
ML7012-04

2400 bps Single Chip Full Duplex Data Modem with Protocol

GENERAL DESCRIPTION

The ML7012-04 is a single chip modem LSI device that enables data communication conforming to ITU-T recommendations V.22bis, V.22, and V.21. This device is equipped with the error correction protocol function conforming to MNP Class 4. (The MNP Class 4 can be used for V.22bis or V.22.)

The ML7012-04 consists of high speed DSP, analog front end, and digital logic circuit. In addition, this device provides local analog loop testing, synchronous/asynchronous switching, dialing, and auto answering functions.

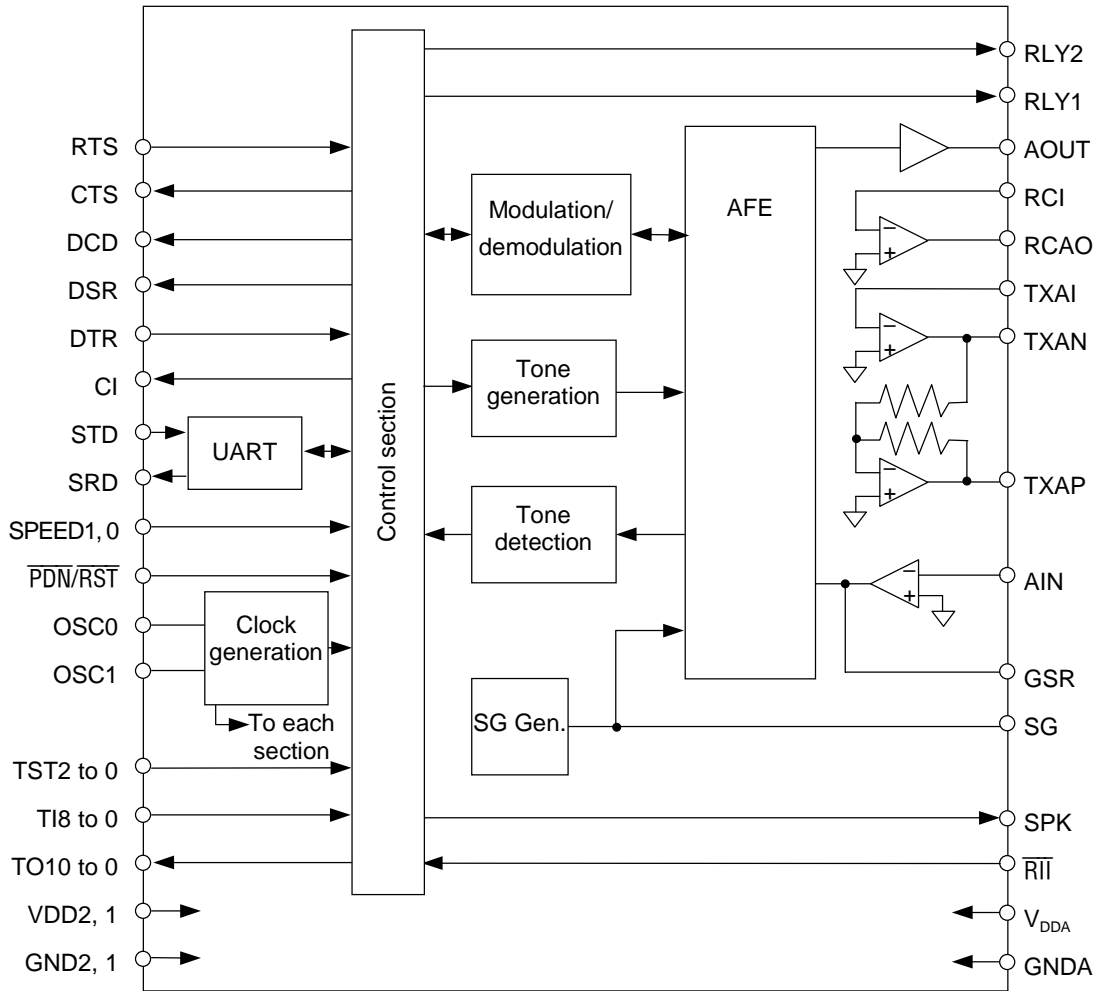
The ML7012-04 has a serial interface as an external interface. When integrated into the system, it is controlled from a control CPU through a serial interface (e.g. UART). By connecting a level converter, the ML7012-04 can easily implement a modem that can be controlled through the RS-232C interface.

FEATURES

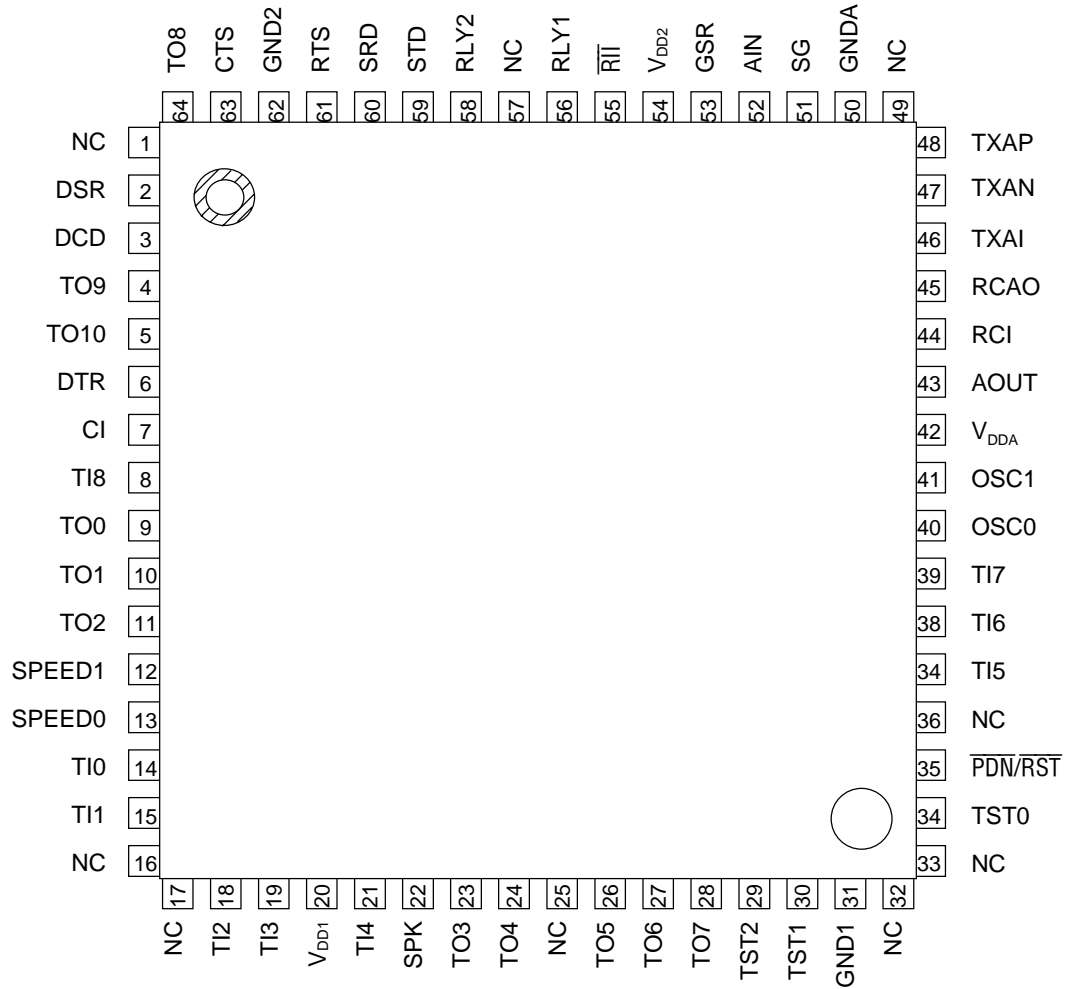
- Conforming to ITU-T Recommendations V.22 bis, V.22, and V.21: Asynchronous
- Error correction function conforming to MNP Class 4
- Serial interface: V.24 interface
- AT commands (excluding automatic command speed detection)
- Terminal data speed between DTE and DCE: 9600 bps, 2400 bps, 1200 bps, 300 bps
- Character format: 10 bit/character
- DTMF sending function
- Pulse-dial control signal output
- Call progress tone
- Auto answering function
- Built-in electronic HYB circuit (a line transformer can be directly coupled)
- Single +3 V power supply
- Power consumption: Typ. = 35 mA ($V_{DD} = 3.3$ V)
- Package: 64-pin plastic QFP (QFP64-P-1414-0.80-BK) (Product name: ML7012-04GA)

* MNP is a registered trademark of Microcom Inc.

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



64-Pin Plastic QFP

Note: Pins marked (NC) are no-connection pins which are left open.

PIN DESCRIPTIONS

System & Clock

Symbol	I/O	Description
OSCO	I	Pins to connect crystal, resistors and capacitors for the master clock oscillation. When supplying the master clock from an external source, use OSC0 and leave OSC1 open.
OSC1	O	Master clock frequency = 11.0592 MHz. When $\overline{\text{PDN/RST}} = "0"$, OSC1 = "1".
$\overline{\text{PDN/RST}}$	I	<p>Power-down and reset control input pin. When $\overline{\text{PDN/RST}} = "0"$, this device is in the power-down state and internal circuits are reset.</p> <p>"0": Power-down state, "1": Normal operation</p> <p>After power-on, use this pin after setting it to "0" for 1 μs or more to reset internal circuits. Waiting for 230 ms or more is required until restarting a normal operation after reset release.</p> <p>If this pin remains at "0" after power-on, the internal circuits become undefined and the power-down current may increase. To avoid this, input "1" to this pin and start oscillation or input the master clock to operate the internal circuits, and then set it to "0"</p>

V.24 Serial Interface

Symbol	I/O	Description
STD	I	Send data input pin 0: Space, 1: Mark
SRD	O	Receive data output pin When $\overline{\text{PDN/RST}} = "0"$, SRD outputs "1". 0: Space, 1: Mark
RTS	I	RTS (Request to Send) signal input pin 0: On, 1: Off
CTS	O	CTS (Clear to Send) signal output pin When $\overline{\text{PDN/RST}} = "0"$, CTS outputs "1". 0: On, 1: Off
DCD	O	DCD (Data Carrier Detect) signal output pin When $\overline{\text{PDN/RST}} = "0"$, DCD outputs "1". 0: On, 1: Off
DSR	O	DSR (Data Set Ready) signal output pin When $\overline{\text{PDN/RST}} = "0"$, DSR outputs "1". 0: On, 1: Off
DTR	I	DTR (Data Terminal Ready) signal input pin 0: On, 1: Off
CI	O	CI (Calling Indicator) signal output pin (*2) When $\overline{\text{PDN/RST}} = "0"$, CI outputs "1". 0: On, 1: Off

Analog Interface

Symbol	I/O	Description
AOUT	O	Transmit analog output pin When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, AOUT is in a high impedance state.
RCI	I	Operational amplifier input pin constituting transmit RC active
RCAO	O	Operational amplifier output pin constituting transmit RC active When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, RCAO is in a high impedance state.
TXAI	I	Input pin of the line transformer drive amplifier
TXAN	O	Output pin of the line transformer drive amplifier (1) When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, TXAN is in a high impedance state.
TXAP	O	Output pin of the line transformer drive amplifier (2) When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, TXAP is in a high impedance state.
AIN	I	Input pin of the receive input amplifier
GSR	O	Output pin of the receive input amplifier When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, GSR is in a high impedance state.
SG	O	Pin to connect capacitors for the SG circuit When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, SG is in a high impedance state.

PSTN Line Control Interface

Symbol	I/O	Description
RLY1	O	Off-hook and pulse dial control signal output pin (*1) 0: On-hook or break state of pulse dial 1: Off-hook or make state of pulse dial When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, RLY1 outputs "0".
RLY2	O	The control signal output pin to disconnect interlinked telephones (*1) 0: PSTN is connected with interlinked telephones 1: PSTN is disconnected with interlinked telephones but connected with modem When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, RLY2 outputs "0".
$\overline{\text{RII}}$	I	Incoming signal input pin (*2) Input "0" while detecting an incoming signal Input "1" while not detecting an incoming signal Fix this pin to "1" when a ring detector is not used.
SPK	O	Speaker control signal output pin 0: speaker On 1: speaker Off When $\overline{\text{PDN}}/\overline{\text{RST}} = "0"$, SPK outputs "1".

Other Interface

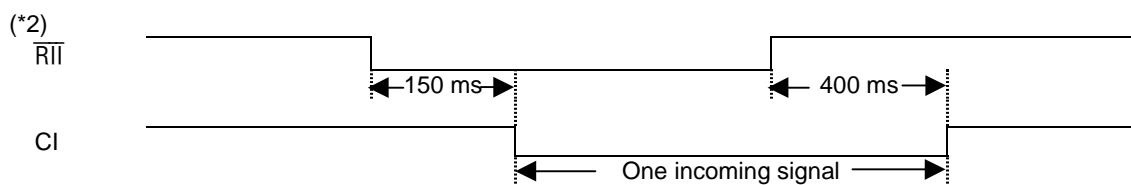
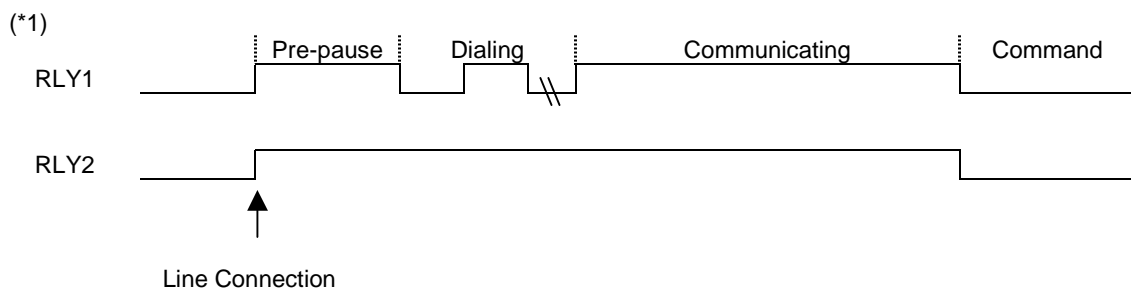
Symbol	I/O	Description		
Speed 1	I	Data Transmission Speed between DTE and DCE		
		Speed 1	Speed 0	Speed
		0	0	300 bps
		0	1	1200 bps
Speed 0	I	1	0	2400 bps
		1	1	9600 bps

Test Interface

Symbol	I/O	Description
TST2 to 0	I	Input "0".
TI8 to 0	I	Input "0".
TO10 to 0	O	Leave open.

Power Supply

Symbol	I/O	Description
V _{DDA}	I	Analog V _{DD} pin
GND _A	I	Analog GND pin
V _{DD2 to 1}	I	Digital V _{DD} pin
GND _{2 to 1}	I	Digital GND pin



Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Power Supply Voltage	V_{DD}	-0.3 to +5.0	V
Analog Input Voltage	V_{AIN}	-0.3 to $V_{DD} + 0.3$	V
Digital Input Voltage	V_{DIN}	-0.3 to $V_{DD} + 0.3$	V
Power dissipation	P_D	to 500	mW
Output short-circuit current	V_{OUT}	to 90	mA
Storage Temperature	T_{STG}	-55 to +150	°C

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	
Power Supply Voltage	V_{DD}	—	2.7	—	3.6	V	
Operating Temperature	T_{OP}	—	-20	+25	+70	°C	
High Level Input Voltage	V_{IH}	All digital input pins excluding OSC0	$0.7 \times V_{DD}$	—	V_{DD}	V	
Low Level Input Voltage	V_{IL}		0	—	$0.16 \times V_{DD}$	V	
Digital Input Rise time	t_{ir}	All digital input pins	—	—	20	ns	
Digital Input Fall Time	t_{if}		—	—	20	ns	
Input Clock Frequency Deviation	FMCK	11.0592 MHz	-100	—	+100	ppm	
Master CLK Duty	DMCK	Input to OSC0	40	50	60	%	
Digital Output Load	C_{DL}	Digital output pin	—	—	50	pF	
R1 to R3 Resistance Ratio (R3/R1)	Rrat1	—	—	1	1.05	—	
R4 to R5 Resistance Ratio (R5/R4)	Rrat2	$V_{DD} \geq 3\text{ V}$	—	—	2	—	
	Rrat3	$V_{DD} \geq 2.7\text{ V}$	—	—	1.6	—	
SG Bypass Capacitor	C_{SG}	SG pin	1	—	—	μF	
Oscillator Feedback Resistance	R_{OSC}	Between OSC0 and OSC1	800	1000	1200	kΩ	
OSC0 and OSC1 Load Capacitance	C_{01}, C_{02}	OSC0 and OSC1 pins	—	15	—	pF	
Crystal	Oscillation Frequency	—	—	11.0592	—	MHz	
	Frequency Deviation	—	Including temperature characteristics	-80	—	+80	ppm
	Equivalent Series Resistance *1	—	—	—	—	90	Ω
	Load Capacitance *1	—	—	—	12	—	pF

*1: If the crystal manufacturer's evaluation is sufficiently verified, the values of equivalent series resistance and load capacitance may be changeable so long as the frequency deviation is within the range specified above.

ELECTRICAL CHARACTERISTICS**DC Characteristics** $(V_{DD} = 2.7 \text{ to } 3.6 \text{ V}, T_a = -20 \text{ to } +70^\circ\text{C})$

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power Supply Current	I_{DO}	—	—	35	65	mA
	I_{DDS}	Power-down mode *1	—	1	1000	μA
Input Leakage Current	I_{IH}	$V_I = V_{DD}$	—	0	20	μA
	I_{IL}	$V_I = 0 \text{ V}$	—	0	20	μA
High Level Digital Output Voltage	V_{OH}	$I_{OH} = -0.4 \text{ mA}$	$0.8 \times V_{DD}$	$0.99 \times V_{DD}$	—	V
Low Level Digital Output Voltage	V_{OL}	$I_{OL} = 3.2 \text{ mA}$	—	0.1	0.4	V
Input Capacitance	C_{IN}	—	—	5	—	pF

*1: In the case where the device is powered down after once activated.

Analog Interface

(V_{DD} = 2.7 to 3.6 V, T_a = -20 to +70°C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	
Input Resistance	R _{IN}	RCI, TXAI, AIN	—	10	—	MΩ	
Output Load Resistance	R _{L1}	AOUT, RAO, GSR	20	—	—	kΩ	
	R _{L2}	Between TXAN and TXAP	1080	—	—	Ω	
Output Load Capacitance	C _L	Analog output	—	—	100	pF	
SG Output Voltage	V _{SG}	SG	1.3	1.4	1.65	V	
SG Output Impedance	R _{SG}	SG	—	30	—	kΩ	
Carrier Output Level	VAOM	AOUT, S34 = 0 dm	-19.5	-18.0	-16.0	dBm	
DTMF Low Group Output Level	VDTL	AOUT, S35 = 0 dm	-17.0	-15.5	-13.5	dBm	
DTMF High Group Output Level	VDTH	AOUT, S35 = 0 dm	-16.0	-14.5	-12.5	dBm	
DTMF Output Frequency Precision	TSDF	Against a nominal frequency	-1.5	—	+1.5	%	
Answer Tone Output Level	VAOAT	AOUT, S34 = 0 dB	-20	-18.0	-15.5	dBm	
Answer Tone Output Frequency Precision	TSAF	Against 2100 Hz	-10	—	+10	Hz	
Undesired Sending Level	VS1	TXAN, TXAP	4 to 8 kHz	—	—	-20	dBm
	VS2		8 to 12 kHz	—	—	-40	dBm
	VS3		12 kHz or more (each 4 kHz band)	—	—	-60	dBm
Carrier Receive Input Level	VGSR	GSR level	-46	—	-15	dBm	
Carrier Detection Level	VON	GSR level *2	OFF → ON	-46	—	—	dBm
	VOFF		ON → OFF	—	—	-54	dBm
Carrier Detection Delay Time	t _{CDD}	—	OFF → ON	—	25	ms	
Carrier Detection Hold Time	t _{CDH}	—	ON → OFF	—	15	ms	
Answer Tone Detection/Non-detection Level	ATDL	GSR level	—	-50	—	dBm	
			—	—	—	dBm	
Call Progress Tone Detection/Non-detection Level	CPDL	GSR level	—	-50	—	dBm	
			—	—	—	dBm	

*1: The unit of the signal level (dBm) is 0 dBm = 0.775 V_{rms}.

*2: The values of the carrier detection level are those for QAM, PSK and FSK modulation signals.

COMMAND DESCRIPTIONS

AT Commands

(1) Command format

AT commands begin with <AT> or <at>. Character strings to a carriage return code are interpreted as commands to be executed successively. A result code is returned to DTE after the completion of interpretations.

AT	Characters	CR	LF
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However, the commands of A, D, Dc, On, Zn, Ax, &Tn and &Zn must be set at the end of the sequence of commands.

Any commands set after those commands are ignored.

The maximum command character string is 40 characters (space <20h> is ignored).

Input characters can be deleted by a backspace function (a cord is changeable).

<CR> is a Carriage Return code (changeable).

<LF> is a Line Feed code (not mandatory and changeable).

Both capital and small letters can be recognized with the exception of At and aT. The communication with the terminal when inputting commands is handled as an asynchronous mode, and the character format is checked automatically as soon as <AT> or <at> is input.

This device cannot be guaranteed for normal operation when character strings or parameters not listed below are input.

(2) Terminal data speed and character format

The communication mode to DTE with the V.24 interface is as follows:

Terminal data speed: 9600/2400/1200/300 bps

Character format: Listed below

Start Bit	Data Bit	Parity	Stop Bit	Character Length
1	7	None	2	10
1	7	Odd number	1	10
1	7	Even number	1	10
1	8	None	1	10

(3) AT command list

It is regarded that n = 0 when the parameter is not specified to the command with parameter (n).

CMD	Style	Function	Initial Value	Note
+++AT <CR>	—	Goes to on-line command mode from data mode. Inputs +++AT <CR> in data mode. Does not move to on-line command mode until <CR> is input.	—	
A	ATA	Starts line connection in answer mode	—	
	ATD	Starts line connection in originate mode	—	
D	ATDc	Connects lines in originate mode after dialing. c: Dial control character Pulse: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 Tone: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, *, # @ Silence Detection Next dialing is executed when continuous silence of 5 sec is detected after ring back tone within the period specified in S7 register. Sends back 'BUSY' when busy tone is detected and sends back 'NO ANSWER' when no silence is detected after ring back tone. ! Flash Dialing is put on hold for the period specified in the S8 register for pause settings. ,Comma The line is put on-hook for 0.5 sec. Dialing is put on hold for the period specified in the S8 register for pause settings. ; Moves to command mode without disconnecting lines after dialing is completed. P: Dials the number in pulse mode thereafter. T: Dials the number in tone mode thereafter. W: Detects a dial tone. Detects the next dial string process when dial tone is detected during the period specified in S7 register regardless of ATXn command settings. When it is not detected, 'NO DIALTONE' is returned.	—	
E	ATEn	Selects the answer-back function for the commands. N = 0: No answer back for command input characters. N = 1: Answer back for command input characters.	1	
H	ATH	Controls the line connection. N = 0: On-hook N = 1: Off-hook	—	
I	ATI	Displays the modem manufacturer's code '24A' as a result code is returned to DTE after ATIO<CR> is executed.	—	
M	ATMn	Selects the monitor speaker operation. N = 0: Always OFF N = 1: ON from dialing to line connection N = 2: Always ON N = 3: ON when connected with a remote modem	1	
O	ATO	Goes to data mode from on-line command mode.	—	

CMD	Style	Function	Initial Value	Note																																																	
P	ATP	Sets dialing mode to pulse.	—																																																		
Q	ATQn	Selects the result code transmission. n = 0: Result code is transmitted. n = 1: Result code is not transmitted.	0																																																		
S	ATSr	Sets the pointer value for S resistor to "r".	—																																																		
	ATSr?	Echoes back the content of S resistor specified by "r".	—																																																		
	ATSr = d	Sets the content of S resistor specified by "r" to "d".	—																																																		
T	ATT	Sets dialing mode to DTMF.	—																																																		
V	ATVn	Selects the type of result code. n = 0: Number n = 1: Characters	1																																																		
X	ATXn	Selects the extended result code and call progress tone detection. <table border="1" style="margin-left: 40px;"> <thead> <tr> <th colspan="5">n</th> <th>Function</th> <th>Result Code</th> </tr> <tr> <th>0</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>o</td> <td>o</td> <td>o</td> <td>o</td> <td>o</td> <td>Line connection 300 bps</td> <td>CONNECT</td> </tr> <tr> <td>—</td> <td>o</td> <td>o</td> <td>o</td> <td>o</td> <td>Line connection 1200 bps</td> <td>CONNECT 1200</td> </tr> <tr> <td>—</td> <td>o</td> <td>o</td> <td>o</td> <td>o</td> <td>Line connection 2400 bps</td> <td>CONNECT 2400</td> </tr> <tr> <td>—</td> <td>—</td> <td>o</td> <td>—</td> <td>o</td> <td>Dial tone detection</td> <td>NO DIAL TONE</td> </tr> <tr> <td>—</td> <td>—</td> <td>—</td> <td>o</td> <td>o</td> <td>Busy tone detection</td> <td>BUSY</td> </tr> </tbody> </table>	n					Function	Result Code	0	1	2	3	4			o	o	o	o	o	Line connection 300 bps	CONNECT	—	o	o	o	o	Line connection 1200 bps	CONNECT 1200	—	o	o	o	o	Line connection 2400 bps	CONNECT 2400	—	—	o	—	o	Dial tone detection	NO DIAL TONE	—	—	—	o	o	Busy tone detection	BUSY	4	
n					Function	Result Code																																															
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—	—	o	—	o	Dial tone detection	NO DIAL TONE																																															
—	—	—	o	o	Busy tone detection	BUSY																																															
Z	ATZ	Reset in the same way the PDN/RST pin is set to "0".	—																																																		
&C	AT&Cn	Controls data carrier detection signals (DCD). n = 0: Always sets DCD to ON. n = 1: Controls DCD by detecting reception carriers.	0																																																		
&D	AT&Dn	Controls the modem in DTR signal state. n = 0: Ignores DTR signals. n = 1: Ignores DTR signals. In data mode, however, moves to on-line command mode when DTR signals change from ON to OFF n = 2, 3: Goes to command mode after disconnecting lines when the change of DTR from ON to OFF is detected during communication.	2																																																		
&G	AT&Gn	Sets the guard tone transmission. n = 0: No guard tone n = 1: With guard tone of 550 Hz n = 2: With guard tone of 1800 Hz	0																																																		
&P	AT&Pn	Selects the make rates of pulse dialing. n = 0: 39% (10 pps) n = 1: 33% (10 pps) n = 2: 33% (20 pps)	1																																																		

CMD	Style	Function	Initial Value	Note
&T	AT&Tn	Controls the loop back test mode. n = 0: None n = 1: Starts local analog loop back test (ALB) n = 2, 3: None n = 4: Responds to the RDL test requirement n = 5: Does not respond to the RDL test requirement n = 6: Starts remote digital loop back test (RDL) n = 7: Starts RDL self-diagnostic test. n = 8: Starts ALB self-diagnostic test.	—	
%E	AT%En	Selects automatic re-training function due to poor incoming conditions of the receive section. n = 0: Automatic re-training is invalid. n = 1: Automatic re-training is valid.	1	
\L	AT\Ln	Checks the line type and displays the result. n = 0: Checks PBX or direct line. n = 1: Checks pulse or tone line.	—	
\N	AT\Nn	Selects data control mode. n = 0,1: Selects normal mode (without error correction). n = 2-5: None n = 6: Selects reliable mode. Disconnects the line when MNP connection is not available. n = 7: Selects auto-reliable mode. Connects in normal mode when MNP connection is not available.	7	
\Q	AT\Qn	Selects the flow control between DTE and modem. n = 0: No flow control n = 1: None n = 2: None n = 3: Bi-directional control by CTS/RTS	3	
\V	AT\Vn	Selects extended result code. n = 0: Displays the normal result code. n = 1: Displays the result code with the mode of the MNP connection. n = 2, 3: None	0	

Result Code

The result code is returned to DTE after AT command is executed.

Two types of result codes are available and can be selected by the Vn command. It is possible to select whether the result code is returned or not by using the Qn command.

The format of 2 types of result codes is as follows:

In the case of number | number | CR | _____

In the case of characters | CR | LF | Characters | CR | LF | _____

Result Code List

Number	Character String	Meaning
0	OK	Command is correctly executed.
1	CONNECT	Connected
2	RING	Incoming signal is detected.
3	NO CARRIER	Aborted the connection or on-hook
4	ERROR	Found the error in the command
5	CONNECT 1200	Connected at 1200 bps
6	NO DIAL TONE	Dial tone cannot be detected.
7	BUSY	Busy tone is detected.
8	NO ANSWER	Silence state cannot be detected.
10	CONNECT 2400	Connected at 2400 bps
12	CONNECT 9600	Connected at 9600 bps in normal mode
22	CONNECT 1200/REL	Connected at 1200 bps in MNP mode
23	CONNECT 2400/REL	Connected at 2400 bps in MNP mode
90	EXT	Judged as PBX line
91	DIRECT	Judged as a direct line
92	DTMF	Judged as a tone line
93	PULSE	Judged as a pulse line

REGISTERS

S Register Setting

In this modem, memory used as S Registers is provided in RAM to set variables used for modem environment settings or to read modem status.

Normal operation is not guaranteed when register numbers not specified in this data sheet or parameters outside the specification are input.

(1) S register setting

The format to set S registers is as follows:

AT<Sn> = <d>

<n> specifies the register No. from decimal 0 to 27, 34, and 35. <d> specifies the number to be set from decimal 0 to 255. If no number is specified at <n> and <d>, it is regarded as "0".

(2) S register reading

The format to read S registers is as follows:

ATS<n>?

<n> specifies the register No. from decimal 0 to 27, 34, and 35. If no number is specified at <n>, it is regarded as "0".

S Register List

Refer to the “Bit map S register list” if the function is specified as “Bit map register”.

Register No.	Set Range	Unit	Initial Value	Function
0	0-255	time	0	Setting of the number to receive the ring signal at automatic receive mode. When set to “0”, automatic receive function is disabled.
1	0-255	time	0	The number of receiving rings
2	—	—	—	Not used
3	0-127	ASCII code	13	Carriage return code
4	0-127	ASCII code	10	Line feed code
5	0-127	ASCII code	8	Back space code
6	4-255	sec	4	Pause time from off-hook to start dialing (Only when setting ATX0, X1, and X3)
7	1-115	sec	60	Waiting time for carrier from the far end modem. It is set to on-hook when no carrier is detected after the time specified.
8	0-255	sec	2	Pause time for dialing. It is referred when dial character < , > is used.
9	—	—	—	Not used
10	1-255	1/10 sec	14	Carrier lost detection time It is set to on-hook automatically when the lost of carrier signal is longer than the specified time. Carrier lost detection is invalid when 255 is set.
11	1-255	1/100 sec	9	DTMF tone transmit time Sets DTMF transmit time. DTMF tone is continuously transmitted when set at 255.
12	—	—	—	Not used
13	—	—	—	Not used
14	—	—	170	Bit map register
15	—	—	—	Not used
16	—	—	0	Bit map register
17	—	—	—	Not used
18	0-255	sec	0	Timer for loop back test
19	—	—	—	Not used
20	—	—	—	Not used
21	—	—	18	Bit map register
22	—	—	244	Bit map register
23	—	—	23	Bit map register
24 to 27	—	—	—	Not used
34*	0-255	dB	2	Sets the level attenuator of transmit carrier. When 15 to 255 is input, value is fixed to 15.
35*	0-255	dB	0	Sets the sending level attenuator of DTMF signal. When 15 to 255 is input, value is fixed to 15.

*Refer to the “Analog Interface Characteristics” for the analog transmit level for S34 and S35.

Bit Map Register List

S14				
Bit	Initial value	Function in 0 setting	Function in 1 setting	Command
7	1	Answer mode	Originate mode	A, D
6	0	Not used	Not used	
5	1	Tone dial	Pulse dial	T, P
4	0	Pulse speed 10 pps	Pulse speed 20 pps	&P
3	1	Makes the result code the number.	Makes the result code the character string.	V
2	0	With the result code	No result code	Q
1	1	No echo back	With echo back	E
0	0	Not used	Not used	

S16				
Bit	Initial value	Function in 0 setting	Function in 1 setting	Command
7	0	Not used	Not used	
6	0	Stops analog loop back self-diagnostic.	Analog loop back self-diagnostic test	&T8
5	0	Stops remote digital loop back self-diagnostic.	Remote digital loop back self-diagnostic test	&T7
4	0	Stops remote digital loop back test.	Remote digital loop back test	&T6
3	0	Not used	Not used	
2	0	Not used	Not used	
1	0	Not used	Not used	
0	0	Stops analog loop back test.	Analog loop back test	&T1

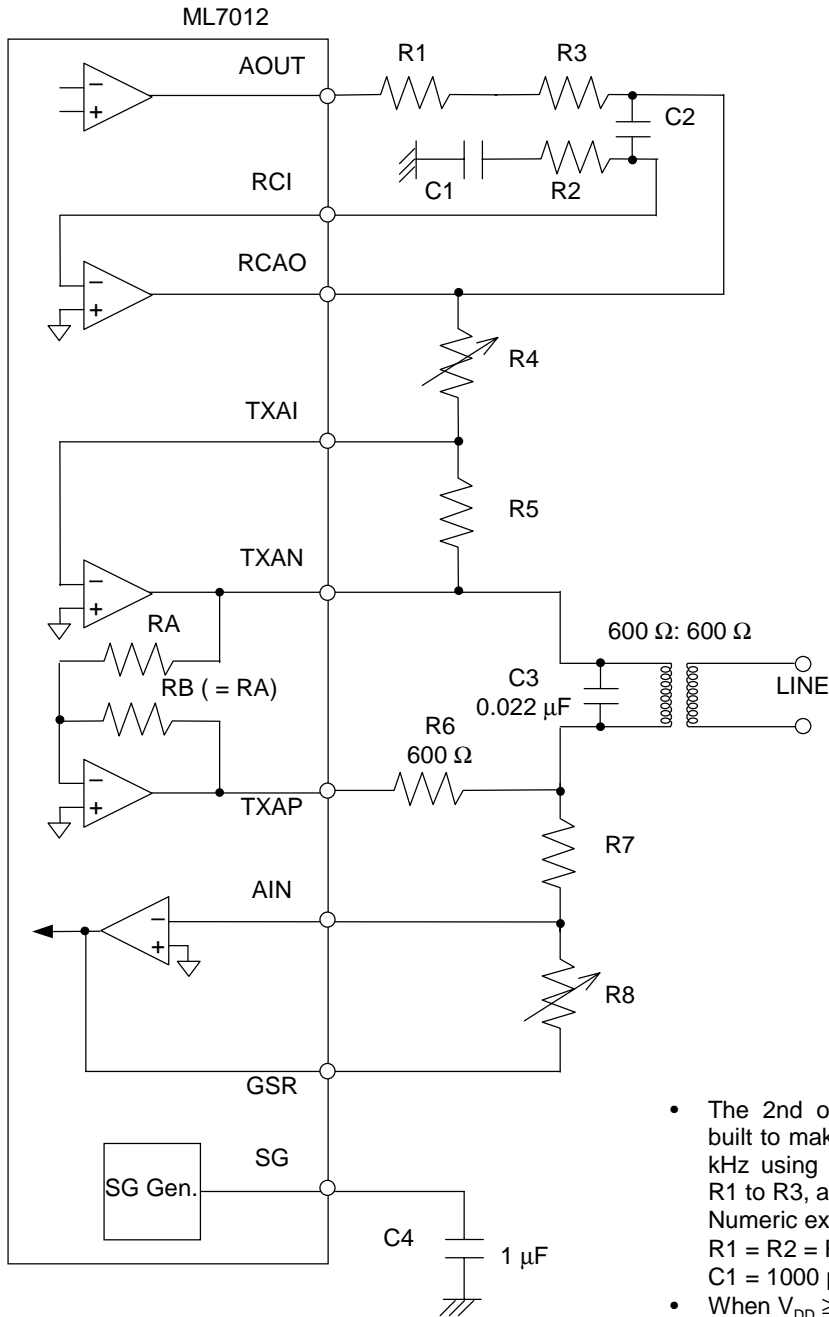
S21				
Bit	First value	Function in 0 setting	Function in 1 setting	command
7	0	Does not break	Breaks	Y
6	0	DSR signal is always ON.	DSR signal operates by ITU-T.	&S
5	0	CD signal is always ON.	CD signal is ON by carrier detection.	&C
4	1	0 <input type="checkbox"/> &D0	1 <input type="checkbox"/> &D2	&D DTR Control
3	0	0 <input type="checkbox"/> &D0	1 <input type="checkbox"/> &D3	
2	0	Not used	Not used	
1	1	Auto re-train disabled	Auto re-train enabled	%E
0	0	Not used	Not used	

S22						
Bit	Initial value	Function in 0 setting		Function in 1 setting		Command
7	1	Pulse dial make rate 39%		Pulse dial make rate 33%		&P
6	1	0 <input type="checkbox"/> X0	1 <input type="checkbox"/> X1	1 <input type="checkbox"/> X2	1 <input type="checkbox"/> X3	X Extended command
5	1	0 <input type="checkbox"/> X0	0 <input type="checkbox"/> X1	0 <input type="checkbox"/> X2	1 <input type="checkbox"/> X3	
4	1	0 <input type="checkbox"/> X0	0 <input type="checkbox"/> X1	1 <input type="checkbox"/> X2	1 <input type="checkbox"/> X3	
3	0	0 <input type="checkbox"/> M0	0 <input type="checkbox"/> M1	1 <input type="checkbox"/> M2	1 <input type="checkbox"/> M3	M
2	1	0 <input type="checkbox"/> M0	1 <input type="checkbox"/> M1	0 <input type="checkbox"/> M2	1 <input type="checkbox"/> M3	
1	0	Not used		Not used		
0	0	Not used		Not used		

S23						
Bit	Initial value	Function in 0 setting		Function in 1 setting		Command
7	0	0 <input type="checkbox"/> &G0	0 <input type="checkbox"/> &G1	1 <input type="checkbox"/> &G2	1 <input type="checkbox"/> &G3	&G
6	0	0 <input type="checkbox"/> &G0	1 <input type="checkbox"/> &G1	0 <input type="checkbox"/> &G2	1 <input type="checkbox"/> &G3	
5	0	0 <input type="checkbox"/> Parity	0 <input type="checkbox"/> Parity	1 <input type="checkbox"/> Parity	1 <input type="checkbox"/> Parity	
4	1	0 <input type="checkbox"/> Even No.	1 <input type="checkbox"/> Mark	0 <input type="checkbox"/> Odd No.	1 <input type="checkbox"/> None	
3	0	Not used		Not used		
2	1	Not used		Not used		
1	1	Not used		Not used		
0	1	Ignores the remote digital loop back request.		Responds to the remote digital loop back request.		&T4, &T5

APPLICATION CIRCUITS

Analog Interface



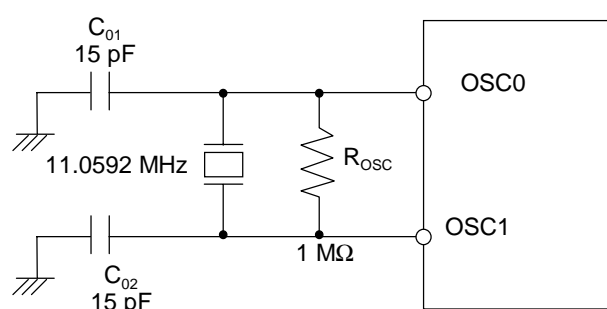
- The 2nd order LPF should be built to make f_c approximately 5 kHz using the built-in amplifier, R1 to R3, and C1 and C2.
 Numeric examples:
 $R1 = R2 = R3 = 68 \text{ k}\Omega$
 $C1 = 1000 \text{ pF}$, $C2 = 220 \text{ pF}$
- When $V_{DD} \geq 3 \text{ V}$, $R5/R4 \leq 2$.
- When $V_{DD} < 3 \text{ V}$, $R5/R4 \leq 1.6$.

Examples of Level Diagram

- (1) Modem transmit: $V_{DD} \geq 3$ V
 AOUT = -20 dBm, RCAO = -20 dBm, TXAN = -14 dBm, TXAP = -14 dBm, LINE = -16 dBm
 (S34 = 2 dB (initial value), R5/R4 = 2, transformer loss = 2 dB)
- (2) DTMF transmit: $V_{DD} \geq 3$ V: high group level
 The low group levels are approximately 1 dB smaller than the values below.
 AOUT = -14.5 dBm, RCAO = -14.5 dBm, TXAN = -8.5 dBm, TXAP = -8.5 dBm, LINE = -10.5 dBm
 (S35 = 0 dB (initial value), R5/R4 = 2, transformer loss = 2 dB)
- (3) Modem transmit: $V_{DD} \geq 2.7$ V
 AOUT = -20 dBm, RCAO = -20 dBm, TXAN = -15.9 dBm, TXAP = -15.9 dBm, LINE = -17.9 dBm
 (S34 = 2 dB (initial value), R5/R4 = 1.6, transformer loss = 2 dB)
- (4) DTMF transmit: $V_{DD} \geq 2.7$ V: high group level
 The low group levels are approximately 1 dB smaller than the values below.
 AOUT = -14.5 dBm, RCAO = -14.5 dBm, TXAN = -10.4 dBm, TXAP = -10.4 dBm, LINE = -12.4 dBm
 (S35 = 0 dB (initial value), R5/R4 = -1.6, transformer loss 2 dB)
- (5) Maximum modem receive:
 LINE = -9 dBm, connecting point of R6, and R7 = -11 dBm, GSR = -15 dBm
 (R8/R7 = 0.63 = -4 dB, transformer loss = 2 dB)
- (6) Minimum modem receive
 LINE = -40 dBm, connecting point of R6 and R7 = -42 dBm, GSR = -46 dBm
 (R8/R7 = 0.63 = -4 dB, transformer loss = 2 dB)

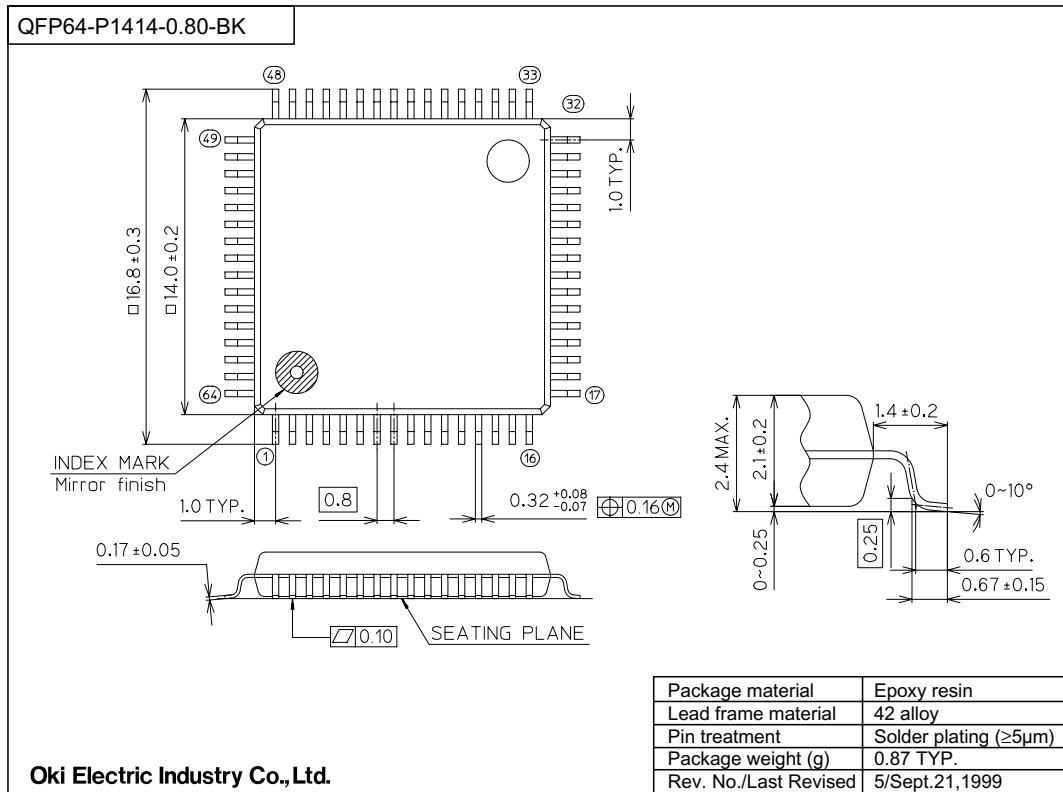
Connection of Crystal Oscillator

Connect a 11.0592 MHz crystal unit and a 1 M Ω feedback resistor between OSC0 and OSC1.
 The values of capacitors C_{01} and C_{02} connected between OSC0 and GND, and OSC1 and GND vary with the load capacitance of the crystal unit and the wiring capacitance of the board. Set the values by the crystal manufacture's matching evaluation.
 If an external clock is used, input it to OSC0.



PACKAGE DIMENSIONS

(Unit: mm)



Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage.

Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

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