# **OKI** Semiconductor

# 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.)

This version: Sep. 2000

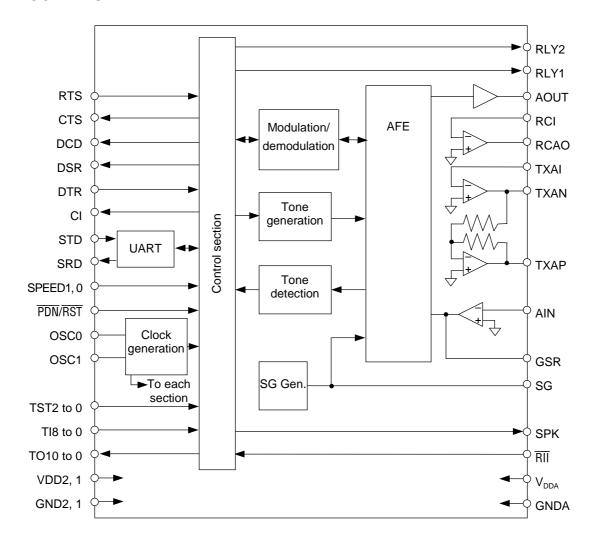
The ML7012-04 consists of high speed DSP, analog front end, and digital logic circuit. In addition, this device provides local analog loop testing, synchronous/asynchronous switching, dialing, and auto answering functions.

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.

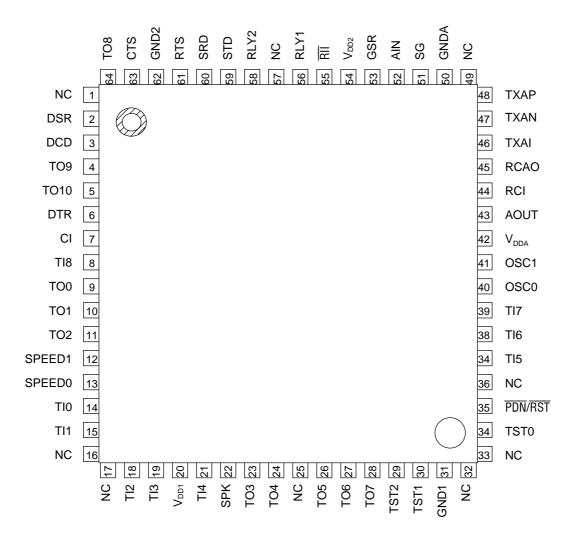
#### **FEATURES**

- 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  $(V_{DD} = 3.3 \text{ V})$
- 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	Ι	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	0	Master clock frequency = 11.0592 MHz. When PDN/RST = "0", OSC1 = "1".
PDN/RST	I	Power-down and reset control input pin. When PDN/RST = "0", this device is in the power-down state and internal circuits are reset.  "0": Power-down state, "1": Normal operation  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.  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"

## V.24 Serial Interface

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

## **Analog Interface**

Symbol	I/O	Description
AOUT	0	Transmit analog output pin
		When PDN/RST = "0", AOUT is in a high impedance state.
RCI	I	Operational amplifier input pin constituting transmit RC active
RCAO	0	Operational amplifier output pin constituting transmit RC active
RCAU	U	When PDN/RST = "0", RCAO is in a high impedance state.
TXAI	I	Input pin of the line transformer drive amplifier
TXAN	0	Output pin of the line transformer drive amplifier (1)
IAAN		When PDN/RST = "0", TXAN is in a high impedance state.
TXAP	0	Output pin of the line transformer drive amplifier (2)
IAAP	0	When PDN/RST = "0", TXAP is in a high impedance state.
AIN	I	Input pin of the receive input amplifier
GSR	0	Output pin of the receive input amplifier
GSR	U	When PDN/RST = "0", GSR is in a high impedance state.
22	0	Pin to connect capacitors for the SG circuit
SG	0	When PDN/RST = "0", SG is in a high impedance state.

## **PSTN Line Control Interface**

Symbol	I/O	Description
		Off-hook and pulse dial control signal output pin (*1)
RLY1	0	0: On-hook or break state of pulse dial
KLII	O	1: Off-hook or make state of pulse dial
		When PDN/RST = "0", RLY1 outputs "0".
		The control signal output pin to disconnect interlinked telephones (*1)
RLY2	0	0: PSTN is connected with interlinked telephones
RL12		1: PSTN is disconnected with interlinked telephones but connected with modem
		When PDN/RST = "0", RLY2 outputs "0".
	I	Incoming signal input pin (*2)
RII		Input "0" while detecting an incoming signal
NII		Input "1" while not detecting an incoming signal
		Fix this pin to "1" when a ring detector is not used.
		Speaker control signal output pin
SPK	0	0: speaker On
SFK		1: speaker Off
		When PDN/RST = "0", SPK outputs "1".

## Other Interface

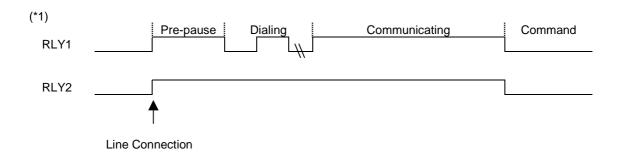
Symbol	I/O		Description					
		Data Transmission Speed b	Data Transmission Speed between DTE and DCE					
Conned 4	I	Speed 1	Speed 0	Speed				
Speed 1		0	0	300 bps				
		0	1	1200 bps				
Speed 0	ı	1	0	2400 bps				
		1	1	9600 bps				

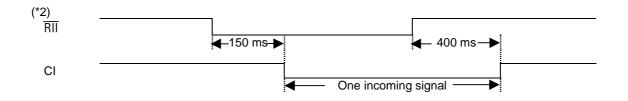
## **Test Interface**

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

## **Power Supply**

Symbol	I/O	Description
$V_{DDA}$	ı	Analog V <sub>DD</sub> pin
GNDA	I	Analog GND pin
V <sub>DD2 to 1</sub>	I	Digital V <sub>DD</sub> pin
GND2 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 <sub>OUT</sub>	to 90	mA
Storage Temperature	T <sub>STG</sub>	-55 to +150	°C

## **Recommended Operating Conditions**

Parameter		Symbol	Condition	Min.	Тур.	Max.	Unit
Power Supply Voltage		$V_{DD}$	_	2.7	1	3.6	V
Operating	Temperature	$T_OP$	_	-20	+25	+70	°C
High Leve	el Input Voltage	$V_{IH}$	All digital input pins	$0.7 \times V_{DD}$	1	$V_{DD}$	V
Low Leve	l Input Voltage	$V_{IL}$	excluding OSC0	0	1	$0.16 \times V_{DD}$	V
Digital Inp	out Rise time	t <sub>ir</sub>	All digital input ping	1	1	20	ns
Digital Inp	out Fall Time	t <sub>if</sub>	All digital input pins		1	20	ns
Input Cloo Deviation	ck Frequency	FMCK	11.0592 MHz	-100		+100	ppm
Master Cl	LK Duty	DMCK	Input to OSC0	40	50	60	%
Digital Ou	itput Load	$C_{DL}$	Digital output pin		1	50	pF
R1 to R3 Resistance Ratio (R3/R1)		Rrat1			1	1.05	_
R4 to R5 Resistance Ratio		Rrat2	$V_{DD} \ge 3 \text{ V}$		1	2	_
(R5/R4)		Rrat3	$V_{DD} \ge 2.7 \text{ V}$	1	1	1.6	_
SG Bypas	ss Capacitor	$C_{\mathtt{SG}}$	SG pin	1	1		μF
Oscillator Resistance	Feedback ce	R <sub>osc</sub>	Between OSC0 and OSC1	800	1000	1200	kΩ
OSC0 and	d OSC1 Load nce	C <sub>01</sub> , C <sub>02</sub>	OSC0 and OSC1 pins		15	_	pF
	Oscillation Frequency	_	_		11.0592	_	MHz
	Frequency Deviation	_	Including temperature characteristics	-80	_	+80	ppm
Crystal	Equivalent Series Resistance *1	_	_			90	Ω
	Load Capacitance *1	_	_	_	12	_	pF

<sup>\*1:</sup> 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

 $(V_{DD} = 2.7 \text{ to } 3.6 \text{ V}, \text{ Ta} = -20 \text{ to } +70^{\circ}\text{C})$ 

			\ DD			
Parameter	Symbol	mbol Condition		Тур.	Max.	Unit
Dower Supply Current	I <sub>DO</sub>	_	-	35	65	mA
Power Supply Current	I <sub>DDS</sub>	Power-down mode *1		1	1000	μΑ
Input Lookage Current	I <sub>IH</sub>	$V_I = V_{DD}$	1	0	20	μΑ
Input Leakage Current	I <sub>IL</sub>	$V_1 = 0 V$	_	0	20	μΑ
High Level Digital Output Voltage	V <sub>oH</sub>	$I_{0H} = -0.4 \text{ mA}$	$0.8 \times V_{DD}$	$0.99 \times V_{DD}$	1	V
Low Level Digital Output Voltage	V <sub>oL</sub>	$I_{0L} = 3.2 \text{ mA}$	1	0.1	0.4	V
Input Capacitance	C <sub>IN</sub>	_		5		pF

<sup>\*1:</sup> In the case where the device is powered down after once activated.

## **Analog Interface**

 $(V_{DD} = 2.7 \text{ to } 3.6 \text{ V}, \text{ Ta} = -20 \text{ to } +70^{\circ}\text{C})$ 

$(V_{DD} = 2.7 \text{ to } 3.6 \text{ V}, \text{ Ta} = -20 \text{ to } +70^{\circ}\text{C})$								
Parameter	Symbol	C	ond	ition	Min.	Тур.	Max.	Unit
Input Resistance	$R_{IN}$	RCI	, TX	ΑI, AIN		10	_	MΩ
Output Land Desistance	$R_{L1}$	AOUT, RCAO, GSR		20	_	_	kΩ	
Output Load Resistance	$R_{L2}$	Between	TXA	N and TXAP	1080		_	Ω
Output Load Capacitance	$C_{L}$	Ana	alog	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	, S3	4 = 0 dm	-19.5	-18.0	-16.0	dBm
DTMF Low Group Output Level	VDTL	AOUT	, S3	5 = 0 dm	-17.0	-15.5	-13.5	dBm
DTMF High Group Output Level	VDTH	AOUT	, S3	5 = 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	
	VS1		4	to 8 kHz		1	-20	dBm
	VS2	TXAN,	8	to 12 kHz	_	_	-40	dBm
Undesired Sending Level	VS3			kHz or more each 4 kHz band)	I	l	-60	dBm
Carrier Receive Input Level	VGSR	G	SR I	evel	-46		-15	dBm
Coming Data sting Lavel	VON	CCD lave	1 * 0	$OFF {\to} ON$	-46	_	_	dBm
Carrier Detection Level	VOFF	GSR leve	1 " 2	$ON \rightarrow OFF$	_	_	-54	dBm
Carrier Detection Delay Time	t <sub>CDD</sub>	_		$OFF {\to} ON$		25	_	ms
Carrier Detection Hold Time	t <sub>CDH</sub>	_		$ON \rightarrow OFF$		15	_	ms
Answer Tone Detection/Non-			-CD -			50	_	dBm
detection Level	ATDL	GSR level			-50		dBm	
Call Progress Tone	CDDI		CD I	0.40		F0		dBm
Detection/Non-detection Level	CPDL G		SR I	evei		<b>–</b> 50	_	dBm

<sup>\*1:</sup> The unit of the signal level (dBm) is 0 dBm = 0.775 Vrms.

<sup>\*2:</sup> 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).

Goes to on-line command mode from data mode. Inputs +++AT CRS- 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  Connects lines in originate mode —  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.  I 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 ATx command settings. When it is not detected. 'NO DIALTONE' is returned.  E ATEN N = 0: No answer back for command input characters. Controls the line connection. N = 1: Answer back for command input characters. Controls the line connection. N = 0: Always OFF  M ATM N = 0: On-hook N = 1: Off-hook N = 1: Off-hook N = 2: Always OFF N = 1: Off-hook N = 3: ON when connected with a remote modem O ATO Gost to date mode from on-line command mode.</cr>	CMD	Style	Function	Initial Value	Note
ATD Starts line connection in originate mode  Connects lines in originate mode after dialing. c: Dial control character Pulse: 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 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 ATM command settings. When it is not detected, 'NO DIALTONE' is returned.  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. N = 1: Answer back for command input characters. N = 1: Answer back for command input characters. N = 0: On-hook N = 1: Off-hook Displays the modem manufacturer's code  1 ATI ATM		_	Inputs +++AT <cr> in data mode.  Does not move to on-line command mode until <cr>is</cr></cr>	_	
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.  I 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 commands settings.  When it is not detected, 'NO DIALTONE' is returned.  Selects the answer-back function for the commands. N = 0: No answer back for command input characters. 1 N = 1: Answer back for command input characters. Controls the line connection.  H ATH N = 0: On-hook N = 1: Off-hook Displays the modem manufacturer's code 24A' as a result code is returned to DTE after ATIO <cr> is executed. Selects the monitor speaker operation. N = 0: Always OFF N = 1: ON from dialing to line connection 1 N = 2: Always ON N = 3: ON When connected with a remote modem</cr>	Α	ATA	Starts line connection in answer mode	_	
E ATEN N = 0: No answer back for command input characters.  N = 1: Answer back for command input characters.  Controls the line connection.  N = 0: On-hook N = 1: Off-hook  Displays the modem manufacturer's code 1 ATI '24A' as a result code is returned to DTE after ATI0 <cr> is executed.  Selects the monitor speaker operation. N = 0: Always OFF  M ATMn N = 1: ON from dialing to line connection N = 2: Always ON N = 3: ON when connected with a remote modem</cr>	D		Starts line connection in originate mode  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.		
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O ATO Goes to data mode from on-line command mode. —	M		<ul> <li>N = 0: Always OFF</li> <li>N = 1: ON from dialing to line connection</li> <li>N = 2: Always ON</li> <li>N = 3: ON when connected with a remote modem</li> </ul>	1	
	0	ATO	Goes to data mode from on-line command mode.		

CMD	Style	Function	Initial Value	Note
P	ATP	Sets dialing mode to pulse.	_	
		Selects the result code transmission.		
Q	ATQn	n = 0: Result code is transmitted.	0	
		n = 1: Result code is not transmitted.		
	ATSr	Sets the pointer value for S resistor to "r".	_	
S	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	ΛT\ /	Selects the type of result code.		
V	ATVn	n = 0: Number n = 1: Characters	1	
		Selects the extended result code and call progress tone		
		detection.		
		n		
		0 1 2 3 4 Function Result Code		
		o o o o Line connection CONNECT		
Χ	ATXn	300 bps		
		— o o o Line connection CONNECT 1200 1200 bps	4	
		— o o o Line connection CONNECT 2400		
		2400 bps		
		— o — o Dial tone detection NO DIAL TONE		
		— — o o Busy tone BUSY detection		
Z	ATZ	Reset in the same way the PDN/RST pin is set to "0".	_	
	7112	Controls data carrier detection signals (DCD).		
&C	AT&Cn	n = 0: Always sets DCD to ON.	0	
		n = 1: Controls DCD by detecting reception carriers.		
		Controls the modem in DTR signal state.		
		n = 0: Ignores DTR signals.		
		n = 1: Ignores DTR signals. In data mode, however, moves		
&D	AT&Dn	to on-line command mode when DTR signals change from ON to OFF	2	
		n = 2, 3: Goes to command mode after disconnecting lines		
		when the change of DTR from ON to OFF is detected during		
		communication.		
		Sets the guard tone transmission.		
&G	AT&Gn	n = 0: No guard tone	0	
ω0	7110011	n = 1: With guard tone of 550 Hz		
		n = 2: With guard tone of 1800 Hz		
		Selects the make rates of pulse dialing. n = 0: 39% (10 pps)		
&P	AT&Pn	n = 1: 33% (10 pps)	1	
		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.		
\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		_		
	1	 I	<u></u>	ı	I	ı
In the case of characters	CR	LF	Characters	CR	LF	

## **Result Code List**

Number	Character String	Meaning
0	ОК	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	1		_	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
				Carrier lost detection time
10 1-255		1/10 sec	14	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	_	<del>_</del>	_	Not used
20	_	_	_	Not used
21	_	<del>_</del>	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.

<sup>\*</sup>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

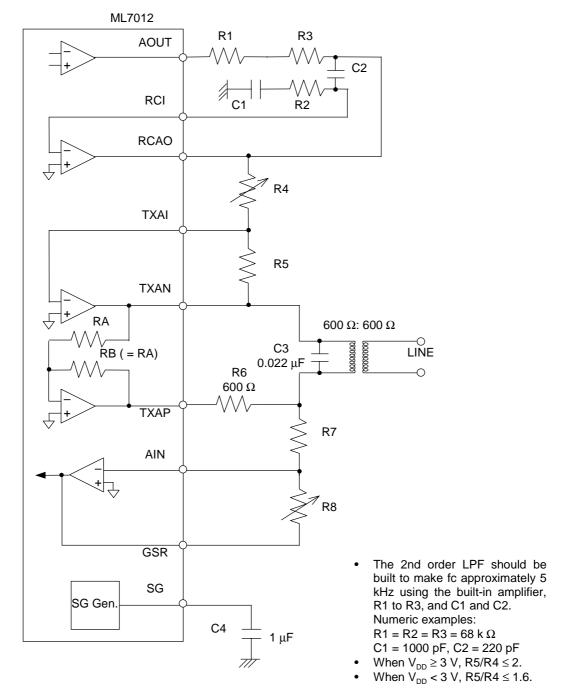
S21				
Bit	First value	Function in 0 setting	Function in 1 setting	command
7	0	Does not break	Breaks	Y
6	0	DSR signal is always ON.	DSR signal operates by ITU-T.	&S
5	0	CD signal is always ON.	CD signal is ON by carrier detection.	&C
4	1	0 7 800 0 7 804	1 7 802 1 7 802	&D
3	0	0 &D0 1 &D1	0 — &D2 1 — &D3	DTR Control
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	Func	tion in 0 setting		Function in 1 setting		1 setting	Command
7	1	Pulse dial ma	ike rate 39%		Pulse d	dial make rate	e 33%	&P
6	1	0	1	1 —		1	1 🦳	Х
5	1	0 X0	0 X1	0	X2	1 X3	1 X4	Extended
4	1	0 —	0 —	1 —		0—	1 —	command
3	0	0M0	0 ¬ M1	1 🔲	M2	1M3		M
2	1	0 — 1010	1 — 1	0 —	IVIZ	1 113		IVI
1	0	Not used			Not use	ed		
0	0	Not used			Not use	ed		

	ì			
S23				
Bit	Initial value	Function in 0 setting	Function in 1 setting	Command
7	0	0 - 0 - 0 - 0 - 0 - 0 - 0 - 0 - 0 - 0 -	1 1 862	0.0
6	0	&G0 1 &G1	0 — &G2 1 — &G3	&G
5	0	0 ─ Parity 0 ─ Parity	1 Parity 1 Parity	
4	1	0 ─ Even No. 1 ─ Mark	0 — Odd No. 1— 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



#### **Examples of Level Diagram**

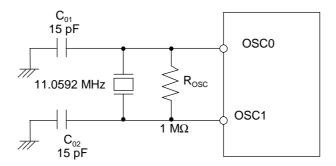
- (1) Modem transmit:  $V_{DD} \ge 3 \text{ V}$  AOUT = -20 dBm, RCAO = -20 dBm, TXAN = -14 dBm, TXAP = -14 dBm, LINE = -16 dBm(S34 = 2 dB (initial value), R5/R4 = 2, transformer loss = 2 dB)
- (2) DTMF transmit:  $V_{DD} \ge 3$  V: high group level The low group levels are approximately 1 dB smaller than the values below. AOUT = -14.5 dBm, RCAO = -14.5dBm, 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:  $V_{DD} \ge 2.7 \text{ V}$  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:  $V_{DD} \ge 2.7$  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**

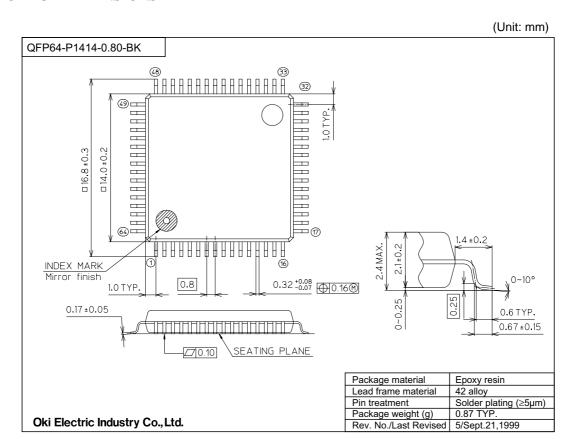
Connect a 11.0592 MHz crystal unit and a 1  $M\Omega$  feedback resistor between OSC0 and OSC1.

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



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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- 2. The outline of action and examples for application circuits described herein have been chosen as an explanation for the standard action and performance of the product. When planning to use the product, please ensure that the external conditions are reflected in the actual circuit, assembly, and program designs.
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