

**TELSON INFORMATION & COMMUNICATION CO., LTD.**

TEL : 82-2-887-2690 (EXT 766)

FAX : 82-2-887-2693

**NT-90**

**USER MANUAL**

**5 WATT HAND-HELD RADIO SERVICE**

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## **USER'S MANUAL**

### **1. PRODUCT INTRODUCTION**

The NT-90 LMR (LAND MOBILE RADIO) FROM TELSON I&C CO.,LTD. UTILIZES THE LATEST TECHNOLOGY IN ITS DESIGN AND MANUFACTURING. NT-90 IS PLL (PHASE LOCK LOOP SYNTHESIZER)/MICROPROCESSOR CONTROLLED, AND OFFER 5 WATTS OF POWER WITH 16 CHANNEL CAPABILITY. MULTIPLE FUNCTIONS INCLUDING SCAN AND CTCSS/DCS SIGNALING ARE STANDARD IN THESE FULLY PROGRAMMABLE WIDE BANDWIDTH HANDHELD UNITS.

THE USE OF MICROPROCESSOR TECHNOLOGY MAKES CHANGING RADIO CHARACTERISTICS SUCH AS OPERATING FREQUENCIES AND SQUELCH CODES BOTH FAST AND ECONOMICAL. ANY COMPUTER EQUIPPED NT-90 DEALER CAN EASILY REPROGRAM YOUR RADIO'S OPERATING CHARACTERISTICS, OR YOUR RADIO CAN BE "CLONED" FROM A RADIO ALREADY PROGRAMMED TO YOUR DESIRED FREQUENCIES AND CODES. THE NT-90 LMR SATISFIES THUGH ENVIRONMENTAL REQUIREMENTS WHILE PROVIDING COST EFFECTIVE AND RELIABLE COMMUNICATIONS.

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### 2. HOW TO USE

**POWER ON/OFF, VOLUME CONTROL** – TURN THE RADIO ON AND ADJUST THE VOLUME LEVEL.

**ROTARY CHANNEL SELECTOR SWITCH** – SELECT THE OPERATING CHANNEL OR INITIATES SCAN OPERATION.

**ACCESSORY CONNECTOR (PHONE JACK AND MIC JACK)** – PROVIDES ACCESSIBILITY FOR CONNECTION TO REMOTE ACCESSORIES SUCH AS A REMOTE SPEAKER MICROPHONE.

**PUSH TO TALK (PTT) BUTTON** – WHEN EXPRESSED AND HELD, ENGAGES THE TRANSMITTER AND PUTS RADIO IN THE TRANSMIT MODE. WHEN RELEASED, THE RADIO OPERATES IN THE RECEIVE MODE.

**MONITOR BUTTON** – SELECTS THE MODE OF OPERATION, CARRIER SQUELCH OR TONE SQUELCH. IT HAS TWO CASES. FIRST CASE OF PRESSING THE MONITOR KEY FOR LESS THAN 2 SEC, CHECKS THE CHANNEL IN USE SCANNING EACH CHANNEL. THEN MONITOR OPERATION STOPS AS MONITOR KEY IS RELEASED, THE RECEIVE MODE BEGINS. SECOND CASE OF PRESSING THE MONITOR KEY FOR 2 SEC, STOPS TO THE CHANNEL IN USE AND KEEPS THE RECEIVE MODE UNTIL IDENTIFYING THE NEXT MONITOR KEY. WHEN THE MONITOR KEY IS PRESSED, THE CURRENT OPERATION STOPS AND RETURNS TO THE RECEIVE MODE.

**ANTENNA** – HELIFLEX OR WHIP WITH THREADED BASE.

**LED INDICATOR** – A TRI-COLORED LIGHT EMITTING DIODE(LED) INDICATES SCAN OPERATING STATUS.

**TRANSMIT TIME-OUT-TIMER (TOT)** – THE TOT IS SYSTEM PROGRAMMABLE FOR 15 SECONDS TO 225 SECONDS, IN 15 SECOND INCREMENTS AND CAN ALSO BE SELECTED AS DISABLED. THE DEFAULT VALUE IS DISABLED.

**CHANNEL SCAN** – TO INITATE THE SCAN FEATURE, ROTATE THE CHANNEL SELECTOR TO THE LOCATION WITH THE SCAN LIST PROGRAMMED TO IT.

**POWER SAVING MODE** – POWER SAVING MODE OPERATES BY THE FOLLOWING CONDITIONS. ONLY IF THE RECEIVE MODE DOES NOT HAVE THE CARRIER, POWER SAVING MODE IS ON. BUT IT IS OFF IN THE SCAN MODE. POWER SAVING MODE BEGINS AFTER 2 SEC OF FOLLOWING CONDITIONS, POWER ON, SELECTING NEW CHANNEL, FINISHING RECEIVING OR TRANSMITTING.

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### 3. THEORY OF OPERATION

#### **FREQUENCY GENERATION CIRCUITRY**

THE FREQUENCY GENERATION CIRCUITRY IS COMPOSED OF THE SYNTHESIZER IC(U102) AND THE VCO. THE BLOCK DIAGRAM ILLUSTRATES THE INTERCONNECT AND SUPPORT CIRCUITRY USED IN THE DESIGN. REFER TO THE SCHEMATIC FOR REFERENCE DESIGNATOR.

THE SUPPLY FOR THE SYNTHESIZER IS REGULATED 5.0 VOLTS WHICH ALSO SERVES THE REST OF THE RADIO. IN ADDITION TO THE VCO, THE SYNTHESIZER MUST INTERFACE WITH THE LOGIC AND AUDIO FILTER CIRCUITRY. PROGRAMMING FOR THE SYNTHESIZER IS ACCOMPLISHED THROUGH THE CLOCK, DATA AND ENABLE SIGNALS FROM THE MICROPROCESSOR, U200.

A SERIAL DATA IS SENT WHENEVER THE SYNTHESIZER IS PROGRAMMED. A 5.0 VOLTS DC SIGNAL FROM PIN 7 INDICATES TO THE MICROPROCESSOR THAT THE SYNTHESIZER IS LOCKED. WHILE UNLOCK IS INDICATED BY A LOW VOLTAGE ON THIS PIN. THE AUDIO SIGNAL FROM THE AUDIO FILTER IS MODULATED BY THE VARICAP DIODE(D59) OF VCO.

#### **PLL FREQUENCY SYNTHESIZER**

THE U102 PLL IC INCLUDES ALL THE FUNCTIONS SUCH AS THE PHASE COMPARATOR, THE PROGRAMMABLE DIVIDER, THE LOCK DETECTOR AND REFERENCE OSCILLATOR. THE SYNTHESIZER USES A 14.4MHz VCTCXO(U103) TO PROVIDE THE REFERENCE FREQUENCY FOR THE SYSTEM.

THE CHARGE PUMP CIRCUIT AND LOOP FILTER, COMPRISED OF Q58, Q59, R133 AND R138, R139, R140, R141, C172, C173, C174, PROVIDE THE NECESSARY DC STEERING VOLTAGE FOR THE VCO AS WELL AS FILTERING OF SPURIOUS SIGNALS FROM THE PHASE DETECTOR. THE PRESCALER FOR THE LOOP IS INTERNAL TO U102 WITH THE VALUE DETERMINED BY THE FREQUENCY BAND OF OPERATION.

THE VCTCXO IS THE TEMPERATURE COMPENSATION CIRCUIT TO MAINTAIN THE FREQUENCY WITHIN THE ALLOWABLE ERROR RANGE EVEN UNDER A LOW TEMPERATURE OF -30° C.

#### **VCO**

THE VCO IS OSCILLATED BY THE CONTROL VOLTAGE SUPPLIED FROM THE SYNTHESIZER AND CONSISTS OF THE COLPITTS OSCILATOR OF THE Q61(RX), Q62(TX).

THE OPERATION OF RX AND THX IS SELECTED BY 5V SWITCH TR(Q75,Q77) AND THE TX VCO OSCILLATES FROM 146MHz TO 174MHz BY CONTROL VOLTAGE (1.5V~5.5V) AND THE RX VCO OSCILLATES FROM 191MHz TO 219MHz BY CONTROL VOLTAGE (1.5V~5.5V).

IN THE TRANSMIT MODE, THE VCO IS OSCILLATED BY THE COLPITTS OSCILLATOR, WHICH CONSISTS OF D58, D57, C157, C158, R134, D59, C187, C188, VC2, L75, C189, C190, C191 AND Q62. C187, D59, R134, C157, C158 MODULATE THE VOICE

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SIGNALS PROCESSED FROM THE AUDIO FILTER.

IN THE RECEIVE MODE, THE VCO IS OSCILLATED BY THE COLPITTS OSCILLATOR, WHICH CONSISTS OF D55, D56, C177, VC1, L72, C178, L72, C179, C180 AND Q61.

THE Q63 AND PERIPHERAL COMPONENTS AMPLIFY AN RF CARRIER OSCILLATED FROM TX AND RX VCO, MAINTAIN -10dBm OUTPUT LEVEL AND REJECT THE EFFECTS OF REVERSE POWER CONNECTED TO OUTPUT TERMINAL.

**POWER DRIVE**

TX DRIVE STAGE AMPLIFIES THE RF POWER FOR THE MODULE INPUT TO BE SATISFIED, AS WELL AS HAS THE ABILITY FOR VCO NOT TO BE OSCILLATED. IT IS COMPOSED OF THE TWO STAGES AMPLIFIER. THE FIRST AMPLIFIER (Q65) OPERATES AS CLASS A AND HAS THE FUNCTION TO BLOCK THE OSCILLATION CAUSED BY THE MISMATCHING BETWEEN VCO AND POWER MODULE. THE SECOND ONE (Q66) AMPLIFIES THE INPUT POWER FOR THE MODULE TO BE AMPLIFIED INTO 5 WATTS. RF POWER DRIVE AMPLIFIES BY 17dBm (50mW).

**TX MODULE AND APC**

THE TX MODULE (U101), WHICH FINALLY AMPLIFIES THE RF CARRIER, IS CONNECTED WITH THE APC (AUTOMATIC POWER CONTROL) CIRCUIT TO CONTROL A POWER. IT AMPLIFIES 50mW OBTAINED FROM TX DRIVE TO 7 WATTS. THE VOLTAGE OF TX MODULE IS PASSED THROUGH THE BEAD COIL BD1.

THE APC IS SENSING AN RF POWER AND CONSTANTLY MAINTAINS AN RF POWER REGARDLESS OF VOLTAGE CHANGES BY DECREASING THE CONTROL VOLTAGE OF POWER MODULE IN OVER CARRIER CASE AND INCREASING THAT OF POWER MODULE IN UNDER CARRIER CASE.

THE APC CONSISTS OF RF CARRIER SENSING PARTS. THE RF CARRIER IS TRANSFORMED TO VOLTAGE BY C226, D60 AND C227. THE VOLTAGE IS SUPPLIED INTO THE BASE OF DIFFERENTIAL AMPLIFIER, Q68. THEN LOW POWER (1 WATT) IS CONTROLLED BY THE VR13, WHEREAS HIGH POWER BY VR14 AND Q67.

THE DIFFERENTIAL AMPLIFIER, Q68 CONTROLS BY COMPARING THE BASE REFERENCE VOLTAGE FROM SENSING PART. THE CONTROL VOLTAGE OF AN POWER MODULE TO BE THE SPECIFIED RF POWER.

**ANTENNA SWITCH AND HARMONIC FILTER**

THE ANTENNA SWITCH IS COMPOSED OF SWITCHING DIODE. THE ANTENNA SWITCH SELECTS TX CARRIER OR RX SIGNAL. THE R/TX SWITCHING IS ACCOMPLISHED BY D50, D51.

IN TRANSMISSION MODE, 5.0V DC IS APPLIED TO R175, L85 THEN D50, D51 ARE ON. TX CARRIER PASSED BY D50 AND THROUGH THE HARMONIC FILTER TO ANTENNA.

IN RECEIVER MODE, 5.0V DC IS NOT APPLIED TO D50. THEN D50 IS OPENED. RX SIGNAL IS PASSED TO C51.

THE HARMONIC FILTER IS COMPOSED OF C100, C103, C104, C105, C106, L50, L51, L52 AND L53. THIS FILTER REMOVES HARMONIC SPURIOUS LIKE A 2<sup>nd</sup>, 3<sup>rd</sup> CONDUCTED SPURIOUS. IN TRANSMISSION MODE, THIS FILTER HAS INSERT LOSS

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THAT IS LESS THAN 1dB.

### FRONT END

FRONT END SELECTS AND AMPLIFIES THE SIGNALS OF WANTED BAND AMONG RF SIGNALS EXISTING IN THE FREE SPACE. IT CONSISTS OF THE BANDPASS FILTER (BPF) AND LOW NOISE AMPLIFIER (LNA).

THE FILTER IS COMPOSED OF 5<sup>TH</sup> BPF BEFORE THE LNA AND 7<sup>TH</sup> BPF AFTER THE LNA. IT SELECTS THE BANDS BETWEEN 450MHz AND 470MHz.

ESPECIALLY THE BILATERAL DIODE, D52 BLOCKS FOR LNA TO BE BROKEN OR SATURATED BY LIMITING THE CRITICAL RF SIGNALS FROM THE ANTENNA. THE GAIN OF THE LNA IS 20dB. THE LNA MAKES SIGNALS MAXIMUM, HAS THE MINIMUM NOISE FIGURE.

### MIXER

THE MIXER USES THE FET TO GENERATE THE FIRST IF, 45MHz BY MIXING THE RF CARRIER SIGNAL AND LOCAL SIGNAL FROM THE VCO. ITS FREQUENCY IS  $F_{IF} = F_{RF} - F_{LOCAL}$ .

### LOCAL DRIVE

THE LOCAL DRIVE SUPPLIES LOCAL CARRIER (405MHz~425MHz) GENERATED FROM THE SYNTHESIZER INTO MIXER, AND BLOCKS TO AFFECT THE UNWANTED FREQUENCY GENERATED IN MIXING TO THE VCO. IT IS COMPOSED OF Q64, PERIPHERAL CAPACITORS AND RESISTORS. THE SIGNAL TO BE BUFFERED MAXIMALLY LIMIT THE SPURIOUS BY USING LOW PASS FILTER THAT IS COMPOSED OF C204, C205 AND L80.

### CRYSTAL FILTER AND IF AMP

THE CRYSTAL FILTER CONSISTS OF A PAIR OF F2 AND F3, ITS PASS BAND WIDTH IS +/- 7.5kHz AND ITS ATTENUATION BANDWIDTH IS +/- 22kHz. ITS RIPPLE IS LESS THAN 1 dB AND INSERT LOSS IS 4 dB.

THE IF AMP (Q52) AMPLIFIES 20dB THE FREQUENCY SELECTED BY THE CRYSTAL FILTER.

### IF IC AND NOISE SQUELCH

THE IF IC (U100) CONSISTS OF THE 2<sup>ND</sup> MIXER, CERAMIC FILTER, CERAMIC DISCRIMINATOR, NOISE SQUELCH.

THE 2<sup>ND</sup> MIXER GENERATE THE 2<sup>ND</sup> IF 455kHz BY MIXING THE 1<sup>ST</sup> IF, 45MHz AND LOCAL FREQUENCY, 44.545MHz (X60). THE MIXED SIGNAL, 455kHz IS PASSED THE CERAMIC FILTER F5, F6 EACH CASE OF 12.5/25kHz. THE CERAMIC DISCRIMINATOR (X61) AND DAMPING RESISTOR (R127) OPERATE WITH A QUADRATURE CIRCUITRY, ENABLE THE RECOVERED AUDIO BY 90° PHASE SHIFTING IF CENTER FREQUENCY. THE DAMPING RESISTOR DETERMINES THE PEAK SEPARATION OF THE DETECTOR.

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WHEN UNWANTED SIGNAL IS RECEIVED, THE NOISE SQUELCH IS ENABLED BY DETECTION OF NOISE LEVEL. NOISE DETECTION IS GIVEN FROM NOISE HIGH PASS FILTER AMP WHICH HAS 20kHz CUTOFF FREQUENCY. THE NOISE SQUELCH INDICATES TO MICROPROCESSOR FOR AUDIO MUTING.

## MICROPROCESSOR UNIT (MPU)

THE MPU (U200) IS TH HIGH SPEED AND HIGH PERFORMANCE 8-BIT SIGNLE CHIP MICROCOMPUTER. THE MPU CONTAIN CPU CORE, ROM, RAM, INPUT/OUTPUT PORTS, A/D CONVERTER, TIMER/COUNTER.

## MPU PORT ASSIGNMENT

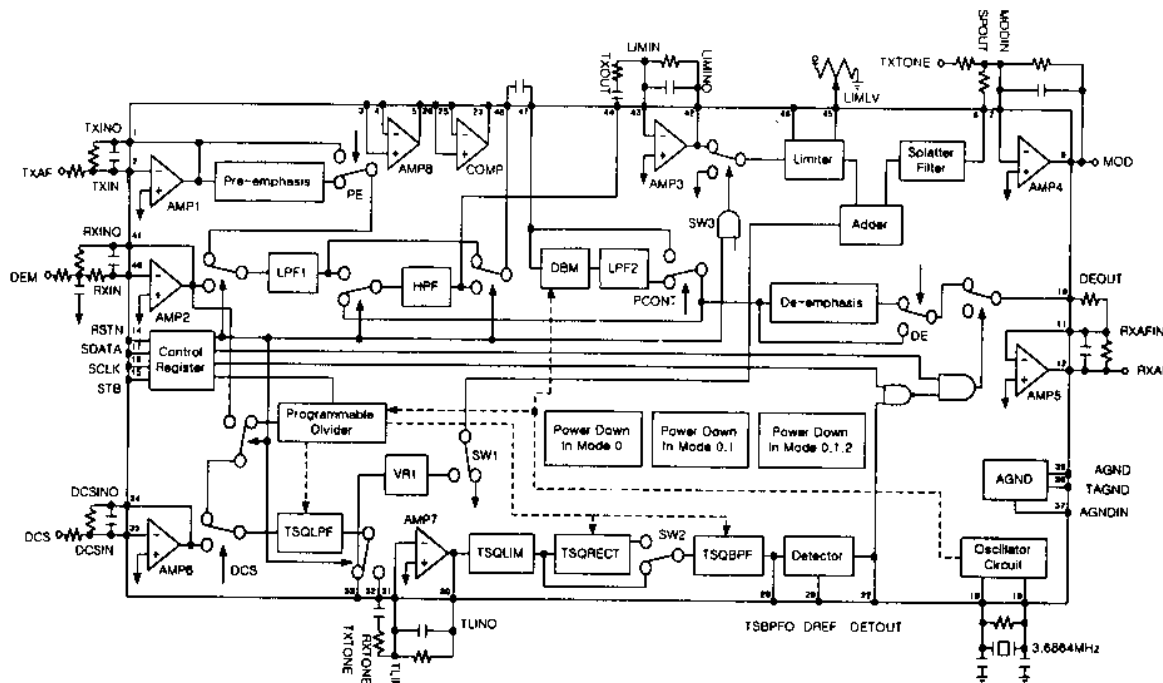
PORT	PORT NAME	FUNCTION	PORT	PORT NAME	FUNCTION
P0	P0.0 P0.1	PLL DATA PLL ENABLE	P6	P6.0 P6.1 P6.2 P6.3 P6.6	CH. SWITCH 1 CH. SWITCH 2 CH. SWITCH 4 CH. SWITCH 8 LOW BAT. DET.
P2	P2.2 P2.3 P2.4 P2.6 P2.7	PC PROGRAM BEEP GEN. TONE DET. PLL LOCK TONE DET	P8	P8.0 P8.1 P8.2 P8.3 P8.4 P8.5 P8.6 P8.7	TX B+ RX B+ TX ENABLE VCO ENABLE H/L POWER AUDIO MUTE MIC ENABLE 12.5/25 CON.
P4	P4.0 P4.1 P4.2 P4.3 P4.4 P4.5	RX LED TX LED AK2342 RSTN AK2342 STB AK2342 SCLK AK2342 SDATA	P9	P9.0 P9.1 P9.2	SQUELCH PTT KEY MONITOR KEY
P5	P5.2 P5.3	EEROM DATA EEROM CLK			

## AK2342B

THE AK2342B IS AN IC WHICH SUPPORTS CTCSS (CONTINUOUS TONE CONTROLLED SQUELCH SYSTEM), COMPATIBLE WITH THE EIA STANDARD. ALSO VOICE SIGNAL FILTERS, A LIMITER, OP-AMP, AND OTHER CIRCUITS ARE INTEGRATED, MAKING IT POSSIBLE TO CONFIGURE A RADIO BASE BAND UNIT. THIS CHIP HAS THE VARIOUS MODES ARE SET BY WRITING DATA TO THE CONTROL REGISTER FROM THE SERIAL INTERFACE PINS (SDATA, SCLK, STB). IT MAKES POSSIBLE THAT AUDIO PASS TO FILTER, AMP, OR LIMITER AT EACH RX/TX MODE.

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## AK2342B BLOCK DIAGRAM



## AUDIO AMP.

THE AUDIO AMP AMPLIFIES AN AUDIO SIGNAL FOR A USER TO LISTEN TO THE VOICE, ALSO AMPLIFIES AN ERROR TONE OF EACH FUNCTION. IT IS COMPOSED OF THE VOLUME SWITCH, MUTE SWITCH (Q206), AND AUDIO AMP. (U205).

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## **4. GENERAL SPECIFICATIONS**

<b>GENERAL</b>	
<b>POWER SUPPLY</b>	Rechargeable Nickel-Cadmium Battery, 7.5 VDC
<b>POWER SUPPLY VOLTAGE RANGE</b>	6.75 – 8.25 VDC
<b>ENVIRONMENTAL</b>	Designed to meet TIA/EIA-603
<b>TEMPERATURE RANGE</b>	-30°C to +60°C
<b>RELEATIVE HUMIDITY</b>	90% at 40°C Non-condensing
<b>FREQUENCY CONTROL</b>	PLL Synthesizer
<b>NUMBER OF RX/TX CHANNELS</b>	16 Maximum
<b>SPEAKER IMPEDANCE</b>	8 ohm
<b>DIMENSIONS</b>	133(L) X 63.5(W) X 37.5(H)
<b>WEIGHT</b>	360g with Battery
<b>CURRENT CONSUMPTION</b>	
<b>STANDBY</b>	< 30 mA (Battery Save On)
<b>RECEIVE</b>	< 250 mA
<b>TRANSMIT</b>	< 3000 mA (5W)
<b>BATTERY LIFE(5-5-90% DUTY CYCLE)</b>	
<b>1100mAh</b>	8 hrs @ 5W (Battery Save On)
	6 hrs @ 5W (Battery Save Off)
<b>FREQUENCY BANDS</b>	
<b>VHF OPERATION BANDWIDTH</b>	R/TX 450 – 470MHz
<b>TRANSMITTER</b>	
<b>OUTPUT POWER</b>	1W / 5W
<b>CONDUCTED SPURIOUS EMISSIONS</b>	-60 dBc max
<b>RADIATED SPURIOUS EMISSIONS</b>	-60 dBc max
<b>MODULATION SYSTEM</b>	8K50F3E/16K0F3E
<b>AUDIO FREQUENCY RESPONSE</b>	6dB per octave Pre-emphasis response
<b>AUDIO DISTORTION</b>	< 5% @ 60% System Deviation
<b>MAXIMUN DEVIATION</b>	+/- 5kHz @ 25kHz BW
<b>TEMPERATURE STABILITY</b>	+/- 2.5PPM

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<b>FM HUM &amp; NOISE</b>	40dB
<b>RECEIVER</b>	
<b>SENSITIVITY (12dB SINAD)</b>	-116dBm
<b>ADJACENT CHANNEL SELECTIVITY</b>	-65dB @ 25kHz
<b>INTERMODULATION REJECTION</b>	< -60dB
<b>SPURIOUS RESPONSE REJECTION</b>	< -60dB
<b>AUDIO POWER OUTPUT</b>	400MW min. @ 10% THD
<b>AUDIO DISTORTION</b>	5% THD
<b>AUDIO FREQUENCY RESPONSE</b>	6dB per octave De-emphasis response
<b>FM HUM &amp; NOISE</b>	40dB