Cavli C10QM – Custom AT Command Specification

Module Overview

- **Model:** Cavli C10QM LTE Cat M1/NB-IoT Module
- **Interfaces:** UART (115200 baud), USB 2.0, GPIO, I2C, SPI
- **Cellular:** LTE Cat M1 (DL: 1 Mbps, UL: 1 Mbps) / NB-IoT (DL: 32 kbps, UL: 70 kbps)
- **GNSS:** GPS, GLONASS, BeiDou, Galileo (optional)
- **Regions:** Global (700/800/850/900/1800/1900/2100 MHz + regional bands)
- **Power:** Ultra-low power consumption with PSM and eDRX support

Custom AT Command Specifications

1. AT+CQMGNSSINFO - Enhanced GNSS Information Query

Purpose: Retrieve comprehensive GNSS positioning data optimized for IoT applications with power-efficient operation.

Syntax:

AT+CQMGNSSINFO[=<mode>]

Parameters:

- <mode> (optional): 0=Basic info, 1=Extended info

Query Command:

AT+CQMGNSSINFO?

Response:

+CQMGNSSINFO:
<fix_type>,<lat>,<lon>,<alt>,<speed>,<heading>,<hdop>,<satellites_used>,<ttff>,<power_mw>

OK

Example Usage:

AT+CQMGNSSINFO=1

+CQMGNSSINFO: 3,12.971598,77.594566,920.4,0.0,0.0,1.2,6,28,45.2

+CQMGNSSINFO: UTC=143022.00,DATE=180725,PDOP=2.1,ACCURACY=3.5

OK

Parameter Definitions:

- fix_type: 0=No fix, 1=GPS, 2=DGPS, 3=3D fix
- lat: Latitude in decimal degrees (-90.0 to 90.0)
- lon: Longitude in decimal degrees (-180.0 to 180.0)
- alt: Altitude in meters above sea level
- speed: Speed in km/h
- heading: Course over ground in degrees (0-359)
- hdop: Horizontal dilution of precision
- satellites_used: Number of satellites used in fix
- ttff: Time to first fix in seconds
- power_mw: Current GNSS power consumption in mW

2. AT+CQMRATCFG - RAT Configuration for Cat M1/NB-IoT

Purpose: Configure and query Radio Access Technology (RAT) preferences for Cat M1 and NB-IoT networks.

Syntax:

AT+CQMRATCFG[=<rat_preference>]

Parameters:

- <rat_preference>: 0=Cat M1 only, 1=NB-IoT only, 2=Cat M1 preferred, 3=NB-IoT preferred, 4=Auto

Query Command:

AT+CQMRATCFG?

Response Format:

+CQMRATCFG: <current_rat>,<available_rats>

OK

Set Command Example:

AT+CQMRATCFG=2

OK

Band Configuration:

AT+CQMRATCFG="CATM1","B1,B2,B3,B4,B5,B8,B12,B13,B18,B19,B20,B26,B28"

AT+CQMRATCFG="NBIOT","B1,B2,B3,B4,B5,B8,B12,B13,B18,B19,B20,B26,B28"

Example Response:

AT+CQMRATCFG?

+CQMRATCFG: CATM1,B3,B5,B20,B28

+CQMRATCFG: NBIOT,B3,B8,B20,B28

+CQMRATCFG: PREFERENCE=2

OK

3. AT+CQMNETSTAT - Extended Network Status for IoT

Purpose: Provide comprehensive cellular network status optimized for Cat M1/NB-IoT networks with power efficiency metrics.

Syntax:

AT+CQMNETSTAT[=<detail_level>]

Parameters:

- <detail_level>: 0=Basic, 1=Extended

Response Format:

+CQMNETSTAT:
<reg_state>,<rat>,<band>,<rssi>,<rsrp>,<rsrq>,<snr>,<ecl>,<tx_power>,<drx_cycle>

OK

Example Usage:

AT+CQMNETSTAT=1

+CQMNETSTAT: 1,8,20,-78,-108,-12,8,0,14,1280

+CQMNETSTAT: PLMN="26201",EARFCN=6300,PCI=245,TAC=AB12

+CQMNETSTAT: ECL=0,CE_LEVEL=0,REP_FACTOR=1,COVERAGE_CLASS=A

OK

Parameter Definitions:

- reg_state: 0=Not registered, 1=Registered home, 2=Searching, 5=Registered roaming
- rat: 8=Cat M1, 9=NB-IoT
- band: Current LTE band number
- rssi: Received Signal Strength Indicator (dBm)
- rsrp: Reference Signal Received Power (dBm)
- rsrq: Reference Signal Received Quality (dB)
- snr: Signal-to-Noise Ratio (dB)
- ecl: Extended Coverage Level (0-2)
- tx_power: Transmit power (dBm)
- drx_cycle: DRX cycle length (ms)

4. AT+CQMIOTCFG - IoT Platform Configuration for LPWAN

Purpose: Configure connection parameters for IoT platforms optimized for Cat M1/NB-IoT with CoAP and LWM2M support.

Syntax:

AT+CQMIOTCFG=<platform>,<endpoint>,<device_id>,<auth_method>[,<protocol>]

Parameters:

- <platform>: 0=AWS IoT Core, 1=Azure IoT Hub, 2=Google Cloud IoT, 3=Generic MQTT, 4=CoAP, 5=LWM2M
- <protocol>: 0=MQTT, 1=CoAP, 2=LWM2M, 3=HTTP

Supported Platforms:

- AWS IoT Core (MQTT over TLS)
- Azure IoT Hub (MQTT/AMQP)
- Google Cloud IoT (MQTT)

- Generic MQTT (with PSK/Certificate)
- CoAP (UDP-based)
- LWM2M (Device Management)

Example Usage:

AT+CQMIOTCFG=4,"coap://iot.example.com:5683","sensor_001",1,1

+CQMIOTCFG: COAP_CONFIGURED,DTLS=1.2,BLOCKWISE=1,OBSERVE=1

+CQMIOTCFG: MAX_PAYLOAD=1024,KEEP_ALIVE=3600

OK

LWM2M Configuration:

AT+CQMIOTCFG=5,"coaps://lwm2m.example.com:5684","urn:imei:123456789012345",2,2

+CQMIOTCFG: LWM2M_CONFIGURED,BOOTSTRAP=1,OBJECTS=3,4,5,6

+CQMIOTCFG: REGISTRATION_LIFETIME=86400,BINDING=U

OK

5. AT+CQMCOVERAGE - Coverage Enhancement Control

Purpose: Configure and monitor coverage enhancement features for improved performance in challenging RF environments.

Syntax:

AT+CQMCOVERAGE=<ce_level>[,<repetition_factor>]

Parameters:

- <ce_level>: 0=Normal coverage, 1=Enhanced coverage level 1, 2=Enhanced coverage level 2
- <repetition_factor>: 1,2,4,8,16,32,64,128 (repetitions for improved reliability)

Example Usage:

AT+CQMCOVERAGE=1,4

+CQMCOVERAGE: CE_LEVEL=1,REP_FACTOR=4,COVERAGE_CLASS=B

+CQMCOVERAGE: MAX_COUPLING_LOSS=154dB,SENSITIVITY=-136dBm

OK

Error Codes-

Code	Description
+CME ERROR: 3	Operation not allowed
+CME ERROR: 4	Operation not supported
+CME ERROR: 100	Unknown error
+CME ERROR: 101	Invalid parameter
+CME ERROR: 102	GNSS not enabled
+CME ERROR: 103	Network not registered
+CME ERROR: 104	RAT not supported
+CME ERROR: 105	Coverage enhancement failed
+CME ERROR: 106	Power saving mode conflict
+CME ERROR: 107	IoT platform connection failed

Implementation Notes

1. **Command Timeout:** All commands have a 30-second timeout (extended for IoT applications)
2. **URC Support:** Unsolicited Result Codes for PSM wake-up, network changes, and coverage updates
3. **Persistence:** Configuration settings saved to non-volatile memory with wear leveling
4. **Compatibility:** Commands follow 3GPP TS 27.007 and TS 24.008 standards for Cat M1/NB-IoT
5. **Security:** Certificate management with hardware security module (HSM) support
6. **Power Optimization:** Automatic power profile adjustment based on application requirements

Testing Procedures

Basic Cat M1/NB-IoT Connectivity Test

AT+CQMRATCFG=4

AT+CQMNETSTAT

AT+CQMCOVERAGE?

Power Optimization Test

AT+CQMPWRMGMT=3,30,7200,163.84

AT+CQMNETSTAT

AT+CQMPWRMGMT?

IoT Platform Integration Test

AT+CQMIOTCFG=4,"coap://test.example.com:5683","test_device",1,1

AT+CQMNETSTAT=1

AT+CQMPWRMGMT?

Coverage Enhancement Test

AT+CQMCOVERAGE=1,4

AT+CQMNETSTAT=1

AT+CQMCOVERAGE?

Regional Deployment Test (Europe)

AT+CQMRATCFG="CATM1","B1,B3,B8,B20"

AT+CQMRATCFG="NBIOT","B8,B20"

AT+COPS=0

AT+CQMNETSTAT=1