, one of the following to the LICENSEE: an existing correction; A new correction; a viable detour or work around; a request for more information to complete analysis of the problem, or a plan on how the problem will be corrected.

(3) Closure: Closure consists of providing a final correction or work around of the problem including an Update and revised or new Documentation as necessary.

If D2 fails to correct Defects according to the schedule specified in this Article 6, LICENSEE shall deduct from future runtime license fees, as specified in Exhibit C, a "late fee" for each day past the deadline in the schedule of this section. The "late fee" shall equal to 50% (fifty percent) of the runtime license fees paid to D2 for the previous two calendar quarters equally divided over 180 (one hundred eighty) days. In the event LICENSEE has selected the Buy-out option in the runtime license fee schedule of Exhibit C, then the "late fee" for each day past the deadline shall be 50% (fifty percent) of the Buy-out fee equally divided over 1095 (one thousand and ninety five) days; and this "late fee" shall be paid to LICENSEE each calendar month until the error is corrected either by D2 or LICENSEE.

6.4 Support. D2 will provide the following support to LICENSEE throughout the Warranty period and for those subsequent years for which support has been purchased by Licensee:

(i) D2 will assist LICENSEE in determining if problems encountered by LICENSEE are caused by programming errors in the Licensed Technology.

(ii) D2 will answer questions concerning the installation of Licensed Technology.

(iii) D2 will assist LICENSEE in resolving LICENSEE's problems, if any, arising from the normal usage of the Licensed Technology.

(iv) D2 shall appoint a qualified technical staff as the "Technical Contact" to co-ordinate all support and maintenance services. The "Technical Contact" shall be available to LICENSEE during D2's normal business hours; in the event that appointed "Technical Contact" is not available, a back-up "Technical Contact" shall be temporarily assigned and LICENSEE shall be notified.

6.5 Notification and Cooperation by LICENSEE. To obtain support from D2 under this Article 6, LICENSEE shall provide D2 with written notice which will contain a description of the problem for which LICENSEE is seeking support. D2 shall have no obligation to correct problems which are due to modifications to Licensed Technology performed by LICENSEE; provided, that if D2 agrees to correct such problems it shall charge its then current time and materials rates, which shall be payable by LICENSEE within thirty days after invoicing by D2. LICENSEE agrees to provide D2 with access to LICENSEE's equipment and computer systems on a temporary basis and as needed to allow D2 to reproduce, correct and verify the correction of the problem reported by LICENSEE or otherwise identified by D2.

7. LIMITED SOURCE CODE LICENSE AND PROTECTION

7.1 Source Code delivery. D2 shall, after acceptance of Licensed Technology by LICENSEE and within fifteen days after receiving such a request from LICENSEE deliver a copy of the fully commented Source Code for the then current version of the Licensed Technology and information needed for compiling and building the Licensed Technology Object Code to LICENSEE. Thereafter, D2 shall automatically deliver a copy of the fully commented Licensed Source Code for the then current version of the Licensed Technology within fifteen days after the release of any Updates or New Versions of the Licensed Technology.

7.2 Source Code Access Conditions. The following events shall constitute "Source Code Access Conditions": (i) D2's insolvency, general assignment for the benefit of creditors, or ceasing to do business, or (ii) D2's failure or inability to meet its warranty, maintenance and support obligations under Article 6, or its warranty obligations under Article 8.3, within fifteen days after written notice by LICENSEE to D2 of D2's failure to meet such obligations, or (iii) termination of this Agreement by LICENSEE pursuant to Articles 9.3 and 9.4, or (iv) as needed by LICENSEE for fault isolation.

7.3 Use of Licensed Source Code. After "Source Code Access Conditions" is met, LICENSEE shall have the right to use, modify, reproduce and have reproduced Object Code from Licensed Source Code to develop, use, market, distribute, and to maintain and support the Licensed Technology in the Licensee Product. LICENSEE shall not have any right to develop new DSP technology or derivative DSP technology with the Licensed Source Code.

7.4 Confidentiality and security.

(A) General. LICENSEE acknowledges and agrees that the Licensed Source Code constitutes the confidential and proprietary trade secrets of D2, and that LICENSEE's protection thereof is essential to this Agreement and a condition of LICENSEE's use and possession of the Licensed Source Code.

LICENSEE shall retain in strict confidence any and all elements of the Licensed Source Code and use the Licensed Source Code only as expressly licensed herein. LICENSEE agrees that it will under no circumstances distribute or in any way disseminate or disclose the Licensed Source Code to third parties, except as expressly provided in this Article 7. LICENSEE shall be relieved of this obligation of confidentiality to the extent that such information was in the public domain at the time it was disclosed or has become in the public domain through no fault of LICENSEE.

(B) Security. LICENSEE agrees to use the Licensed Source Code under carefully controlled conditions for the purposes set forth in this Agreement, and to inform all employees who are given access to the Licensed Source Code by LICENSEE that such materials are confidential trade secrets of D2 and are licensed to LICENSEE as such. LICENSEE shall restrict access to the Licensed Source Code to those employees and Contractors of LICENSEE who have agreed to be bound by a confidentiality obligation which incorporates the protections and restrictions substantially as set forth herein, and who have a need to know in order to carry out the purposes of this Agreement. D2 shall be made a third party beneficiary of any such agreements, and shall have the right to directly enforce the terms of those agreements, and of this Agreement, insofar as such enforcement relates to the Licensed Source Code.

(C) LICENSEE agrees to notify D2 promptly in the event of any breach of its security under conditions in which it would appear that the Licensed Source Code were prejudiced or exposed to loss. LICENSEE shall, upon request of D2, take all other reasonable steps necessary to recover any compromised trade secrets disclosed to or placed in the possession of LICENSEE by virtue of this Agreement. The cost of taking such steps shall be borne solely by LICENSEE.

(D) Remedies. LICENSEE acknowledges that any breach of any of its obligations under this Article 7 is likely to cause or threaten irreparable harm to D2, and accordingly, LICENSEE agrees that in such event, D2 shall be entitled to equitable relief to protect its interest therein, including but not limited to preliminary and permanent injunctive relief, as well as money damages.

(E) Hardware.

(i) Two (2) computers, as identified in Exhibit E, may be used as the Development Computer and Back-up Computer. The Back-up Computer may be used as the Development Computer during any time when the Development Computer is inoperative because it is malfunctioning or undergoing repair, maintenance or other modification.

(ii) LICENSEE may at any time notify D2 in writing of any changes, such as replacements or additions, that LICENSEE wishes to make to Development and Back-up Computers for specific Licensed Source Code. D2 will prepare an amended Exhibit E as required to cover such changes, and such changes shall become effective after execution of the amended Exhibit E by LICENSEE.

(iii) Upon request, LICENSEE shall furnish to D2 a statement, certified by an authorized representative of LICENSEE, listing the location, type and serial number of all Development and Back-up Computers hereunder and stating that the use by LICENSEE of the Licensed Source Code subject to this Agreement has been reviewed and that the Licensed Source Code is being used solely on the Development Computer (or temporarily on Back-up Computer) for such Licensed Source Code in full compliance with the provisions of this Agreement.

(F) Third Party Contractors. LICENSEE may appoint a third party contractor ("Contractor") to assist the LICENSEE in LICENSEE's modification of the Licensed Source Code as authorized hereunder; provided that any such Contractor's access to and use of the Licensed Source Code shall only be permitted pursuant to a signed written agreement between LICENSEE and such

Contractor giving the Contractor rights no broader than those granted LICENSEE in this Agreement, but limited to the sole purpose of assisting the LICENSEE, and including provisions incorporating the additional requirements set forth below:

(i) Any claim, demand or right of action arising on behalf of a Contractor from furnishing to it or use by it of Licensed Source Code shall be solely against LICENSEE, and LICENSEE hereby indemnifies D2 against any such claims.

(ii) Contractor shall agree to the same responsibilities and obligations and other restrictions pertaining to the use of Licensed Source Code as those undertaken by LICENSEE under this Agreement.

(iii) Contractor may not retain any copy of the Licensed Source Code or any modification or derivative work thereof and, upon completion of the project for which Contractor was permitted access to the Licensed Source Code or termination of this Agreement, shall return or destroy (i) all copies of Licensed Source Code furnished to such Contractor or made by such Contractor and (ii) all copies of any modifications or derivative works made by such Contractor based on such Licensed Source Code copies stored in any computer memory or storage medium, and Contractor's computer shall be removed from Exhibit E if such computer was listed as a Development Computer. A writing executed by an officer of Contractor shall be provided to D2 certifying that the Contractor has returned or destroyed all copies of the Licensed Source Code in its possession or control.

(iv) Unless Contractor obtains a license for the Licensed Source Code from D2, Contractor may not acquire any ownership interest in any modification or derivative work prepared by such Contractor based upon or using Licensed Source Code licensed to LICENSEE under this Agreement.

(v) Copies of such agreements shall be provided to D2 on request; provided however, that portions of such agreements not required by this Article 7 may be deleted from such copies.

8. REPRESENTATIONS AND WARRANTIES

8.1 By Both Parties. D2 warrants that it owns all rights, title, and interests to Licensed Technology listed as Basic Services in Exhibit A. LICENSEE and D2 each individually warrants that it (i) has all right, power and authority necessary to enter into this Agreement and to grant the rights granted herein; (ii) has obtained all approvals and authorizations that it is required to obtain in connection with this Agreement; and (iii) has not entered, and will not enter, into any arrangements or agreements inconsistent with this Agreement.

8.2 Additional D2 Warranties. D2 additionally warrants that it (i) is not aware of any pending or actual litigation which is likely to have a material adverse effect on the rights or obligations of LICENSEE under this Agreement; and (ii) is not aware of any claim or any basis for any claim that Licensed Technology, or LICENSEE's use of the Licensed Technology as contemplated herein, will infringe any patents, trade secrets of other intellectual property rights belonging to any third party.

8.3 Software Warranty. D2 warrants to LICENSEE that the media upon which the Licensed Technology is delivered to LICENSEE will be free from Defects in materials and workmanship, and that Licensed Technology shall meet and perform in accordance with D2's specifications on Exhibit A. D2 shall promptly correct any

errors in the Licensed Technology, or failures of the Licensed Technology according to the terms of Article 6 of this Agreement. D2's warranty and error correction obligations with respect to any portion of the Licensed Technology shall extend for a period (the "Warranty period") of one year commencing on acceptance of such portion of the Licensed Technology by LICENSEE.

8.4 Disclaimer of Other Warranties. THE REPRESENTATIONS AND WARRANTIES EXPRESSLY SET FORTH IN THIS ARTICLE 8 ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, EITHER IN FACT OR BY OPERATION OF LAW, STATUTORY OR OTHERWISE. D2 SPECIFICALLY DISCLAIMS ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE IN CONNECTION WITH THE LICENSED TECHNOLOGY.

9. TERM AND TERMINATION.

9.1 Term. This Agreement shall become effective on the Effective Date and shall continue in effect until terminated in accordance with the provisions of this Article 9.

9.2 For Convenience. LICENSEE may terminate this Agreement upon ninety (90) days written notice.

9.3 Default. If either party defaults in the performance of any of its material obligations hereunder and if such default is not corrected within thirty (30) days after written notice thereof by the other party, then the nondefaulting party, at its option, may, in addition to any other remedies it may have, terminate this Agreement by giving written notice of termination to the defaulting party.

9.4 Survival. Articles 7.2, 7.3,7.4, 8, 9, 10, 11, 12, 13, 14 shall survive any termination or expiration of this Agreement.

10. INDEMNIFICATION

10.1 By D2. D2 agrees to indemnify and hold LICENSEE harmless against any cost, loss, liability, or expense (including attorney's fees) arising out of any breach of D2's warranties hereunder, or out of third party claims against LICENSEE alleging that the Licensed Technology, or LICENSEE's use or distribution of the Licensed Technology as set forth in this Agreement, infringes any third party's patent, trade secret, copyright of other intellectual property right in any country, provided that LICENSEE shall (i) notify D2 promptly in writing of such claims, and (ii) give D2 sole control of the defense or settlement of such claims. D2 shall not be liable for any claims to the extent that such claims arise out of the LICENSEE's unauthorized modifications of the Licensed Technology, and not out of the Licensed Technology as delivered by D2 to LICENSEE. If the Licensed Technology, or any part thereof, is

adjudicatively determined to be, or in either party's reasonable opinion will be, the subject of any claim, suit or proceeding for infringement of any third party's patent, copyright or trade secret in any country, or if the distribution of use of the Licensed Technology is enjoined, then D2 may, at D2's sole option and expense, (i) obtain for LICENSEE and its distributors, resellers and customers the right to distribute or use the Licensed Technology under such third party patents, trade secrets, copyrights or other intellectual property rights, or (ii) replace the Licensed Technology with other software of equivalent or superior functionality, or (iii) suitably modify the Licensed Technology to avoid such infringement. In the event that D2 is unable to carry out the options set forth in (i), (ii) and (iii) of the proceeding sentence, at the option of Licensee D2 may terminate this Agreement and refund all amounts paid by LICENSEE to D2 hereunder; provided, that such termination shall have no effect on the rights of end users to use LICENSEE products, incorporating any Licensed Technology, which were acquired by such end users prior to such

termination.

11. LIMITATION OF LIABILITY

IN NO EVENT SHALL EITHER PARTY BE LIABLE TO THE OTHER PARTY FOR LOST PROFITS OR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL, OR INDIRECT DAMAGES OR SUCH OTHER PARTY, HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, ARISING OUT OF THIS AGREEMENT. THESE LIMITATIONS SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY. IN NO EVENT SHALL D2'S LIABILITY HEREUNDER EXCEED THE TOTAL AMOUNT PAID OR OWED BY LICENSEE TO D2 UNDER THIS AGREEMENT.

12. CONFIDENTIALITY.

12.1 Confidential Information. As used in this Agreement, the term "Confidential Information" shall mean any information disclosed by one party to another pursuant to this Agreement which is marked as confidential or proprietary, or, if disclosed orally, is designated as confidential at the time of disclosure and is subsequently reduced to a writing which is marked as confidential or proprietary and is provided to the receiving party within thirty (30) days after such oral disclosure.

12.2 Confidentiality. Each party shall treat as confidential all Confidential Information of the other party, shall not use such Confidential Information except as set forth herein, and shall use reasonable efforts not to disclose such Confidential Information disclosed to it by the other party under this Agreement. Each party shall promptly notify the other party of any actual or suspected misuse or unauthorized disclosure of such other party's Confidential Information.

12.3 Exception. Not withstanding the above, neither party shall have liability to the other party with regard to any Confidential Information of such other party which the receiving party can demonstrate:

(i) was in the public domain at the time it was disclosed or has entered the public domain through no fault of the receiving party;

(ii) was known to the receiving party, at the time of disclosure, as demonstrated by files in existence at the time of disclosure;

(iii) was disclosed with the prior written approval of the disclosing party;

(iv) was, is presently or may be in the future independently developed by the receiving party without any use of the Confidential Information of any other party, as demonstrated by files created at the time of such independent development;

(v) became known to the receiving party, without restriction, from a source other than the disclosing party without breach of this Agreement by the receiving party and otherwise not in violation of the disclosing party's rights;

(vi) has been disclosed to third parties by the disclosing party without restrictions similar to those contained in this Agreement; or

(vii) is disclosed pursuant to the order or requirement of a court, administrative agency, or other governmental body; provided, however, that the receiving party shall provide prompt written notice thereof to the disclosing party to enable the disclosing party to seek a protective order or otherwise prevent or restrict such disclosure.

12.4 Return of Confidential Information. Upon expiration or

termination of this Agreement each party shall upon request promptly return all tangible Confidential Information received from the other party.

12.5 Survival of Confidentiality Obligations. This Article 12 will survive the termination of this Agreement, for any item of Confidential Information, for five (5) years after the disclosure of such Confidential Information to the receiving party under this Agreement.

13. CONFIDENTIALITY OF AGREEMENT.

D2 and LICENSEE agree that the terms and conditions of this Agreement shall be treated as confidential and shall not be disclosed to any third party without the

prior written consent of the other party. Notwithstanding the statements above in this Article 13, any party may disclose any of the terms and conditions of this Agreement;

(i) as required by any court of other governmental body;

(ii) as otherwise required by law (including without limitation with regard to any registration statement filed by a party with the Securities and Exchange Commission);

(iii) to legal counsel of the parties;

(iv) in confidence, to accountants, banks, and financing sources, and other advisors or consultants of the parties;

(v) in connection with the enforcement of this Agreement or rights under this Agreement;

(vi) in confidence, in connection with an actual or proposed license, merger, acquisition, or similar transaction;

(vii) which have been previously disclosed in a joint press release by the parties hereto, or

(viii) in confidence, to a third party to the extent reasonable necessary to permit the consideration of a bona fide collaboration which would involve rights, obligations or limitations arising under this Agreement, provided that such collaboration is not prohibited under this Agreement.

In the event of any disclosure pursuant to (i) or (ii) above, the disclosing party shall use all reasonable efforts to obtain confidential treatment of materials so disclosed. The parties shall in good faith consult regarding the text of any proposed public announcement regarding this Agreement or the terms and conditions hereof before such announcement is actually made. Any press release to be issued in connection with the terms and conditions of this Agreement must be approved in advance by both parties.

14. EXPORT RESTRICTIONS

LICENSEE's distribution of products incorporating Licensed Technology shall be subject to all United States laws and regulations governing the license and delivery of technology and products abroad by persons subject to the jurisdiction of the United States. LICENSEE shall not export any such products without first

obtaining all required licenses and approvals from the appropriate government agencies.

15. GENERAL

15.1 Governing Law. This Agreement shall be governed by and interpreted in accordance within the laws of the State of New York without reference to conflicts of laws provisions.

15.2 Venue. The parties agree that any litigation arising out of this Agreement shall be brought in the state courts in Delaware.

15.3 Partial Invalidity. If any provision in this Agreement shall be found or be held to be invalid or unenforceable in any jurisdiction in which this Agreement is being performed, then the meaning of said provision shall be construed, to the extent feasible, so as to render the provision enforceable, and if no feasible interpretation would save such provision, it shall be severed, solely in such jurisdiction, from the remainder of this Agreement, which shall remain in full force and effect. In such event, the parties shall negotiate, in good faith, a substitute, valid and enforceable provision, effective solely in such jurisdiction, which most nearly effects the parties' intent in entering into this Agreement.

15.4 Relationship of the Parties. D2 and LICENSEE are independent contractors under this Agreement. Nothing contained in this Agreement is intended to, nor is it to be construed so as to, constitute D2 and LICENSEE as partners or joint ventures with respect to this Agreement. Employees of any party remain employees of said party and shall at not time be considered agents of or to be obligated to render a fiduciary duty to the other party.

15.5 Modification. No alteration, amendment, waiver, cancellation or any other change in any term or condition of this Agreement shall be valid or binding on any party unless the same shall have been mutually assented to in writing by both parties.

15.6 Waiver. The failure of any party of enforce at any time any of the provisions of this Agreement, or the failure to require at any time performance by the other parties of any of the provisions of this Agreement, shall in no way be construed to be a present or future waiver of such provision, nor in any way affect the right of any party to enforce each and every such provision thereafter. The express waiver by any party of any provision, condition or requirement of this agreement shall not constitute a waiver of any future obligation to comply with such provision, condition or requirement.

15.7 Assignment. This Agreement shall be binding upon and shall inure to the benefit of the parties hereto and their respective successors and assigns. No party may assign any of its rights, obligations or privileges (except by operation of law or other corporate reorganization) hereunder without the prior written consent of the other party, which shall not be unreasonable withheld, provided, that any party shall have the right to assign its rights, obligations and privileges hereunder to a successor in business or an acquirer of all or substantially all of its business or assets to which this Agreement pertains without obtaining the consent of the other party.

15.8 Notices. Any notice required or permitted to be given by any party under this Agreement shall be in writing, shall be addressed to the President of D2, or to the President of LICENSEE, and shall be personally delivered or set by certified or registered letter, or by telecopy confirmed by registered or certified letter, to the receiving party at its address first set forth above, or such new address as may from time to time be supplied hereunder by the receiving party. Notices will be deemed effective upon receipt.

15.9 Force Majeure. Notwithstanding anything else in this Agreement, no default, delay or failure to perform on the part of any party shall be considered a breach of this Agreement if such default, delay or failure to perform is shown to be due to causes beyond the reasonable control of the party charged with a default, including, but not limited, causes such as strikes, lockouts or other labor disputes, riots, civil disturbances, actions or inactions of governmental authorities or suppliers, epidemics, war, embargoes, were weather, fire, earthquakes, acts god, acts of the public enemy or nuclear disasters; provided, that for the duration of such force majeure the party charged with such default must continue to use all reasonable efforts to overcome such force majeure.

15.10 Entire Agreement. The terms and conditions contained in this Agreement constitute the entire agreement between the parties and supersede all previous agreements and understandings, whether oral or written, between the parties hereto with respect to the subject matter hereof.

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be signed by duly authorized officers or representatives as of the date first above written.

"LICENSEE"	D2 TECHNOLOGIES, INC.
BY: /s/ Dick Swee	BY: /s/ David Y. Wong
PRINT NAME: Dick Swee	PRINT NAME: David Y. Wong
TITLE: VP Engineering	TITLE: President

Software License and Maintenance Agreement August 4, 1997 D2 Technologies, Inc. CONFIDENTIAL

EXHIBIT A

LICENSED TECHNOLOGY SPECIFICATION

Basic Services:

The Basics Services algorithm group shall include the following list of standard D2 products with LICENSEE required modifications as specified in the attached Specification and the Contract for Products and Services, dated August 6, 1997:

DTMF Detection and Removal Algorithm	5007-54A
Universal Tone Detection Algorithm	50030-54A
Multifrequency Tone Detection Algorithm	50028-54A
Tone Generation Algorithm	50015-54A

Exhibit A continued.

Detailed Signal Processing Algorithm Specification

A.1 HDLC Communications

Not included as Licensed Technology.

A.2 Voice Activity Detection

Voice Activity Detection (VAD) detects voice activity, adapts to background ambient or line noise as well as the presence of echo, classifies voice activity as "early" versus "sustained", and assigns an "effort level" to the speaker that is independent of network loss.

This module is used to detect voice activity in the CP Detect state.

A.2.1 Functional requirements:

The Voice Activity Detector discriminates voice activity generated by a caller from background noise (acoustic and line noise) as well as echo and sidetones reflected back to the receive voice path. It also provides an "effort level" quantity that indicates the level of effort of the caller. The functional and performance requirements are specified to cover a wide range of applications, such as voice activated recordings (as in voice messaging), outbound call classification, digital speech interpolation (DSI), and voice conferencing.

1. The Voice Activity Detector classifies every block of voice data (8 ms long) as "port active" (early detect), "speaker active" (port sustained), and "not active".

2. It provides a measurement that approximates the level of effort exerted by the caller. Such an approximation is made by normalizing the short term RMS of the voice signal by a longer term RMS value. The "effort level" varies between -32 dB and 31 dB, and is at 0 dB when the speaker is speaking at his/her "normal" level.

3. The Voice Activity Detector adapts to background noise up to -24 dBm. Adaptation is 200 ms when the noise level drops, and is approximately 1000 ms when noise rises.

4. The Voice Activity Detector screens out sidetone or echo as speech up to an ERL of -26 dB.

A.2.2 Performance Requirements:

The accuracy of the voice Activity detector is measured by the rate of "false detection" (i.e. classifying noise or echo as voice activity) and "clipping" (i.e. classifying voice activity as noise or echo) under different ambient noise and echo conditions. "Port active" detection under different ambient noise conditions:

1. No perceptible clipping at quiet to modest noise levels of -50 dBm to -40 dBm with nominal levels of speech activity (-20 dBm average power over 2 seconds of speech). No more than 5% of voice onsets is clipped for noisy conditions (noise level from -40 dBm to -30 dBm).

2. No more than 1% of "silence" periods is detected as speech for the modest noise condition. No more than 2% of "silence" is detected as port active for noisy conditions.

3. The performance goals above is met when noise levels change during the test.

"Speaker active" detection under different ambient noise conditions:

1. Speech activity that lasts more than tSUSTAIN is detected as "Sustained" or "Speaker Active".

2. The clipping requirements is better than "Port Activity" detection. Fewer than 0.5% of onsets/hour (2.5 per hour) for modest noise condition (-45 dBm) and fewer than 2% (10 per hour) for high noise condition (-35 dBm) have perceptible clipping.

3. False detection performance (i.e., detecting noise as "speaker active") exceeds those of "port activity" due to tSUSTAIN criteria. No more than 1% (36 seconds per hour) of noise segments is misclassified as "sustained" for modest noise conditions, and no more than 2% (72 seconds per hour) of "silence" is detected as port active for noisy conditions.

"Port active" and "Speaker active" detection in the presence of echo:

1. Less than 1% of residual echo is detected as "port active" - (i.e. 36 sec. per hour) during normal operation of canceller.

2. Less than 0.1 % (i.e. 3.6 sec per hour) of residual echo is detected as "speaker active" or "port sustained" during normal operation of canceller.

3. Clipping of input speech in the presence of echo is no higher than clipping in the presence of modest to high level of noise.

A.3 DTMF Detection

A.3.1 Functional requirements:

Table A-1 specifies the nominal frequencies for the DTMF digits that must be detected.

Nominal High Group Frequencies (Hz)			
1209	1336	1477	1633

Nominal	697	1	2	3	A
Low Group	770	4	5	6	B
Frequencies	852	7	8	9	C
(Hz)	941	*	0	#	D

Table A-1: Nominal DTMF Frequencies

1. Detect the presence of all 16 DTMF digits that are produced by different phones on the market under a broad range of network conditions.

2. DTMF digit information is provided as soon as the minimum duration is met. This information is called leading edge detection. This allows the earliest possible response to the digit, such as stopping voice output.

3. The trailing edge of a DTMF digit must be detected. This allows the system to delay any response (such as playing out voice) to the digit until the user has released the DTMF key. The criteria selected for trailing edge detection will debounce DTMF digits.

4. The DSP reports leading and trailing edge in the 8 ms block that they are detected. DTMF events are not buffered.

A.3.2 Performance requirements:

Table A-2 consists of performance requirements taken from EIA-464A and Bellcore TR-TSY-000181. Also shown is D2's DTMF performance requirements, which is a superset of the EIA and Bellcore requirements.

<TABLE>
<CAPTION>

	Requirement		
Characteristic	Bellcore	EIA/TIA-464A	D2
<S>	<C>	<C>	<C>
Frequency Deviation	+/-1.5% must accept; +/-3.5% must reject	+/-1.5% must accept; +/-3.5% must reject	Configurable choice of four sets of must accept/must reject: +/-2.0% accept to +/-3.0% reject; +/-2.5% accept to +/-3.5% reject; +/-3.0% accept to +/-4.0% reject; +/-3.5% accept to +/-4.5% reject.
Minimum Tone Duration	40 ms must accept; 23 ms must reject	40 ms must accept	Configurable from 24 to 80 ms
Minimum Interdigital Interval	40 ms	40 ms	Configurable from 24 to 80 ms
Minimum Cycle Time	93 ms	93 ms	Configurable from 48 to 160 ms
Accept Levels	0 to -36 dBm must accept, -55 dBm must reject	0 to -25 dBm must accept	0 dBm to configurable minimum (-25 to -45 dBm range)
Twist (ratio of high group power to low)	-8 to +4 dB	-8 to +4 dB	Separately configurable positive and negative twists:

			+/- 4, 6, 8, 10, and 12 dB
Bellcore talkoff tape	Fewer than 670 total talkoffs; fewer than 330 talkoffs of digits 0-9; fewer than 170 talkoffs of signals * and #.	-	Fewer than 20 talkoffs (with default configuration of 2.5% to 3.5% frequency deviation; 40 msec min tone duration; +/- 8 dB twists; -45 dBm min accept level)
Mitel talkoff tape	-	-	0 talkoffs (with default configuration)
SNR	23 dB	15 dB	15 dB
Impulse Noise	Fewer than 14 missed or split digits in Bellcore Impulse Noise Tape No. 201	Fewer than 10 errors in 10,000 tones for EIA test #1; fewer than 500 errors in 10,000 tones for test #2	Pass both Bellcore and EIA/TIA-464A impulse noise requirements

</TABLE>

<TABLE>

<S>	<C>	<C>	<C>
Echo	16 dB Signal-to-Echo ratio at 20 ms; 24 dB at 45 ms	10 dB Signal-to-Echo ratio at 20 ms	Pass both Bellcore and EIA/TIA-464A echo requirements
Dial Tone	DTMF Detection in the presence of dial tone at -15 dBm per dial tone frequency	DTMF Detection in the presence of dial tone at -16 dBm per dial tone frequency	Pass both Bellcore and EIA/TIA-464A requirements for detection of DTMF digits in the presence of dial tone

</TABLE>

TABLE A-2: DTMF Performance Requirements

Other performance requirements:

1. A leading edge of DTMF digit is signaled during the block in which the minimum duration is met, and the trailing edge is signaled during the block in which the minimum debounce interval is met.

2. Talk-down: DTMF detection must work reliably in the presence of echo (for the maximum allowable output voice level) and with varying levels of DTMF signals (due to network loss). D2's DTMF detector combined with the echo must meet the performance requirements of Figure A-I in the presence echo generated by playing pause-removed voice (male and female) at - 18 dBm ASL (averaged over 3 seconds) over a telephone circuit with 15 dB echo return loss (ERL).

INSERT GRAPH

Figure A-1: DTMF Talk-down Acceptance Curve

3. Debounce test: Long tones (generated by "hard" key presses) must not be detected as multiple tones in the presence of echo interference or line noise. Combined with the echo canceller, the DTMF detector is required to reliably "debounce" all DTMF digits above -18 dBm in the presence of voice levels below -15 dBm (ASL) and a telephone circuit with echo return loss (ERL) of 15 dB.

4. Double-talk talk-off: Many voice processing hardware or semiconductor manufacturers significantly degrade the "talk-off' performance of their detector in the presence of voice echo or sidetone to achieve a high level of talk-down performance. This strategy is acceptable in a pure digit-in-voice-out scenario, but for voice conferencing or voice recognition applications, voice could be present in the both the transmit and receive path. In such cases, the DTMF detector must be very robust against "talk-off" in double-talk situations. The talk-off requirements for D2's DTMF detector under double-talk is fewer than 66 talkoffs for the Bellcore talk-off tape.

A.4 Tone Generation

The tone generation module can be programmed to generate any single, dual or amplitude modulated tone required to meet international telecommunications specifications. This functionality is provided by the GENF module, which produces the sum or product of two independently generated sine waves as its output. Each sine wave can be individually parameterized.

A.4.1 Functional requirements:

The GENF module is designed to generate a wide range of DTMF, Call Progress Signals, MF R1/R2, and miscellaneous tones. In order to meet or exceed international telecommunication specifications, GENF must meet or exceed the following functional requirements.

1. Independent arguments shall be supplied for each frequency for dual tones that GENF generates. Single tones are generated by specifying that one of the dual tone's frequencies is 0 Hz.

2. Independent arguments shall be supplied for the carrier and modulation frequencies for amplitude modulated tones that GENF generates.

3. Arguments shall be supplied that allow the frequency of a tone to be set in the range of 0 to 4000 Hz in 1 Hz units.

4. Arguments shall be supplied that allow the output power to be set in the range of +3 to -50 dBm in 0.5 dB steps.

5. Arguments shall be supplied that allow an amplitude modulated tone's modulation percentage to be set in the range of 0 to 300% in 1% units.

6. The tone duration (make time) shall be specified in 1 ms units. Tone durations shall be specified in the range of 0 to 8191 ms.

7. An unlimited tone duration shall be specified by setting the make duration to -1.

8. The silence duration between tones (break time) shall be specified in 1 ms units. Silence durations shall be specified in the range of 0 to 8191 ms.

9. An unlimited silence duration shall be specified by setting the make duration to -1 and setting both frequencies of a dual tone to 0 Hz.

10. The GENF module shall allow tones to be generated that meet or exceed EIA/TIA-464 requirement for DTMF and call progress tone generation.

11. The GENF module shall allow tones to be generated that meet or exceed CCITT Blue Book Volume VI Fascicle VI.4 recommendations Q.310-Q.490 requirements for MF R1 and R2 tone generation.

12. The GENF module shall generate tones with one to three unique cadence pairs (on/off pairs).

A.4.2 Performance Requirements

1. Frequency accuracy shall exceed 1 Hz.
2. Level accuracy shall exceed 0.5 dB.
3. Timing information shall exceed 1 ms accuracy.

A.5 Universal Tone Detector

A.5.1 Overview

The Universal Tone Detector (UTD) is a high configurable tone detector. By changing parameters, this algorithm can classify a wide range of single and dual tone call progress signals generated in a wide variety of countries.

A.5.2 General

Since different tones need different detection heuristics, and tones may have multiple specifications, each tone is tagged with a tone category identifier.

Tone Category	Call Progress Signal
1	Modem
2	FAX CNG
3	Audible Ringback
4	Busy
5	Reorder or Congestion
6	Number Unobtainable
7	SIT
8	Dial tone
9	Unknown Tone

Table A-3: Tone Categories

In addition to specifying a tone category, the parameters include a value that is returned to the application when the tone is detected. This parameter need not be unique. This allows multiple specifications to report the same tone event to the application. UTD is table driven. Using this approach, the tone detector searches parameter tables for a matching tone. When a tone matches, the tone code determines the heuristics necessary to completely classify the tone. Also, the tones must be specified in a way that a set of parameters corresponds to either a single tone, a dual tone, or an amplitude modulated tone.

Code	Tone Type
0	Single Tone
1	Dual Tone
2	Modulated Tone

Table A-4: Call Progress Tone Types

A.5.3 General Functional Requirements

UTD functionally combines a single tone detector and a dual/modulated tone detector into a single module. UTD combines the results of these detectors into a single result. UTD has the following requirements.

1. The DSP shall indicate that the first ringback has started after at least 400 ms of ringback like signal has been processed, as long as no other tone type is early detected. If more than one type of tone is early detected, the first ringback reporting shall be delayed until either cadence information disqualifies the other types, or tone precedence is used as a 'tie-breaker'.

2. The DSP shall indicate ringback has stopped when ringback is no longer detected.

3. The DSP shall indicate a busy tone has been detected after the requisite number of make and break intervals have been processed, and no other tone category is still a candidate for detection.

4. The DSP shall indicate a reorder tone has been detected after the requisite number of make and break intervals have been processed, and no other tone category is still a candidate for detection.

5. The DSP shall indicate a number unobtainable tone has been detected after the requisite number of make and break intervals have been processed, and no other tone category is still a candidate for detection.

6. In the event that more than one tone is a candidate for detection, detection is delayed until all characteristics that may disqualify any of the candidates are tested (for example, waiting for multiple cadence pairs to occur). If there is still more than one potential tone after all differentiating features have been exhausted, then the tone with the highest precedence is detected. Also, if the tone ceases prior to singling out one candidate tone, then the tone with the highest precedence is detected. Precedence is shown in Table A-3.

7. The DSP shall supply an early detect flag. This flag shall be valid after the detector has processed no more than 72 ms of a tone. If more than one tone category is early detected, then the early detect flag shall indicate the tone category with the highest precedence.

8. The DSP shall indicate that a modem has been detected if a single tone falls within the specified frequencies for modem tones, the minimum make interval has been exceeded while the average tone power is in excess of the minimum power requirement, and no other tone category is still a candidate for detection.

9. The DSP shall indicate that a FAX CNG tone has been detected if a single tone falls within the specified frequencies for a CNG tone, the requisite number of on/off cadences have been processed, and no other tone category is still a candidate for detection.

10. The DSP shall indicate that a SIT tone has been detected if at least two of the three segments of possible SIT tones have been detected for at least the minimum interval in excess of the minimum power requirement.

11. The DSP shall indicate that an Unknown tone has been detected when it has been determined that a tone has been detected that falls within the specified frequencies for an Unknown tone, the minimum duration has been exceeded, and the tone does not match and other category tones.

A.5.3.1 TONE DETECTOR PERFORMANCE REQUIREMENTS

A.5.3.1.1 Single Tones

There are four types of parameters that shall be used to control single tone detection. The variation of each parameter shall be limited by the constraints listed in Table A-5.

	Minimum	Maximum
Frequency	300 Hz	3300 Hz
Bandwidth	0 Hz	1800 Hz
Duration	100 msec	32760 msec
Minimum Power Level	-45 dBm	3 dBm

Table A-5: Single Tone Detection Constraints

The frequency detection range shall be specified the Frequency and Bandwidth parameters. Figure A-2 shows the relationship of these parameters. Note that the bandwidth specification is symmetric about the center frequency. The Frequency and Bandwidth parameters define a "must detect" range. The detector shall not use frequency criteria to reject any tones which are within the range specified Frequency/Bandwidth parameters. Tones whose frequencies are outside but close to frequency range may be detected.

INSERT GRAPH

Figure A-2: Frequency Domain Representation of tone parameters for a Single Tone

If the Power Level of the detected parameter is greater than the minimum power specified by the parameters, the signal shall not be rejected by Power Level heuristics. Duration parameters are used to set the allowable duration of a tone. Minimum and maximum tone durations may be specified (make durations). Also, minimum and maximum silence durations between tones may be specified.

A.5.3.1.2 Dual Tones

Dual tones are created by summing two sinusoids. Since each tone can be isolated in the frequency domain, dual tones are specified as a pair of single tones. Parameters for each tone of a dual pair use the same constraints as single tones. Namely, frequency1 is the center frequency of the lower tone, and bandwidth1 specifies its frequency tolerance. The same is true for frequency2 and bandwidth2 for the high tone. Figure A-3 shows the definition of the frequency and bandwidth parameters for a dual tone.

INSERT GRAPH

Figure A-3: Frequency Domain Representation of Tone Parameters for a Dual Tone

Not all dual tones are detectable by UTD. A dual tone shall detected only when the difference between the two component frequencies is greater than 10 Hz and less than 230Hz.

A.5.3.1.3 Amplitude Modulated Tones

Amplitude modulated tones are created by multiplying two sinusoids. When analyzed in the frequency domain, a modulated tone looks like three tones. Figure A-4 shows the frequency spectrum for a modulated tone.

The tone whose frequency is the average of the other tones is the carrier. The other two tones can be referred to as side lobes. For amplitude modulated tones, frequency1 and bandwidth1 specify the low sidelobe and its tolerance, while frequency2 and bandwidth2 specify the high sidelobe and its tolerance.

INSERT GRAPH

Figure A-4: Frequency Domain Representation of Tone Parameters
for an Amplitude Modulated Tone

As with dual tones, not all modulated tones will be detected by UTD. Modulated tones shall be detected if the difference between the carrier frequency and the sidelobes is between 10 Hz and 230 Hz.

A.5.3.1.4 Precedence

By assigning a detection precedence to the classification process, tone frequency ranges can overlap. When a tone's parameters fall into a range shared by two or more signals, the signal is classified as the one with the highest precedence.

Precedence	Call Progress Signal
1	Modem
2	FAX CNG
3	Audible Ringback
4	Busy
5	Reorder or Congestion
6	Number Unobtainable
7	SIT
8	Dial Tone
9	Unknown Tone

Table A-6: Tone Detection Precedence

Table A-6 shows the precedence of typical tones that the UTD module detects. Modem signals have the highest precedence, and Unknown tones have the lowest. Therefore, the frequency range of unknown tones can safely overlap the other tone ranges without causing tones to be misclassified. If the range for Unknown tones is allowed to be the maximum range allowed by the detector, any detected tone that is unclassified would be designated as Unknown.

A.5.3.1.5 North American Call Progress Signal Detection

Functional Requirements:

The tables below specify the frequencies, power levels, and cadence of the Bellcore and EIA-464A call progress tones.

	Frequency (Hz)				Power Level (dBm)	
Name	350	440	480	620	Per Frequency	Combined
Audible Ring		X		X	-22.5 +/- 1.5	
Busy			X	X	-27 +/- 1.5	
Dial Tone	X	X			-17.5 to -15	-13 to -14.5

Intercept	X	X	-20 +/- 1.5
Reorder	X	X	-27 +/- 1.5

Table A-7: Call Progress Tone Frequency and Power Requirements

Audible ring (ring-back)	repetition of the tone on for 0.8 to 2.2 seconds, and off for 2.7 to 4.4 seconds
Busy	repetition of the tone on for 0.5+/-0.05 seconds, and off for 0.5 +/-0.05 seconds
Dial	steady uninterrupted
Intercept	repetition of an alternating sequence, of the two frequencies each being on for 0.16 to 0.30 seconds with a total cycle time of 0.5 +/-0.05 seconds
Reorder (fast busy)	repetition of the tone on for 0.25+/-0.025 seconds, and off for 0.25+/-0.025 seconds

Table A-8: Call Progress Tone Cadence

Performance Requirements:

1. Frequency Deviation: Even though the generator is required to meet a frequency tolerance per tone of +/-0.5%, the detector needs to allow for a wider frequency tolerance due to variations in generators and line distortions. The CP detector detects all tones whose component frequencies deviate less than 1% from nominal.

2. Twist: The CP detector detects all tones whose twist is less than +/-4 dB.

3. Dynamic Range: The CP detector exhibits a minimum dynamic range of 25 dB.

4. Cadence: The CP detector must detect call progress tones whose cadence is within +/-10%.

5. Talkoff: The CP detector makes no false detections in 12 hours of testing with voice at -15 to -18 dBm ASL.

A.5.3.1.6 FAX CNG Tone Detection

The standard connection protocol for automatic connection of a FAX modem requires that the calling FAX modem generate a calling tone (CNG). Hence for incoming calls, the EVP software has to detect a CNG signal. When CNG is detected, EVP alerts the Core Processor to redirect the call to a FAX machine or a FAX modem embedded within the call processing system.

Functional Requirements:

Detect the presence of the FAX calling tone (CNG). A CNG signal is defined as follows.

INSERT GRAPH

Figure A-5: Fax calling tone (CNG)

a) The CNG tone is within 38 Hz of nominal frequency.

b) The timing tolerance of a CNG tone is +/-15%.

c) The power of a CNG tone is between 0 and -43 dBm.

Performance Requirements:

1. The detector does not miss any CNG signals on a prerecorded tape containing 50 CNG tone samples collected from S different FAX machines.

2. The detector does not miss any CNG signals from the same FAX machines connected to a local CO with a noise level of less than -45 dBm.

3. The detector misses less than 0.5% of CNG signals (generated at -10 dBm) when compressed voice is output at a level of-15 dBm or less (average over 3 seconds) into a network whose ERL is greater than 15 dB.

4. The detector does not falsely detect more than 1 CNG tone per 5 hours of voice (based on Bellcore recorded talk radio voice tapes.)

A.5.3.1.7 Modem Tone Specification

All answering modems that conform to the ITU V.25 answering sequence present a 2100 Hz tone 1.8 to 2.5 seconds after answering the telephone line. Figure A-6 and Figure A-7 show the timing of the answering tone (ANS). In Figure A-6, the 2100 Hz

tone reverses phase every [tau] intervals. These phase reversals disconnect echo cancellers and echo suppressors from the network. According to ITU G.164, phase reversal shall be accomplished such that the phase is within 180 +/-10 degrees in 1 ms and that the amplitude of the 2100 Hz tone is not more than 3 dB below its steady state value for more than 400 musec.

INSERT GRAPH

Figure A-6: Timing for Answering Modem with Phase Reversal

A timing diagram for an answering modem without phase reversal is shown in Figure A- 7. The timing is identical with that of phase reversing tone except for the reversal timing.

INSERT GRAPH

Figure A-7: Timing for Answering Modem without Phase Reversal

Table A-9 contains the nominal frequency, power, and duration requirements for

	Minimum	Maximum	Unit
Frequency	2085	2115	Hz
Duration	2.6	4.0	seconds
Power	-18.0	-6.0	dBm0

generating modem tones as derived from V.25 and G.164.

Table A-9: Modem Tone Generation Requirements

Performance Requirements:

1. The detector does not miss any modem answer tone on a pre-recorded tape containing 50 modem answer tone samples collected from 5 different data modems.

2. The detector does not miss any modem answer tone signals from the same data modem connected via a local CO with a noise level of less than -45 dBm.

3. The detector does not miss more than 0.5% of modem answer tones (generated at -10 dBm) when compressed voice is played at a level of -15 dBm (ASL) or lower into a network connection with ERL greater than 15 dB.

4. The detector does not falsely detect the presence of a modem answer tone more than once per 5 hours of voice (using Bellcore recorded talk radio voice tapes).

5. There is no talkdown performance requirement. The near end is always silent and does not interfere with far end modem ANS signals.

6. There shall be fewer than 1 talkoff in 5 hours of call classification when the detector is programmed with the recommended parameters. Assuming that each call is resolved within an average time of 10

seconds, there shall be less than 1 talkoff in 1800 calls.

A.5.3.1.8 Three Tone Sequences

Most countries that generate Special Information Tones (SIT) use a three tone sequence. SIT sequences are generated by various central offices or common carrier switching points to indicate a problem with the dialed call. A SIT tone sequence generally precedes a recorded voice announcement such as "the number you have dialed is no longer in service..." and is provided specifically for the purpose of detection of the problem type by an automated device.

There are two popular types of SIT sequences. The first type is used mainly in Europe. It consists of a sequence of three tones of identical durations. The second type is the one used in North America. There are several North American SIT sequences that are encoded using various combinations of frequency and duration for each of the three tones. The encoding has been standardized by Bellcore.

Performance Requirements:

1. The UTD shall handle both types of sequences.

2. There is no talkdown performance requirement. The near end is always silent and does not interfere with far end SIT signals.

3. There shall be fewer than 1 talkoff in 5 hours of voice when the detector is programmed with the recommended parameters. Assuming that each voice call is has an average of 2 seconds of voice, there shall be fewer than 1 talkoff in 9000 calls.

A.5.3.1.9 Unknown Tone

Any single tone, dual tone, amplitude modulated tone or single tone sequence that is not classified as a CP, SIT, CNG or modem ANS tone, shall be reported as an unknown tone.

Performance Requirements:

1. Talkdown performance requirement [TBD]

2. There shall be fewer than 1 talkoff in 5 hours of voice when the detector is programmed with the recommended parameters (minimum tone duration 400 ms). Assuming that each voice call is has an average of 2 seconds of voice, there shall be fewer than 1 talkoff in 9000 calls.

A.6 Multifrequency Tone Detection (MFD)

The MFD algorithm module detects the presence of R1, R2 Forward, and R2 Backward Multi frequency (MF) tones under a broad range of network conditions and under international telecommunications specifications.

A.6.1 Functional requirements:

Table A-10, Table A-11, and Table A-12 specify the nominal frequencies for the MF digits that must be detected.

F1 (Hz)	F2 (Hz)			
	900	1100	1300	1500	1700

700	1	2	4	7	Spare
900	--	3	5	8	Spare
1100	--	--	6	9	KP
1300	--	--	--	0	Spare
1500	--	--	--	--	ST

Table A-10: Nominal MF R1 Frequencies and corresponding digit definitions

F1 (Hz)	F2 (Hz)				
	1500	1620	1740	1860	1980
1380	1	2	4	7	11
1500	--	3	5	8	12
1620	--	--	6	9	13
1740	--	--	--	10	14
1860	--	--	--	--	15

Table A-11: Nominal MF R2 Forward Frequencies and corresponding combination numbers

F1 (Hz)	F2 (Hz)				
	1020	900	780	660	540
1140	1	2	4	7	11
1020	--	3	5	8	12
900	--	--	6	9	13
780	--	--	--	10	14
660	--	--	--	--	15

Table A-12: Nominal MF R2 Backward Frequencies and corresponding combination numbers

1. Be configurable to detect either R1, R2 forward, or R2 backward MF digits on a per-call basis.

2. Detect the presence of all 15 R1, 15 R2 Forward, and 15 R2 Backward digits under a broad range of network conditions.

3. MF digit information is provided as soon as the minimum duration is met. This information is called leading edge detection. This allows the earliest possible response to the digit, such as in compelled signaling.

4. The trailing edge of a MF digit must be detected. This allows the system to delay any response (such as in compelled signaling) to the digit until it is removed. The criteria selected for trailing edge detection will debounce MF digits.

5. The DSP reports leading and trailing edge in the 8 ms block that they are detected. MF events are not buffered.

A.6.2 R1 Detection Performance requirements:

Table A- 13 consists of MF R1 tone detection performance requirements taken from CCITT/ITU Q310-Q331 and Bellcore TR-NWT-000506. Also shown is D2's MF R1 performance requirements, which is a superset of the CCITT and Bellcore requirements.

<TABLE>
<CAPTION>

	Requirement		
Characteristic	Bellcore	CCITT/ITU	D2
<S>	<C>	<C>	<C>
Frequency Deviation	+/-(1.5% + 5 Hz) must accept	+/-1.5% must accept	Configurable choice of three sets of must accept frequency tolerance: +/-(1.5% + 5 Hz), +/-(1.5% + 10 Hz), +/-(1.5% + 15 Hz)
Tone Duration	KP signal >/= 54 ms must accept; </=30 ms must reject All others: >/=30 ms must accept; </=10 ms must reject	>/=30 ms must accept </=10 ms must reject	Minimum duration is configurable in 4 ms steps, from 28 ms up. Can be configured for >/=30 ms must accept; </=10 ms must reject
Minimum Interdigital Interval	Must accept interdigital intervals >/=25 ms. Must bridge interdigital intervals </=10 ms	Must accept interdigital intervals >/=20 ms	Minimum interdigital interval is configurable in 4 ms steps. Can be configured for >/=20 ms accept; </=10 ms bridge
Minimum Cycle Time	Up to 10 pulses per second (100 ms cycle time)	-	>10 pulses per second (<100 ms cycle time)
Accept Levels	0 to -25 dBm must accept </=-35 dBm must reject	-	Minimum power is configurable from -25 dBm to -45 dBm per frequency
Twist (ratio of high group power to low)	</=6 dB twist must accept	</=6 dB twist must accept	</=6 dB twist must accept
SNR (white noise)	20 dB	-	20 dB
Impulse Noise	Fewer than 14 missed or split digits in Bellcore Impulse Noise Tape No. 201	-	Fewer than 14 missed or split digits in Bellcore Impulse Noise Tape No. 201

</TABLE>

<TABLE>
<S> <C> <C> <C>

Disturbing Frequencies	Detection in the presence of 2A-B and 2B-A modulation products 28 dB below each frequency component level of the signals.	-	Detection in the presence of 2A-B and 2B-A modulating products 28 dB below each frequency component level of the signals

</TABLE>

Table A-13: MFD R1 Detection Performance Requirements

A.6.3 R2 Detection Performance Requirements

Table A- 14 shows the MF R2 tone detection performance requirements taken from CCITT/1TU Q400-490. The MFD module is required to pass all CCITT/ITU requirements.

<TABLE>
<CAPTION>

Characteristic	CCITT/ITU Requirement	CCITT/ITU Requirement
<S> Frequency Deviation	<C> +/-10 Hz must accept	<C> Configurable choice of three sets of must accept frequency tolerance: +/-10 Hz +/-15 Hz +/-20 Hz
Tone Duration	Must reject signals </= 7 ms	Must reject signals </= 7ms
Minimum response time for R2 compelled signaling	detect delay + generate delay </= 70 ms detect delay + decision delay + generate delay </= 80 ms	detect delay + generate delay </= 70 ms detect delay + decision delay + generate delay </= 80 ms
Accept Levels	-5 dBm0 to -31.5 dBm0 must detect; -38.5 dBm0 must reject	Minimum power is configurable from -25 dBm to -45 dBm per frequency
Twist (ratio of high group power to low)	</= 5 dB twist must accept for adjacent frequencies; </= 7 dB twist must accept non-adjacent frequencies; 20 ddB twist must reject	</= 5 dB twist must accept for adjacent frequencies; for </= 7 dB twist must accept for non-adjacent frequencies 20 dB twist must reject

</TABLE>

<TABLE>

<S>	<C>	<C>
Disturbing Frequencies	Must not falsely detect due to any one or more valid R2 frequencies at -55 dBm per frequency. In the presence of a valid R2 tone, no missed detections and no false detections due to any of the remaining frequencies at 20 dB below the highest of the MF tone pair. Must not falsely detect due to: 1. Any 1 or 2 pure sine waves, each at -38.5 dBm0, 300-3400 Hz. 2. Any 1 or 2 pure sine waves, each at -42 dBm, 300-3400 Hz. 3. Forward detector: Any 2 pure sine waves, each at -5 dBm, 330-1150 Hz or 2130-3400 Hz. 4. Backward detector: Any 2 pure sine waves, each at -5 dBm, 1300-3400 Hz.	Must not falsely detect due to any one or more valid R2 frequencies at -55 dBm per frequency. In the presence of a valid R2 tone, no missed detections and no false detections due to any of the remaining frequencies at 20 dB below the highest of the MF tone pair. Must not falsely detect due to: 1. Any 1 or 2 pure sine waves, each at -38.5 dBm0, 300-3400 Hz. 2. Any 1 or 2 pure sine waves, each at -42 dBm, 300-3400 Hz. 3. Forward detector: Any 2 pure sine waves, each at -5 dBm, 330-1150 Hz or 2130-3400 Hz. 4. Backward detector: Any 2 pure sine waves, each at -5 dBm, 1300-3400 Hz.
Transmitted signal interference	Must not falsely detect due to generation of outgoing MF digits.	Must not falsely detect due to generation of outgoing MF digits.

</TABLE>

Table A-14: MFD R2 Detection Performance Requirements

A.7 MFcR2 compelled signaling

In order to pass the CCITT requirements for compelled signal timing, the following additional requirements are made on the MFD detector:

1. The MFD detector shall detect the leading edge of an R2 digit after processing no more than 24 ms of the digit.

2. The MFD detector shall detect the trailing edge of an R2 digit after processing no more than 16 ms of the silence following the digit.

EXHIBIT B

LICENSEE PRODUCT DESCRIPTION

Service Resource Module (SRM) for high density programmable switching systems.

EXHIBIT C

DEVELOPMENT, MAINTENANCE, AND RUNTIME LICENSE FEE SCHEDULE

DEVELOPMENT LICENSE FEES: LICENSED TECHNOLOGY FOR THE BASIC SERVICES SPECIFIED IN EXHIBIT A

Development license fees are specified in PO #104962.

50% of which has already been paid to D2 and the final 50% to be paid upon the delivery and acceptance of the Licensed Technology for Basic Services by Licensee in accordance with Article 4 of this Agreement.

MAINTENANCE FEES: LICENSED TECHNOLOGY FOR THE BASIC SERVICES SPECIFIED IN EXHIBIT A

The Maintenance Fee after the expiry of the Warranty period shall be $20,000 per year, starting from the date after the Warranty period (Contract Year), renewable at the end of each Contract Year.

In the event that during the four consecutive calendar quarters which begin immediately after the start of a Contract Year, LICENSEE completes payments to D2 of one hundred thousand dollars in Runtime License Fees under this Agreement, D2 will apply a credit equaling to 100% of the Maintenance Fee against the Runtime License Fees of that Contract Year.

In the event that LICENSEE exercises the Buy Out option for Runtime License Fees, there shall be no Maintenance Fee for the first three years after the expiry of the Warranty period.

RUNTIME LICENSE FEES: LICENSED TECHNOLOGY FOR BASIC SERVICES SPECIFIED IN EXHIBIT A AND SIMPLE CONFERENCING TECHNOLOGY

A runtime license fee shall be paid for each SRM in the Licensee Product (Exhibit B) which contains the Licensed Technology for Basic Services and simple conferencing which does not require network echo cancellation technology (Exhibit A) sold by LICENSEE. Licensee Products which do not run the Licensed Technology are not subject to runtime license fees.

The runtime license fee is based on the number of ports of service that a customer can expect the SRM to provide. As such, this runtime license fee calculation may be used for an SRM with any number of DSP processors (DSPs), with any MIPS

performance rating, as long as it is from the TI TMS320C54x, TMS320C55x, or TMS320C6x processor family.

Fee_per_SRM = Fee_per_Port * DSPs_per_SRM * Average_Ports_per_DSP

Where:

Fee_per_SRM is the runtime license fee for each SRM.
Fee_per_Port is on Table 1.
DSPs_per_SRM is the number of DSPs on each SRM.
Average_Ports_per_DSP is defined below.

total quantity of processors licensed	Fee_per_port
1-5,000	$2.00
5,001 - 25,000	$1.00
25,001 - 50,000	$0.75
5,001 - 75,000	$0.50
> 75,000	$0.00

Table 1. Fee per port

If LICENSEE commits to purchase licenses for a minimum of 10,000 processors for the first year after first customer shipments, the fee_per_port will be reduced for $1.00 for the first 5,000 processors.

The SRM will provide 5 Basic Services and simple conferencing (which does not require network echo cancellation):

1. DTG -- Digital Tone Generation (static channels and outpulsing)
2. CPA -- Call Progress Analysis (with Voice Activity Detection)
3.- DRC -- DTMF Detection
4. MFR(1) -- Multifrequency Reception (1)
5. MFCR2 -- Multifrequency Reception and Transmission, Compelled R2

To determine the Average ports per DSP, the completed software will be tested in a heavily-loaded VCO/20 to determine the maximum number of ports that a single DSP processor performing each of the Basic Services can reliably satisfy. This

maximum will be documented in Table 2 below, and will be encoded in software, to prevent a customer from exceeding it.

This maximum will vary depending on the DSP processor speed, so a separate measurement will have to be done for SRMs containing faster processors. Due to system limitations, this number will never exceed 63.

The number of ports supported for each of the Basic Services, per DSP processor, will be averaged (arithmetic mean) to create an average number of ports per DSP (Average_Ports_per_DSP). Because of the computational simplicity of the DTG

Service, it will not be included in this calculation:

Average_Ports_per_DSP = (#CPA + #DRC + #MFR1 + #MFCR2)/4

Service	Predicted Maximum # Ports	Measured Maximum # Ports	Included in Average?
DTG	63	To be measured	Not included
CPA	30	To be measured	Included
DRC	30	To be measured	Included
MFR1	30	To be measured	Included
MFCR2	30	To be measured	Included

TABLE 2. MEASURED PERFORMANCE OF SERVICES

CAP: The runtime license fees is fully paid up after it reaches the CAP, which is the cumulative runtime license fees paid by LICENSEE for the first 75,000 processors as specified in Table 1 above. The CAP is cumulative across the Texas Instruments TMS320C54x, TMS320CSSx, and TMS320C6x, and other TI processors based on the same core processor architecture.

BUYOUT OPTION: Within the Warranty period, LICENSEE may elect to pay D2 a sum of $1,400,000 as a one time paid-up runtime license fees for the Basic Services specified in Exhibit A.

EXHIBIT D

MODEL LICENSEE AGREEMENT FOR LICENSEE PRODUCT

SOFTWARE LICENSE

Licensed Technology incorporated in LICENSEE Product, together with Updates and New Versions thereof, are provided to LICENSEE's Customer under a non-exclusive worldwide license subject to the following terms:

1. LICENSEE's Customer shall have the right to distribute copies of the Licensed Technology to end users in Object Code form either directly or indirectly through others for use in connection with the LICENSEE Product. LICENSEE's Customer shall require that such end users agree to protect D2's and LICENSEE's intellectual property rights in the Licensed Technology as set forth in this LICENSEE's Customer Agreement.

2. LICENSEE's Customer shall have the right to reproduce the Licensed Technology for distribution and make a reasonable number of copies of the Licensed Technology for backup or archival purposes.

3. LICENSEE's Customer shall not have the right to modify, reverse engineer, decompile or derive Source Code from the Licensed Technology, nor shall LICENSEE's Customer permit any third party to do so. LICENSEE's Customer shall not have the right to disclose the Licensed Technology except as permitted herein.

4. LICENSEE's Customer shall have the right to transfer a licensed copy of the Licensed Technology to a third party provided LICENSEE's Customer does not retain any copies of such licensed copy and the third party agrees to abide by the terms and conditions of this LICENSEE's Customer Agreement. All Licensed Technology must be transferred upon a change in title of any hardware in which

it was installed.

5. LICENSEE's Customer agrees that D2 or LICENSEE retain the entire right and title to Licensed Technology.

6. The provisions of this Article (paragraphs 1 through 6 preceding) shall survive the termination or expiration of this LICENSEE's Customer Agreement.

EXHIBIT E

1. Development and Back-up Computers

	Computer Manufacturer and Model	Serial Number	Dev/Backup
(1)	--	--	
(2)	--	--	
(3)	--	--	

1. FORMAT OF Licensed Software Media

(1)	--	--
(2)	--	--
(3)	--	--

Date:

EXHIBIT F

Acceptance Test Specification

To be provided by D2 and LICENSEE within 90 days of effective date of this Agreement.