OCR
Oxford Cambridge and RSA

# GCE

# Electronics

Unit **F615:** Communications Systems

Advanced GCE

## Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

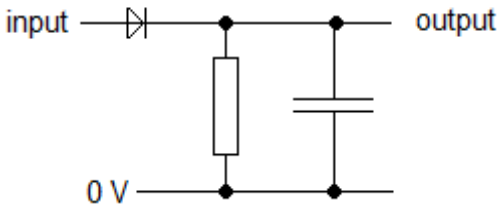
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

## Annotations

| | | | | |
|---|---|---|---|---|
| **1** | BOD | 31 | BOD | Benefit of doubt |
| **2** |  | 21 | Cross | Cross |
| **3** | ECF | 241 | ECF | Error carried forward |
| **4** | NBOD | 191 | NBOD | Benefit of doubt not given |
| **5** |  | 1841 | Not Relevant | Expandable vertical wavy line |
| **6** | REP | 271 | REP | Repeat |
| **7** | TV | 201 | TV | Too vague |
| **8** |  | 11 | Tick | Tick |
| **9** | 0 | 1741 | ZERO | Zero (big) |
| **10** | | | | |
| **11** | | | | |
| **12** | | | | |
| **13** | | | | |
| **14** | | | | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 1 | a | i | need red, green and blue pixels;<br>as any colour can be made by combining these colours; | 1<br>1 | <br>Accept 'full colour' |
| 1 | a | ii | $2^4 = 16$ | 1 | Accept just 16 |
| 1 | b | i | 0 at beginning of word;<br>1 at the end;<br>so that display can tell when each six-bit word starts; | 1<br>1<br>1 | accept start and stop bits for [1] Accept low for 0 and high for 1<br>**not** starts and ends |
| 1 | b | ii | one wire carries line sync pulses;<br>to tell display when to start scanning/refreshing a new row;<br>other wire carries frame sync pulses;<br>to tell display when to start scanning a new frame; | 1<br>1<br>1<br>1 | Must say 'sync' |
| 1 | b | iii | pixels per frame = 768 x 1380 = $1.06 \times 10^6$;<br>words per second = $1.06 \times 10^6$ x 35 = $3.71 \times 10^7$;<br>bits per second = $3.71 \times 10^7$ x 6 = $2.22 \times 10^8$; | 1<br>1<br>1 | look for words as well as numbers<br><br>correct calculation with no explanation [1] |
| 1 | b | iv | 111 MHz | 1 | accept 100 MHz |
| 1 | c | | extra bits are the address information for each word;<br>each display has a different address;<br>$2^5 = 32$ so enough for 24 displays; | 1<br>1<br>1 | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 2 | a | i | sinusoidal / sine wave;<br>frequency 117.5 kHz; | 1<br>1 | <br>accept 117 or 118 |
| 2 | a | ii | sinusoidal / sine wave;<br>frequency 5 kHz; | 1<br>1 | <br>Between 4.5 and 5.5 kHz |
| 2 | a | iii | same a.c. component as **A**;<br>but centred on 5 V; | 1<br>1 | Accept audio input shifted by 5V |
| 2 | b | | amplifier;<br>with variable gain;<br>gain determined by voltage at B | 1<br>1<br>1 | <br><br>Accept input signal, signal at A |
| 2 | c | i |  | 5 | diode-resistor rectifier [1]<br>resistor-capacitor treble cut filter [1]<br>input, output and 0 V labels [1]<br>*RC* between 32 μs and 16 μs [1]<br>justified with $f_0 = \frac{1}{2\pi RC}$ [1] |
| 2 | c | ii | the diode (and resistor) rectify the signal;<br>the resistor and capacitor remove carrier / high frequencies; | 1<br>1 | |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>a</td><td></td><td>(binary) word at outputs;<br>represents voltage at input</td><td>1<br>1</td><td></td></tr>
<tr><td>3</td><td>b</td><td>i</td><td>voltage drop across 20 k□ is 0.20 V;<br>so inverting inputs of comparators are 0.10 V apart</td><td>1<br>1</td><td></td></tr>
<tr><td>3</td><td>b</td><td>ii</td><td>0.1 V across 10 kΩ;<br>15 - 0.4 = 14.6 V across R;<br>so R is 1460 kΩ</td><td>1<br>1<br>1</td><td>Allow use of potential divider equation for full credit.</td></tr>
<tr><td>3</td><td>c</td><td>i</td><td>
<table>
<tr><th>P</th><th>Q</th><th>R</th><th>S</th><th>C</th><th>B</th><th>A</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
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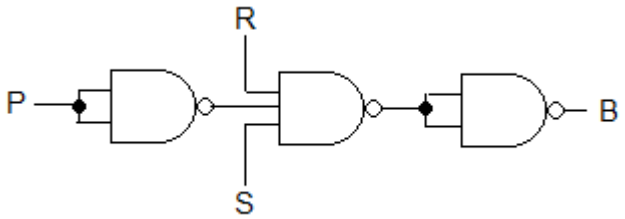
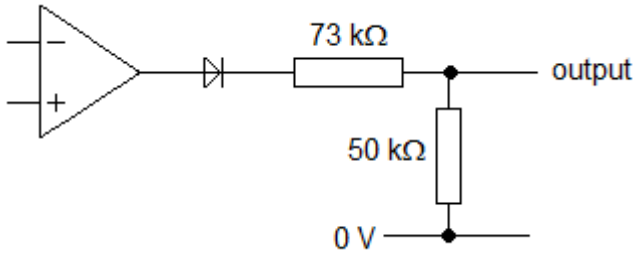
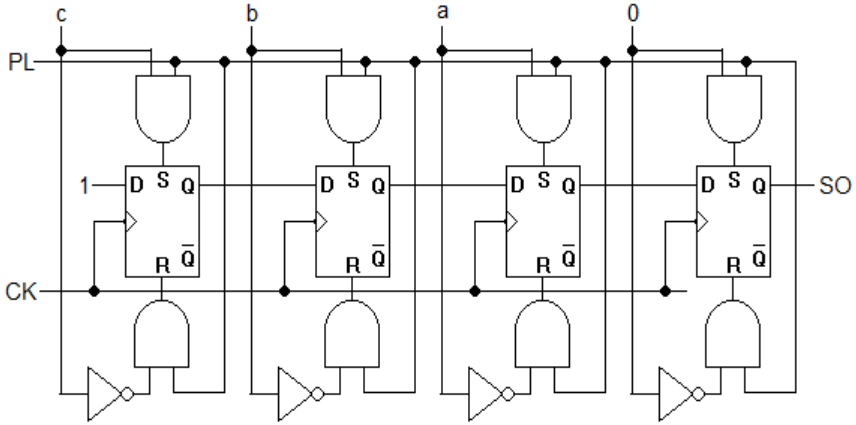
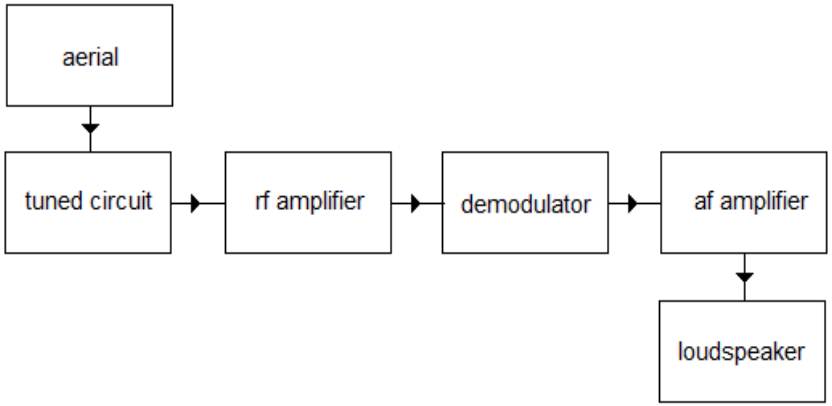
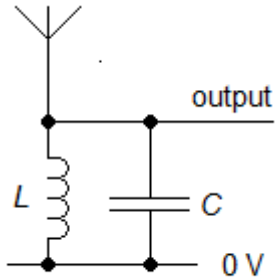
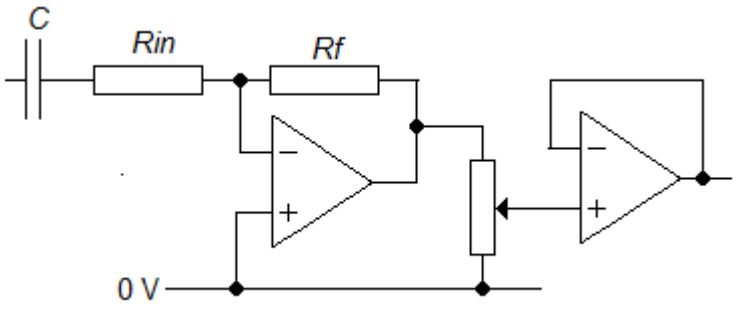
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
</table>
</td><td>3</td><td>PQRS correct [1]<br>C correct [1]<br>A correct [1]<br><br>no ecf from incorrect PQRS</td></tr>
<tr><td>3</td><td>c</td><td>ii</td><td>[redacted];<br> 
</td><td>3</td><td>any correct Boolean algebra statement for B [1]<br>any correct NAND gate circuit ( ecf for incorrect expression) [1]<br>use of algebra to justify circuit [1]</td></tr>
<tr><td>3</td><td>c</td><td>iii</td><td> 
</td><td>4</td><td>correct circuit [1]<br>suitable resistor values for 5V [1]<br>0.7 V drop across diode, op-amp saturates at 13 V [1]<br>justification for values using voltage divider, op-amp behaviour and diode behaviour [1]</td></tr>
</table>

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 4 | a | | frequency modulation;<br>frequency of carrier/radio wave;<br>determined by voltage of signal; | 1<br>1<br>1 | <br><br>**not** amplitude |
| 4 | b | i | bandwidth of one station = 5x20 = 100 kHz;<br>available bandwidth = 107.9 -87.9 = 20 MHz;<br>maximum channels = 20 / 0.1 = 200 | 1<br>1<br>1 | 200 on its own =[1]<br><br>no ecf from incorrect bandwidth |
| 4 | b | ii | no overlap of signals from adjacent stations;<br>making it easier for receivers to tell them apart; | 1<br>1 | |
| 4 | c | i | more channels;<br>because AM bandwidth less than FM bandwidth; | 1<br>1 | |
| 4 | c | ii | more noise;<br>in demodulated signal;/ received signal<br>because limiters/Schmitt triggers can't be used; | 1<br>1<br>1 | Accept argument from FM perspective |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 5 | | |  | 7 | all clock connections in parallel to CK, Q to D [1]<br>right-hand Q to SO, left-hand D to +5V [1]<br>logic systems / multiplexers controlling S and R from PL and a/b/c [1]<br>SR = 00 when PL =0 [1]<br>SR = 10 when PL = 1 and a/b/c = 1 [1]<br>SR = 01 when PL = 1 and a/b/c = 0 [1]<br>S0 goes low when PL pulsed high [1]<br>If MUX used signals to D<br>R must be 0V[1]<br>S must be 0V[1]<br>0 into last stage [1]<br>MUX signal a/b/c/0; Q [1] |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 6 | a | i |  | 2 | rf amplifier [1]<br>(loud)speaker [1] |
| 6 | a | ii | (rf amplifier):<br>increases amplitude;<br>of modulated carrier;<br>(loudspeaker):<br>converts alternating signal into sound; | <br>1<br>1<br><br>1 | Just saying amplifier amplifies is insufficient |
| 6 | b | i |  | 5 | correct circuit ( ignore any input resistor)[1]<br>output and 0 V/earth labels [1]<br>$LC = 1.3\times10^{-14}$ s [1]<br>$C$ between 100 nF and 1 pF [1]<br>use of $f_o = \frac{1}{2\pi\sqrt{LC}}$ [1] |
| 6 | b | ii | aerial converts radio signals into alternating currents;<br>tuned circuit converts alternating current into voltage;<br>for a narrow range of frequencies;<br>at 1.4 MHz ± 5 kHz; | 1<br>1<br>1<br>1 | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 6 | c | |  | 8 | correct voltage follower [1]<br>correct volume control [1]<br>correct inverting amplifier circuit [1]<br>correct coupling capacitor [1]<br>*Rf* / *Rin* = 200 [1]<br>justified with $G=-\frac{R_f}{R_{in}}$ [1]<br>all resistor values between 1 kΩ and 10 MΩ [1]<br>*RinC* = 3.2x10$^{-3}$ s [1] |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 7 | a | i | use of summing amplifier formula;<br>X = 5 x (4/16) = - 1.25 V;<br>-(256/200) x -1.25 (= 1.6 V); | 1<br>1<br>1 | |
| 7 | a | ii | EITHER<br>calculation for DCBA = 0001;<br>OR<br>DCBA = 0100 is binary equivalent of 4<br>THEN<br>resolution = 0.4 V; | <br>1<br><br><br><br>1 | |
| 7 | a | iii | DCBA = 0000 gives 0 V;<br>DCBA = 1111 gives 15 x 0.4 = 6.0 V | 1<br>1 | |
| | b | i | how long it takes output to stabilise;<br>when word at input is changed; | 1<br>1 | Accept time taken to convert for [1] |
| | b | ii | need at least two samples per cycle;<br>so each cycle cannot be shorter than 40 µs;<br>maximum frequency = 1/40 x $10^{-6}$ (= 25 kHz); | 1<br>1<br>1 | <br>Accept correct argument from frequencies |
| | c | | allows a number of different signals to (simultaneously) pass down a single link;<br>by allowing each signal in turn on the link;<br>for many short time slots; | 1<br><br>1<br>1 | |

**APPENDIX 1**

**Quality of Written Communication**

| | |
|---|---|
| 3 | The candidate expresses complex ideas extremely clearly and fluently.<br>Sentences and paragraphs follow on from one another smoothly and logically.<br>Arguments are consistently relevant and well structured.<br>There will be few, if any, errors of grammar, punctuation and spelling. |
| 2 | The candidate expresses straightforward ideas clearly, if not always fluently.<br>Sentences and paragraphs may not always be well connected.<br>Arguments may sometimes stray from the point or be weakly presented.<br>There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas. |
| 1 | The candidate expresses simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts.<br>Arguments may be of doubtful relevance or obscurely presented.<br>Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas. |
| 0 | The language has no rewardable features. |

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