# KP Electronic Systems, Ltd.

# MT2PIT

# Tuning Procedure

File: I:\Products\Current\Hardware\MT2PIT\Tuning_Procedure.spec

**Revision History:**

| Rev. | Date | Description | Reason of change | Affect Paragraph/ Documents | Initiator |
|---|---|---|---|---|---|
| 0.1 | 3/12/2016 | Initial release | | | Efi |
| 1.0 | 6/2/2017 | Remove irrelevant paragraphs | | | Efi |
| 1.1 | 22/2/2017 | Fix power out | | | Efi |

| Name | Title | Date | Signature |
|---|---|---|---|
| **Efi  Rushinek** | R&D Mgr | | |

| Leonid Kreimer | Project Mgr. | | |
|---|---|---|---|
| **Vladimir  Dashinsky** | RF Senior Engineer | | |

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## Contents

**K P  P r o p r i e t a r y  I n f o r m a t i o n**     **16.00/6/NEW:**  טופס מסי

# 1. Introduction.

The MT2P design is based on MT1P logic design and a new RF design that is based on CC1120 – a transceiver chip.  The MT2PIT is a 2W output power and -117DBm sensitivity long-range, synthesized radio-metering transceiver for narrowband wireless networks in the VHF 151-156/174 MHz frequency band.  The output power is fixed and has a manufacturing tolerance of +/-0.5 Watts.

# 2. References.

Company References
- MT2PIT SOW :
- Meter type table: WaterMeters.xls
- Technical References
- Data sheet: R8C/25 Group Hardware Manual Rev.3.00 2008.02 RENESAS 16-BIT SINGLE-CHIP MCU R8C FAMILY / R8C/2x SERIES.
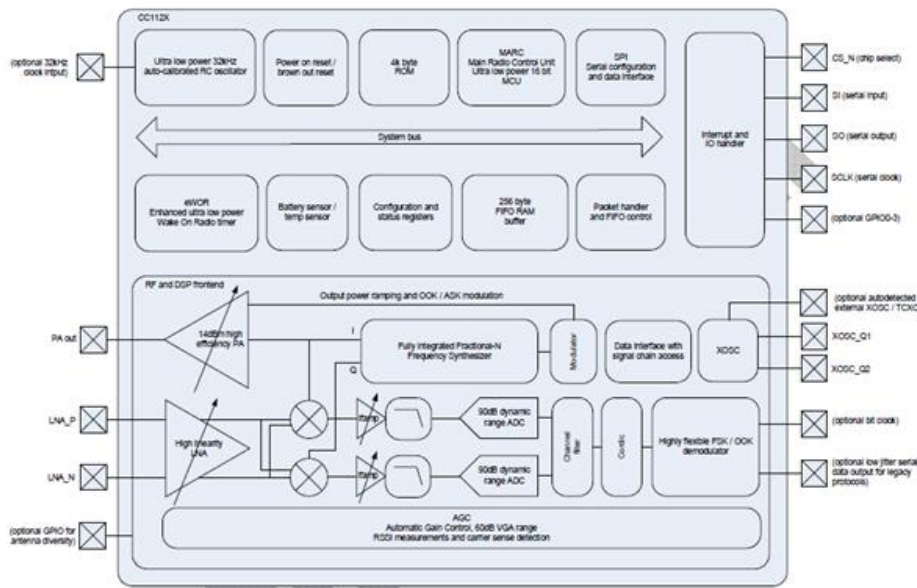
# 3. VHF Radio

The MT2PIT transceiver has next   chain blocks configuration:
- Single-chip radio transceiver CC1120
- RF amplifiers
- Antenna Switch
- Power supply and voltage switches


 MT2PIT RF part block diagram is attached below:
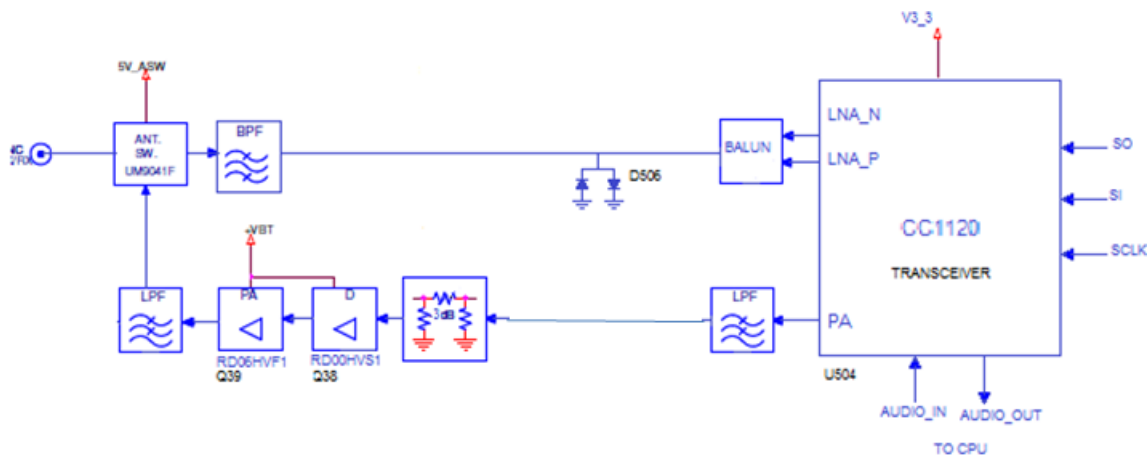


MT2PIT RF part block diagram

CC1120 System Block Diagram

## 4. Transmitter:

The CC1120 transmitter is based on direct synthesis of the RF frequency (in-loop modulation). To achieve effective spectrum usage, CC1120 has extensive data filtering and shaping in TX to support high throughput data communication in narrowband channels. The modulator also controls power ramping to remove issues such as spectral splattering when driving external high power RF amplifiers.

## 5. RF amplifiers:

The RF frequency that was created by the CC1120 will be amplified by three stages before transmitting:
  ✘  First stage is class AB amplifier (Q8) with 15 db gain.
  ✘  Second stage is class AB amplifier (Q9) with 12db gain.

At the output of three stages amplification and -6db attenuation, the RF signal power will be +33dbm.

## 6. Radio RF calibration.

The radio power and radio deviation are fixed and can't be changed. The frequency is based on TCXO 32.000MHz that has maximum 1ppm temperature stability. The procedure of frequency calibration is by try and error loop i.e. measuring the MT2PIT carrier transition frequency error, setting the freq offset and measure the frequency again until the frequency error is less than 0.5ppm.

The CC1120 has 4 register for customer frequency:

### SYNC3 - Sync Word Configuration [31:24]

| Bit # | Name | Reset | R/W | Description |
|-------|----------|-------|-----|-------------------|
| 7:0 | SYNC31_24 | 0x93 | R/W | Sync word [31:24] |

### SYNC2 - Sync Word Configuration [23:16]

| Bit # | Name | Reset | R/W | Description |
|-------|----------|-------|-----|-------------------|
| 7:0 | SYNC23_16 | 0x0B | R/W | Sync word [23:16] |

### SYNC1 - Sync Word Configuration [15:8]

| Bit # | Name | Reset | R/W | Description |
|-------|---------|-------|-----|------------------|
| 7:0 | SYNC15_8 | 0x51 | R/W | Sync word [15:8] |

### SYNC0 - Sync Word Configuration [7:0]

| Bit # | Name | Reset | R/W | Description |
|-------|--------|-------|-----|-----------------|
| 7:0 | SYNC7_0 | 0xDE | R/W | Sync word [7:0] |

The frequency offset:

### FREQOFF1 - Frequency Offset MSB

| Bit # | Name | Reset | R/W | Description |
|-------|--------------|-------|-----|-------------|
| 7:0 | FREQ_OFF_15_8 | 0x00 | R/W | Frequency offset [15:8]. Updated by user or SAFC strobe. The value is in two's complement format |

### FREQOFF0 - Frequency Offset LSB

| Bit # | Name | Reset | R/W | Description |
|-------|-------------|-------|-----|-------------|
| 7:0 | FREQ_OFF_7_0 | 0x00 | R/W | Frequency offset [7:0]. Updated by user or SAFC strobe. The value is in two's complement format |

The frequency calculation based on the offset:

## FREQ2 - Frequency Configuration [23:16]

| Bit # | Name | Reset | R/W | Description |
|-------|------|-------|-----|-------------|
| 7:0 | FREQ_23_16 | 0x00 | R/W | Frequency [23:16] $$f_{RF} = \frac{f_{VCO}}{\text{LO Divider}} \,[\text{Hz}]$$ where $$f_{VCO} = \frac{FREQ}{2^{16}} \cdot f_{XOSC} + \frac{FREQOFF}{2^{18}} \cdot f_{XOSC} \,[\text{Hz}]$$ and the LO Divider is given by `FS_CFG.FSD_BANDSELECT` |

## FREQ1 - Frequency Configuration [15:8]

| Bit # | Name | Reset | R/W | Description |
|-------|------|-------|-----|-------------|
| 7:0 | FREQ_15_8 | 0x00 | R/W | Frequency [15:8]. See `FREQ2` |

## FREQ0 - Frequency Configuration [7:0]

| Bit # | Name | Reset | R/W | Description |
|-------|------|-------|-----|-------------|
| 7:0 | FREQ_7_0 | 0x00 | R/W | Frequency [7:0]. See `FREQ2` |

## 7. Warning Statements.

- THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:
    a. THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE.
    b. THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.
- NOTE:   THE GRANTEE IS NOT RESPONSIBLE FOR ANY CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.